A MATHEMATICS FRAMEWORK APPROACH TO
INTEGRATING CALCULATORS INTO ELEMENTARY CLASSES

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ABSTRACT

A Mathematics Framework Approach to Integrating Calculators into Elementary Classes

The issue of raising the mathematical competency of students is an important one for mathematics educators. The implementation of calculators into mathematics classes, even at the elementary level, is one way for students to improve their performance in mathematics and increase the number of topics covered in each grade level. This position is advocated by the California State Department of Education and professional mathematics groups. Research, however, has tended to find that one drawback to integrating the calculator into elementary mathematics classes is a lack of materials and guides for teachers to use. As a result, a guide to aid teachers in implementing calculators into elementary mathematics classes was warranted.

Using a variety of sources, numerous calculator activities were collected. Student worksheets and teacher instructions were developed. Then the activities were sorted by mathematical strands according to the California Mathematics Framework and by grade levels. These guides were then distributed to teachers who had courses in mathematics beyond the undergraduate level.
The teachers critiqued the format and content of the guide on a questionnaire. The percentage response for each question was found, and the mean score was calculated for the questions on the format and content.

Overall, the teachers rated the guide highly, regardless of how much they used a calculator in their classrooms. Most teachers indicated the materials would be useful in their curriculum, except some who had below average students. Lack of availability of calculators was noted by a few teachers who said the activities would not be useful in their classes.

The results indicate the majority of the teachers would use the guide if they had calculators and if the activities were appropriate for the level of their students. Recommendations were given to address these issues.
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Approved: Date:

[Signatures and dates]
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CHAPTER 1

THE PROBLEM

Problem Statement

In international studies of mathematics achievement, the United States has ranked very poorly in almost all areas of mathematics. The issue of raising the mathematical competency of students in this country is a significant one for all mathematics educators. The use of calculators in elementary mathematics classes may significantly increase the competency levels of students in the computation, application, and understanding of mathematics, as well as allow for the introduction of mathematical concepts at much earlier grade levels than previously taught.

In 1980, the National Council of Teachers of Mathematics recommended that "mathematics programs must take full advantage of the power of calculators and computers at all levels." In addition, the 1985 California Mathematics Framework emphasizes the incorporation of calculators into mathematics programs from the primary grades on. These statements strongly proclaim the need for calculators to be an integral part of the mathematics curriculum. Proponents of calculators claim that they
allow students to complete more complicated mathematics problems, spend less time on computational drills, learn the basic concepts of mathematics better, and prepare for their participation in an ever increasing technological society in which the calculator is one of the most common forms of technology. Therefore, teachers of primary grade students need to begin integrating calculators into appropriate phases of their mathematics classes to take full advantage of the calculator as a powerful tool in mathematics education.

Since the calculator is an accessible tool for all students, there is a need to investigate the application of it into the mathematics program to benefit from its power. The intent of this study is to assess the areas of primary mathematics programs in which a calculator is found to be an asset and collect specific activities for a calculator resource guide for teachers for the implementation of the calculator into routine mathematics instruction.

**Background of the Problem**

Parents, teachers, and principals are concerned about the integration of calculators into the mathematics curriculum. They ask, "But won't the children decline in their paper and pencil computational abilities?" Research over the past ten years has strongly answered,
"No!" In fact, in many studies, computational skills appeared to be strengthened with the use of calculators.

However, the push to use calculators is not only based on the desire to increase computational skills. Calculators are seen as a way to increase problem-solving abilities by allowing students to concentrate on how to solve the problems rather than on doing the computation involved. Problems that may normally be beyond a student's capabilities tend to be more manageable using a calculator. Calculators also permit the exploration of new concepts and discovery of patterns and rules that otherwise may not be possible. In addition, the enthusiasm and motivation toward mathematics of students who have use of calculators have been rated highly.

While many positive outcomes on the use of calculators have been indicated by studies, many teachers have little knowledge of these outcomes nor are many aware of the current recommendations of the state of California and professional mathematics organizations that the calculator be an integral part of the mathematics program, even at the elementary level. Therefore, a summary of the benefits of calculator use as well as an update of the recommendations of the state and prominent mathematical groups is warranted. Moreover,
many teachers are unaware of when and how to use calculators properly. Since many textbooks do not yet reflect the importance of calculators, a resource guide on the integration of calculators into the mathematics curriculum, particularly at the elementary school level, needs to be developed so teachers will be able to achieve the maximum benefits of this relatively new educational tool.

**Definition of Terms**

**Algorithm** - a set of rules for solving a problem in a finite number of steps.

**Applications** - the act of applying or putting to use.

**Concepts** - an idea of something formed by mentally combining all of its characteristics or particulars.

**Guess and Check** - a problem solving strategy which "often provides a starting point that gives inspiration that leads to more efficient plans" (Wheeler, 1984, p.26) to find an answer.

**Place Value** - a numeration system has place value if the placement of the symbols in a numeral determines the power of a base by which the value of the symbol is multiplied to determine the value of the number.

**Problem Solving** - applying previously acquired knowledge to new and unfamiliar situations.
Delimitations

The activities to be gathered for the calculator guide will come from a variety of sources. However, none of the activities collected will be trial tested for their effectiveness in the classroom, nor will any data on their effectiveness be researched or tabulated.

In addition, to use the guide properly, it will be necessary for there to be at least one calculator for every two children in a class. This will permit the activities to be accomplished more efficiently and meaningfully for the children, rather than just seeing a teacher use a calculator on an overhead projector or waiting too many turns to try an activity.
CHAPTER 2

Review of the Literature

Introduction

This review of the literature considers discussions on student achievement, on student attitudes, on teacher attitudes, and on state guidelines and recommendations of professional mathematics organizations. These sections will reveal benefits of calculator use in the classroom as well as reasons why the calculator is not widely utilized in elementary mathematics classes currently. In particular, contributions from literature on student achievement are noted from Hembree (1986), Suydam (1982), C. Wheatley (1980), and Wheatley et al. (1979). The discussion of student attitudes is illustrated primarily by the work of Reys and Reys (1987), Zakariya, McClung, and Winner (1980), and Wheatley et al. (1979). The presentation on teacher attitudes is developed from the work of Reys et al. (1980), and Wyatt et al. (1979). Lastly, the discussion on state and professional guidelines and recommendations centers on the 1985 California Mathematics Framework, the California Mathematics Model Curriculum Guide for Grades Kindergarten Through Grade Eight, and the position
statements of the National Council of Teachers of Mathematics.

**Student Achievement**

Virtually all studies have indicated that the use of calculators either improves or maintains the computational skills of students who use them as compared with control groups who only use paper and pencil to do computing (Hembree, 1986; Standifer and Maples, 1981; Vannatta and Hutton, 1980; Wheatley et al., 1979). Suydam (1982) did a review of 75 studies on calculator use in the classroom and found that in 35 percent of the studies, students who used calculators had higher achievement scores than control groups, and 44 percent of them showed no significant difference between groups. Only 3 percent of the studies indicated lower scores by the calculator group. Concurring with these findings is the work of Wheatley and Shumway (1979, Moursand) who reported no measurable detrimental effects for students in grades two through six when they used calculators for learning mathematics. Szetela's study (1981, in McNicol et al., 1985) on calculator use in grades three through eight had similar conclusions. He found no negative effects on computational work when using calculators. The Second Mathematics Assessment (1977) by the National Association for Educational
Progress (NAEP) found that children using calculators had an advantage over those who didn't have calculators when doing regular algorithmic problems. This finding is critical when compared with the time spent on teaching routine algorithms and the rate of retention and effective use of these algorithms. Wheatley (1980) calculated that two out of the first nine years of mathematics education is spent on teaching the division algorithm alone, 40 percent of which tends to be in the fifth grade. However, the Second Mathematics Assessment results indicated most students have not mastered the algorithm by the age of thirteen. Without a calculator, only 46 percent of the thirteen year-olds could solve a division problem with a two digit divisor, and the percentage of students able to do such a problem accurately did not increase significantly in the seventeen year old group tested (Carpenter et al., 1981). These results indicate a low performance level for a skill on which a significant portion of a student's mathematics time is spent learning. However, when a calculator was used, it aided all students tested, in the nine, thirteen, and seventeen year old age groups, in completing problems involving the four basic algorithms.

Other studies have indicated the advantage of
calculator use in specific areas with children. In a 1979 report, Mason (in Moursand, 1979) found that third graders had an advantage with division problems when using a calculator. A study by Moser (1979) concurred with Mason's finding, and he also concluded that third grade students using calculators had significant gains in work on place value over students not using calculators. In addition, he found second graders using a calculator did significantly better than non-calculator users with subtraction problems up to three digits. Although Hembree (1986) reported that all grades, except fourth, showed no harm from using calculators, Duffy and Thompson (1980) stated that when fourth graders were able to use calculators they performed at criterion level for decimal computation but not when using paper and pencil. In addition, one fourth grade teacher, after using calculators with her students for a semester, observed that her pupils were able to do a number of mathematics activities that would not have been possible using just paper and pencil. These included converting fractions to decimals and using the four basic operations to solve problems involving negative numbers and decimals. In addition, Channel's research (1980, in Reys, November, 1980) tended to support the use of calculators to enhance the learning of basic mathematics
facts.

With time saved by the decrease of time spent on just computational work, more application and problem solving work can be emphasized. Calculators are beneficial in this area as well since they permit the concentration of effort to be on the process of doing problems and decrease the amount of energy and fear involved in the algorithmic portion of problems (Zakariya, McClung and Winner, 1980). Since children are able to solve more problems correctly with the aid of calculators, they will, as a result, become better problem solvers since "problem solving skill is directly related to the number of problems solved correctly." (Duea et al., p.117, NCTM Yearbook, 1980). One report (Wheatley and Wheatley, 1982) concluded that it took significantly less time to solve problems with calculator usage. C. Wheatley's study (1980) on fifth graders found them able to solve 10 percent more problems daily using the calculator. One researcher, however, found the rate of completion on problems solving subtests lower for fourth and eighth grade students using calculators (Rabe, 1981).

Another advantage of the calculator in problem solving is that it increases the students' opportunities to try various problem solving approaches, such as guess
and check. The number of guesses a student can make is increased through the use of a calculator, and, thus, he should eventually improve his guessing ability. The emphasis on problem solving and applications is more desirable than the emphasis on computation since it reflects real-world situations to a greater degree. Calculators make it easier to solve consumer problems without causing students to get distracted by calculating large or "messy" numbers. Indeed, Wheatley (1980) found that by eliminating the execution part of problem solving by using calculators, the problem solving ability of children increased.

A number of studies has focused on the problem solving abilities of specific age groups that have used calculators. C. Wheatley (1980), in a study of fifth graders on calculator use and problem solving, reported many benefits. The interview team stated that calculator users spent more time attacking problems and exhibited more exploratory behavior. The students' teachers remarked that the students who were weak in their knowledge of basic facts were more successful problem solvers as a result of being able to use calculators. Wheatley also noted that calculator users estimated, checked conditions, and retraced steps in problems more often than non-calculator users. One fourth grade teacher
found that her students were more able to reason logically to solve multi-step story problems involving whole numbers, fractions, or both (Meyer, 1980). Brey's work (1980, in Suydam, 1981) supports Meyer's observations, as long as the problems are within the paper and pencil computational ability of the students. In a study of students in grades three, five, and seven, calculator use didn't make a difference in choosing a correct operation to solve a problem, but it helped them to compute better once an operation was chosen (Szetela, 1982).

Many positive effects in one study were noted in third graders who used calculators to solve problems. Calculator use facilitated the development of choosing correct operations in multi-step problems, restating problems with irrelevant information, organizing information in lists, and planning strategies (McNicol and LeMaistre, 1981). A few studies indicated no significant effects on problem solving when using a calculator. Stewart (1981, in Suydam, 1981) indicated this in a study with students in grades three through eight. Overall, however, research to date seems to be supportive of calculator use in the elementary school for improving problem solving ability.

Children can also explore new concepts with
the calculator, not just use them as a reinforcement of concepts already learned (Suydam, 1979, in Reys, Nov., 1980). Using a calculator, students can try many examples of a concept which makes it easier for them to generalize properties. Through discovery lessons, children find their own patterns and generate their own rules and conclusions which aid in the retention of learning. Indeed, Suydam (1979, in Reys, 1980) reports that "no research exists to support the claim that concepts must be developed prior to calculator use (p.40)." For example, Moser (1979) in a report to NCTM, stated that second and third graders who used a calculator had a definite advantage with learning topics such as place value.

Calculator use should particularly benefit the low achieving students or the students who have difficulty memorizing basic facts. If they are allowed to use the calculator to solve computational work, then the students are not prohibited from entering classes where advanced concepts and applications are introduced. Prior to the calculator age, many students were not permitted to enter advanced mathematics classes or learn concepts until they had mastered computational work in the four basic operations.
Student Attitudes

Another important aspect of calculator use is the intangible benefits, such as increased enthusiasm and motivation toward mathematics. Numerous studies, even those indicating minimal gains using calculators, tended to cite increases in the excitement children had towards mathematics (Reys and Reys, 1987; Zakariya, McClung and Winner, 1980; Wheatley et al., 1979). By eliminating tedious and unnecessary computational work, a child's interest in mathematics seems to increase. The children in one study were more motivated to solve problems using calculators (C. Wheatley, 1980). Other behaviors exhibited as a result of using calculators were greater persistence when working on mathematics problems and more time spent on tasks. A more positive attitude was cited in numerous studies (Wheatley and Shumway, 1979; Moursand, 1979; Anderson, 1977, in Parkhurst, 1979; Nelson, 1976, in Rabes, 1981). Interestingly, in her Fifth Annual State-of-the-Art Review on the Use of Calculators in Pre-college Education, Suydam (1982) summarized thirty-six studies on student attitudes. Only six studies indicated an improved attitude while the others reported no significant difference. A possible reason for these results may be that most of the studies were short term
Self-concept about mathematics appeared better (Yvon, 1987; Hembree, 1986) since the calculator made problems more manageable for students, particularly low achieving ones. Second and third graders increased their levels of confidence in mathematics in one study (Moser, 1979), and another showed significant gains in levels of confidence in the mathematics achievement of sixth graders (Jones, 1976, in McNicol et al., 1982). One reason for these changes may be that errors are no longer an issue with calculators. Since errors can be erased instantaneously, children may not feel inhibited since there is no record of incorrect answers. In addition, students were more likely to try different solutions to problems when they had access to a calculator (Reys and Reys, 1987; Brey, 1980, in Suydam, 1981; Sutherlin, 1977, in Rabes, 1981), and in general, children expressed a greater desire to pursue problems (Wyatt et al., 1979).

Teacher Attitudes

Professional educational organizations such as the NCTM and California State Department of Education, clearly advocate the integration of the calculator into the mathematics curriculum. It will not become a reality, however, until teachers, who are the people directly
responsible for the success or failure of the implementation of the calculator into mathematics classes, are informed of the purposes and benefits of its use and know how to utilize its power most efficiently. Scott (1983) reported that only 6.3 percent of the teachers surveyed reported using the calculator more than five times a year, although reported use is generally higher than actual use. Other studies also indicate a low percentage of use of calculators. The Second Mathematics Assessment in 1977 stated that while 75 percent of the nine year-olds had access to calculators, less than 20 percent of classroom teachers use them. Szetela (1982) indicated that while 84 percent of the teachers agreed that calculators should be used in school, only 35 percent said they had used them in class. Another study found a higher rate of use by teachers in grades four through six at 47 percent to a lower rate of 7 percent by teachers in grades three and lower (Campbell and Virgin, 1976).

Numerous studies have focused exclusively or in part on teachers' attitudes towards calculators. A large percentage of teachers convey that they don't use calculators because of the adverse effects they believe calculators will have on children's learning of mathematics facts and concepts. In one survey of
teachers in ten Missouri school districts, 43 percent of those responding believed the children would lose the ability to compute with paper and pencil or to remember mathematics facts (Wyatt et al., 1979). The percentage of teachers believing the calculator detracted from learning basic facts was even higher in a Canadian survey (Campbell and Virgin, 1976). In that study, 62 percent of the teachers of fourth grade believed that calculators detracted a great deal or quite often from fact learning. At the fifth and sixth grade levels, the percentages dropped to 42 percent and 45 percent respectively, a relatively high rate considering the amount of research that indicates what actually happens. In the same survey, 61 percent of those polled felt the children should have a high level of computational proficiency before the calculator was introduced to them. A common fear voiced by teachers as well is that students will become dependent on calculators, but, again, no evidence is available to support that contention (Bell, 1976). Other concerns include calculators don't lend themselves to helping cover content material, no adequate guides on how integrate them properly, and lack of training in how to use them (Graeber, et al., 1977).

Another reason for such low use might result
from lack of school or district support. In one study, when teachers were asked about school policy and support on calculator use, responses varied from the school prohibiting their use to not knowing if there was a policy. In actuality, there were no written policies at any school at any level of administration regarding the use of calculators in the classroom (Reys et al., 1980). If administration was more supportive, more teachers would probably use the calculator. The majority of teachers, especially teachers with more years of experience, expressed a desire to learn ways to use calculators in their classes, but only a small percentage had ever attended any workshops on the topic (Reys et al., 1980).

Although research has demonstrated the effectiveness of calculators in a variety of areas in mathematics, most teachers tended to see it as a computational device and a checking device for the paper-and-pencil computations (Hembree and Dessart, 1986; Ogletree and Etlinger, 1980; Suydam, 1981; Wyatt et al., 1979; Graeber, 1977). Interestingly, about 50 percent of the teachers surveyed by the National Advisory Committee on Mathematics Education (NACOME) (Graeber, et al., 1977) agreed with suggestions that the calculator be used to encourage students to be inquisitive and
creative, to become wiser consumers, to develop understanding of computational algorithms, and to formulate generalizations from patterns. This lack of use considering the multitude of ways a calculator can be beneficial indicates that teachers may need guidance in implementing the calculator successfully into their classes.

Most teachers who used calculators with their classes tended to be very positive about the benefits of calculator use, not only for the children but for themselves. Some teachers found they covered more topics with the calculator (Reys et al., 1980), others indicated it aided in diagnosing problems (Davies, 1980; Palmer, 1978; Bell, 1976), and a number stated that it helps them prepare the children for the age of technology in which they live (Palmer, 1978). Benefits that teachers saw for the children were positive attitude change about mathematics (Reys et al., 1980) and a way to motivate them (Campbell and Virgin, 1976). Still other teachers, when surveyed, expressed that calculators can be used for discovering concepts, exploring patterns, helping with problem solving, and encouraging estimation and approximation (Krulik, 1980; Etlinger and Ogletree, 1977).

To make calculator integration into the classroom
most efficient two areas of need become apparent. One is that teachers need training in why the calculator is useful and how to use it (Etlinger and Ogletree, 1977). Studies have produced evidence that inservice training teachers significantly improves the attitudes of teachers toward the use of calculators (Suydam, 1982; Hutton, 1980; Bitter, 1980). The other need is that teachers need guidelines and curriculum materials developed exclusively for calculators to fully utilize the calculator's benefits (Reys and Reys, 1987; Williams, 1987; Hembree and Dessart, 1986; Ogletree and Etlinger, 1980; Suydam, 1980; Palmer, 1978; Etlinger and Ogletree, 1977.)

Professional Committees and Organizations

The 1985 California Mathematics Framework was written to aid districts in developing their programs in mathematics in the areas of curriculum, teacher training, and use of instructional materials and tests. In the curriculum section it outlines the emphases that California schools should consider in their mathematics programs. This latest framework reflects the changes in mathematics, particularly in the area of technology. The need for mathematics programs to include the important aspects of technology, including uses and understanding as it relates to everyday life, is clearly
stated.

Calculator technology is one such emphasis in the Framework. The advantages of incorporating this inexpensive form of technology is that "Calculators decrease the time students must spend on computation and increase the time they can spend on the important aspects of problem-solving: for formulating questions, devising and evaluating strategies, and verifying and interpreting solutions." (California Mathematics Framework, 1985, p.3)

In addition, the Framework states the calculator allows for the use of larger numbers in work and permits slower students to complete work in assigned time limits.

The integration of calculators, the Framework indicates, should begin in the primary grades. However, the Framework stresses that the understanding "of arithmetic operations and the common algorithms used to perform those computations" (p.3) must be developed by each student; the calculator should not be used as a replacement for understanding. In addition, children should learn when calculators are appropriate and when another method may be more efficient in solving a problem.

In 1987, the California State Department of Education released a Mathematics Model Curriculum Guide for Kindergarten Through Grade Eight. The guide explicitly states that "the impact of technology and
its implications for mathematics education can no longer be ignored" (p.9). Specifically, it says that the integration of the calculator into mathematics classes from the primary grades on is one characteristic of a high quality mathematics curriculum. Initially, the curriculum guide suggests use of the calculator for exploratory purposes, but as a student moves through the grades, the calculator is seen as a device to be used with all work in mathematics in the classroom, at home, and on tests.

The National Council of Teachers of Mathematics (NCTM) has issued position statements recommending the integration of calculators into mathematics programs since the early 1970s. The organization believes calculators free time by decreasing the amount of time spent on calculations and suggests using the extra time "to understand mathematics, to develop reasoning and problem solving strategies, and, in general, to use and apply mathematics" (NCTM Position Statement, 1986). It recommends that students at every level use the calculator and that publishers and authors include material specifically designed for calculators in texts and workbooks.

The National Institute of Education (NIE) and the National Science Foundation (NSF) sponsored the
Conference on the Uses of Hand-Held Calculators in Education in 1976. This conference produced twenty-two recommendations for effective implementation of the calculator into the curriculum. Curriculum development for the Immediate Future and Curriculum Development for the Long-Range Future were two of six major categories into which the recommendations were divided. These two categories specifically stated the need to develop materials and alternatives to existing mathematics programs to test and to expand the range of ideas taught currently with a calculator (Werner, 1980).

As early as 1975, NSF reports recommended some major changes in the emphasis of mathematics programs as the result of calculators. One was that the focus of mathematics programs should be on the process since the results are assured (NCTM Yearbook, 1977). Conceptual development, applications of operations, and real-life problem-solving were stressed, while tedious, complicated algorithms and fractions were de-emphasized. In addition, it was suggested that place value, decimals, number theory, statistics, probability, large numbers, and negative numbers be dealt with more and earlier in mathematics programs as a result of the integration of the calculator into the mathematics curriculum.
Summary

Research supports the advantages of calculators in both the cognitive and affective domains. As professional groups suggest, it is vital for children to use calculators routinely as part of their mathematics program from kindergarten through high school. Doing so would most likely increase the knowledge and understanding children have for mathematics and increase the desire to participate more eagerly in mathematics-related activities.

A current drawback to the implementation of the calculator into the curriculum appears to be the lack of materials available for teachers to use to effectively incorporate it into daily classwork. Consequently, a guide comprised of a range of activities involving calculators and how to integrate them into mathematics lessons needs to be developed, particularly for the elementary grades when they are first introduced into the curriculum.
CHAPTER 3
Methodology

Introduction

This discussion on the methodology of this study includes presentations on the methodological focus and the background of the researcher.

The intent of the study was two-fold. One portion included the development and collection of calculator activities in conjunction with regular mathematics topics. The second portion considered the presentation of these activities so they were readily understandable to teachers and usable in elementary mathematics classes. This involved teachers of grades three through six assessing the guide's content and format.

Methodological Focus

Initially, all activities related to calculator use in the classroom were collected from various sources, including books and articles. Sources used included the works of Coburn (1987), Billstein, Libeskind, and Lott (1981), and Miller, (1979). It is during the grades three through six that the Framework suggests the regular use of calculators. Therefore, the activities selected for use in the
calculator guide are appropriate for these grades.

The activities were then categorized by grades into the mathematical strands of number, measurement, geometry, patterns and functions, statistics and probability, logic, and algebra as indicated by the 1975 California Mathematics Framework. The activities are classified according to the Framework because the Framework is a document written by the State of California which recommends specific changes in the manner in which mathematics is taught. Since it is a state document, most schools and districts will be using these recommendations to update their mathematics curriculum. Therefore, it will be easier for teachers to use a calculator guide that parallels the structure of the Framework.

Once the activities were categorized, each was presented in a step-by-step method which included purpose, a list of materials needed, introduction, and the steps necessary to complete it. In addition, extensions of each activity were given, if possible, as well as a cross-reference to the usefulness of it to another grade level or strand.

Then, each strand of activities, ordered by grade levels, was collated into a reference guide for teachers to use.
Finally, the compiled guide was distributed to twenty-three teachers of grades three through six from public and private schools in Alameda County, California. The teachers selected have had coursework and training in mathematics beyond work completed in their teacher preparation programs.

The teachers then reviewed the guide and critiqued its content and format using a questionnaire. The responses to questions 1-14 are tabulated according to responses for each grade level and to total group responses by percentages. A table which displays the measure of central tendency using the mean summarizes the responses to questions 6-14, which specifically pertain to the content and format of the guide. The results are given for each grade level and for the total group. Finally, for questions 15-17, the open-ended questions, some answers that directly relate to specific questions are listed as well as responses pertaining to overall reactions to the guide.

Background of the Researcher

The researcher has had six years teaching experience as a third-grade teacher in self-contained classes at private schools. For two of those years she served as an after-school computer teacher for students in grades one through five. Previously, she was a
consultant at a learning disabilities clinic in the East Bay for one-and-a-half years.

At the learning disabilities clinic the director placed an emphasis on technology to aid students' learning, including the use of calculators and especially with students who had difficulty mastering the basic facts in mathematics and were therefore excluded from advancement in mathematics classes. It was there that the researcher first became aware of the implications of the calculator as a tool in the classroom. Subsequently, through coursework for her Master's degree in mathematics curriculum, the researcher studied the poor results of U.S. students in international studies of mathematics achievement as compared with other countries. She became familiar with further benefits of using a calculator in mathematics classes and how it could aid in increasing students' mathematics achievement. In the classroom she currently uses calculators to extend, enrich, and introduce concepts in mathematics.

The researcher has a Bachelor of Science degree from the State University College at Buffalo, N.Y. in Special Education-Learning and Behavioral Disorders and Elementary Education. She currently holds a Multiple Subject teaching credential in the state of California.
CHAPTER 4

Presentation and Analysis of Data

Introduction

The data of this research methodology are presented and analyzed in this chapter in preparation for drawing implications for the research problem, and, thus, for elementary classroom mathematics instruction. The survey research conducted yields data from within the parameters of this methodology.

In particular, the survey yields data from the total group questioned as well as specific grades in the elementary school. The data are analyzed using the percentage response of each question and the mean response of the questions on the format and content of the guide. Various answers to the open-ended questions are presented, too.

Presentation of the Data

Of the 23 questionnaires distributed, 22 were returned. Of the respondents, 68% were public school teachers and 32% were private school teachers. In the total group, there were five teachers responding in grades 3 and 6. There were six teachers each from grades
4 and 5 who completed the survey. While over half of the teachers reported that mathematics was their favorite subject to teach and almost two-thirds indicated they had taken a workshop on the use of calculators, 45% replied they never used a calculator and 36% used it in their classrooms only one day a week. Specifically, 100% of the teachers in grades 3 and 4 noted they never used a calculator or used it one day a week. See Tables 1-5 for more detailed results of the background of the teachers and their use of calculators.

Overall, the majority of the teachers fully agreed the activities presented could be used as a part of their curriculum, except at the third grade level, where only 40% fully agreed. In addition, most felt the objectives for the lessons were clearly stated. Excluding the sixth grade, almost 100% of the teachers found the introduction and background for the lessons useful and clear, since they chose a 5 or 4. Of the sixth grade teachers who used the rating scale to respond, however, 100% of those fully agreed the introduction and background were useful and clear.

For questions 9 through 14, the responses are more varied. While 100% of the teachers of grades 3 through 5 ranked the teacher instructions 5 or 4, only 40% of
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<td>2 - Type of School?</td>
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<td>9 - Teacher instructions clear/useful?</td>
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<td>10 - Student sheets clear/easy?</td>
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TABLE 1 (Continued)

11. - Activities age appropriate?

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12. - Time frame appropriate?

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13. - Objectives attainable?

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14. - Extensions/Cross references helpful?

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Percentages are rounded so the total percentage for each question may not equal 100%.
TABLE 2

Grade 3 Responses by Percentages
Number Responded = 5
(5 = full agreement, 1 = disagreement)

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<th>Question</th>
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<th>60%</th>
<th>40%</th>
<th>20%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - Type of School?</td>
<td>Public</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - Math favorite subject to teach?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - Days use a calculator?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - Attended a workshop?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 - Use Activities?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - Objectives clear?</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>8 - Intro useful/clear?</td>
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<td></td>
</tr>
<tr>
<td>9 - Teacher instructions clear/useful?</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10 - Student sheets clear/easy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.- Activities age appropriate?</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 - Objectives attainable?</td>
<td>40% 5 40% 4 0% 3 20% 2 0% 1 0% other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 - Extensions/Cross references helpful?</td>
<td>40% 5 20% 4 20% 3 0% 2 20% 1 0% other</td>
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Percentages are rounded so the total percentage for each question may not equal 100%.
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<th>% Other</th>
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<td>0%</td>
</tr>
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<td>4 - Days use a calculator?</td>
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<td>5 - Attended a workshop?</td>
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<tr>
<td>6 - Use Activities?</td>
<td>67%</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>7 - Objectives clear?</td>
<td>67%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>8 - Intro useful/clear?</td>
<td>83%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>9 - Teacher instructions clear/useful?</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>10 - Student sheets clear/easy?</td>
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<tr>
<td>11 - Activities age appropriate?</td>
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### TABLE 3 (Continued)

12 - Time frame appropriate?

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<th>0%</th>
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<th>17% other</th>
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</table>

13 - Objectives attainable?

<table>
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<th>0%</th>
<th>1%</th>
<th>0% other</th>
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</table>

14 - Extensions/Cross references helpful?

|       | 50% | 5% | 33% | 4% | 17% | 3% | 0% | 2% | 0% | 1% | 0% other |

Percentages are rounded so the total percentage for each question may not equal 100%.
TABLE 4

Grade 5 Responses By Percentages
Number Responded = 6
(5 = full agreement, 1 = disagreement)

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<td></td>
</tr>
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<td>3 - Math favorite subject to teach?</td>
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<td>2%</td>
<td>0%</td>
<td>1%</td>
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<td>4 - Days use a calculator?</td>
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<td>17%</td>
<td>2-3 days</td>
<td>17%</td>
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<tr>
<td>5 - Attended a workshop?</td>
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<td>17%</td>
<td>no</td>
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<td></td>
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<td>6 - Use Activities?</td>
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<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>7 - Objectives clear?</td>
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<td>17%</td>
<td>4%</td>
<td>0%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>8 - Intro useful/clear?</td>
<td>50%</td>
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<td>3%</td>
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<tr>
<td>9 - Teacher instructions clear/useful?</td>
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<td>3%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>10 - Student sheets clear/easy?</td>
<td>50%</td>
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<td>0%</td>
<td>3%</td>
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Percentages are rounded so the total percentage for each question may not equal 100%.
TABLE 5

Grade 6 Responses By Percentages
Number Responded = 5
(5 = full agreement, 1 = disagreement)

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<td>2 - Type of School?</td>
<td>60% Public 40% Private</td>
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<tr>
<td>3 - Math favorite subject to teach?</td>
<td>60% 5 40% 4 0% 3 0% 2 0% 1</td>
</tr>
<tr>
<td>4 - Days use a calculator?</td>
<td>20% 0 40% 1 days 20% 2-3 days 20% 4-5 days</td>
</tr>
<tr>
<td>5 - Attended a workshop?</td>
<td>60% yes 40% no</td>
</tr>
<tr>
<td>6 - Use Activities?</td>
<td>80% 5 0% 4 0% 3 0% 2 0% 1 20% other</td>
</tr>
<tr>
<td>7 - Objectives clear?</td>
<td>80% 5 20% 4 0% 3 0% 2 0% 1 0% other</td>
</tr>
<tr>
<td>8 - Intro useful/clear?</td>
<td>60% 5 0% 4 0% 3 0% 2 0% 1 40% other</td>
</tr>
<tr>
<td>9 - Teacher instructions clear/useful?</td>
<td>40% 5 0% 4 20% 3 20% 2 0% 1 20% other</td>
</tr>
<tr>
<td>10 - Student sheets clear/easy?</td>
<td>20% 5 20% 4 40% 3 0% 2 0% 1 20% other</td>
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<tr>
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<td>60% 5 0% 4 20% 3 0% 2 0% 1 20% other</td>
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TABLE 5 (Continued)

12 - Time frame appropriate?

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13 - Objectives attainable?

<table>
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<th>2%</th>
<th>0%</th>
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14 - Extensions/Cross references helpful?

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<th>2%</th>
<th>0%</th>
<th>1%</th>
<th>20% other</th>
</tr>
</thead>
</table>

Percentages are rounded so the total percentage for each question may not equal 100%.
the sixth grade teachers did. All grade 4 and 5 teachers gave very high rankings to the student worksheets for each lesson compared to third and fourth grade teachers, who had mixed reactions. In all, most teachers indicated the activities were appropriate for the age group indicated, yet at the third grade, a few teachers indicated responses of three or lower on a scale of 1-5. Although it was not required the activities be tried with the students, several teachers chose to do so to determine if the time frame listed was appropriate. Others made a professional estimate on the length of time it would take to complete a lesson. Of those using the ranking scale, 17 fully agreed or almost fully agreed the time frame would be feasible. At every grade level, over three fourths of the teachers felt the objectives could be met and chose a ranking of 4 or 5. Finally, while the extensions and cross-references were found to be highly ranked by the teachers in grades 4 through 6, teachers of grade 3 had a variety of responses, one of which showed disagreement on the usefulness of that section of the lesson plans. See Tables 1 through 5 for exact percentages for each question.

Overall, the mean responses for questions 6 through 14 were over four. The scores went from a 4.95 on the question concerning the clarity of the objectives to
a 4.09 on the age appropriateness of the activities. For each question, the grade 4 and 5 mean responses were 4.0 or higher. At grade 3, the mean scores were lower for the usefulness of the activities, the age appropriateness of the activities, the appropriateness of the given time frame, and the helpfulness of the extensions and cross-references, each receiving a mean score of 3.8, 3.4, 3.6, and 3.6, respectively. While the mean response of sixth grade teachers was 3.75 for both the clarity of the teacher instructions and student worksheets, a score of 5 was given to the usefulness of the activities in the curriculum and to the usefulness and clarity of the introduction and background for the lessons. See Table 6 for the mean responses of the total group and for each grade level.

On question 15, which asked what part of the booklet was especially well written, several teachers noted specific lesson plans were well presented, such as Discovering Pi and Multiplying by Powers of 10. A number noted that the worksheets for the students were clear or that certain parts of the procedure page were well presented. One teacher said all of the booklet was well presented "if you have an average or above average class."
### TABLE 6

Mean Response for Questions 6-14 of Total Group and Grades 3, 4, 5, and 6*

(5 = full agreement, 1 = disagreement)

<table>
<thead>
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<td>6 - Use Activities?</td>
<td>4.4</td>
<td>3.8</td>
<td>4.5</td>
<td>4.5</td>
<td>5</td>
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<td>4.95</td>
<td>4.8</td>
<td>4.67</td>
<td>4.83</td>
<td>4.8</td>
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<td>8 - Intro useful/clear?</td>
<td>4.65</td>
<td>4.4</td>
<td>4.83</td>
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<td>5</td>
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<td>9 - Teacher instructions clear/useful?</td>
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<td>4.4</td>
<td>4.5</td>
<td>4.5</td>
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<td>3.4</td>
<td>4.17</td>
<td>4.33</td>
<td>4.5</td>
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<td>12 - Time frame appropriate?</td>
<td>4.10</td>
<td>3.6</td>
<td>4.0</td>
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<td>13 - Objectives attainable?</td>
<td>4.29</td>
<td>4.0</td>
<td>4.0</td>
<td>4.5</td>
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<td>14 - Extensions/Cross references helpful?</td>
<td>4.24</td>
<td>3.6</td>
<td>4.33</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

* Other responses not included in mean score.
Most teachers gave ideas on how to improve the booklet for question 16. One stated the students needed more workspace to complete the activities. A few indicated they wanted to see examples given on each page and that answers would help the teacher, too. One teacher noted the activities seemed more appropriate for small groups rather than large groups and would like activities for larger classes. A couple suggested adding illustrations to the worksheets for motivation. Another thought overhead calculator use for the lessons would be useful, especially in classrooms where not every student has a calculator. Two teachers in particular felt that on the activities on measurement, the units used should be metric.

Several teachers gave general comments or suggestions about the booklet. One teacher was very surprised by results of some activities she tried with her students. "At first I thought that this was going to be too difficult for fifth grade but it wasn't." Another said that the plans were well organized but she recommended correlating more activities to real-life situations. Readability, one suggested, would be improved by better spacing and larger type. A few stated they would definitely use these activities, if they already had not, with their students. Lower functioning students,
two teachers in particular stated, would not be able to do the lessons or would need to have the lessons simplified to do them.

Analysis of Data

Several of the teachers who ranked the usefulness of the activities in their curriculum 4 or less, indicated it was because they either didn't have access to any calculators or to a full set. One teacher noted, "Everything brought to my class and not watched or locked up (I have no place to lock things) is stolen!"

Concerning clarity of the lessons, one teacher stated she would give a higher ranking if she were sure the teachers using the lessons had taken a workshop in calculator use, and she indicated the same response on the clarity of teacher instruction, too.

Two teachers specifically noted why they gave a ranking of 3 for the clarity and ease of use for student worksheets. One said a student example on each page would help, while the other felt more room was needed for responses and that graphics could be added. The age appropriateness question prompted several teachers to give reasons for their answers. A fifth grade teacher stated the activities might be more useful for a fifth/sixth grade level because of some difficult formulas needed to solve the problems. Another said
that since she taught the "average" student some of the exercises would be "harder or more taxing" than others for her sixth graders. A fourth grade teacher agreed that the activities would be a challenge for some.

Finally, the question on the time frame given evoked specific responses, too. One teacher who indicated calculators get stolen in her classroom, felt the time frame would be appropriate if she had calculators and average or above students. The size of the class, a sixth grade teacher wrote, would affect how quickly the lesson was completed. It depended "on whether I'm working with my 31 students -- or someone else's 24 students." She did add, though, that she was flexible with time frames anyway.

Summary

The data collected on teacher background shows that most teachers, while they enjoy teaching mathematics and have attended a workshop on calculator use, do not use or infrequently use calculators as a part of their curriculum. Despite this fact, the majority of the teachers had positive reactions to the calculator guide.

On every question concerning the format and content of the guide, over three fourths of the total group fully agreed or almost fully agreed with the statements,
although on specific questions in grades 3 and 6, the responses were not as high on the average. Several teachers noted especially well done lessons or portions of the lessons, and some suggested using graphics on student worksheets and changing some activities for the average and/or below average students.
CHAPTER 5
Summary and Implications

Introduction
This chapter summarizes this research study, beginning with a restatement of the problem. Importantly, the researcher presents the implications for this research for curriculum development including calculators in the elementary school mathematics classes. In addition, this researcher offers recommendations for administrators and educators as they consider integrating the calculator booklet and other calculator related activities into the mathematics curriculum.

The issues represented in the implications and recommendations are complex. This researcher cautions the reader that these implications be considered as a complex set of considerations.

Summary
The recommendation of the California State Department of Education and professional mathematics organizations is that calculators be used as a regular part of the mathematics curriculum, even at the elementary school level. Research tended to cite that one of the reasons calculators were not used as
frequently as they should was that teachers lacked materials and guides to aid in the implementation of calculators into their mathematics curriculum. Therefore, this researcher put together a guide for teachers to use the following strands outlined in the California Mathematics Framework.

This study found that most teachers surveyed do not use the calculator very often at all or very infrequently in their mathematics classes. However, overall, when presented with the guide developed, the teachers responded favorably to the activities, and a number of them took it upon themselves to try the activities with their students. This response appears to indicate that if the teachers had guides with calculator activities that pertain to their curriculum, that they would be more likely to incorporate calculators into their mathematics lessons. The teachers of grade 3 were less in agreement with the usefulness of the activities in their curriculum than other teachers, however.

At the sixth grade level, the teacher instruction question received mixed responses. This may be since several teachers informally communicated to the researcher they had difficulty trying to do the activities since they had never done them before, such
as the Double or What? and Number Play activities. It seems that calculator use may allow for integrating concepts and activities at this grade level that had not been feasible before the accessibility of the calculator.

The time frame given appeared to be hard to determine for a couple of teachers, particularly in the lower grades. One reason may be that calculators are used less frequently at grade 3, according to this study, so teachers may not have enough experience at judging time parameters. It also may relate to the reaction of third grade teachers concerning the appropriateness of the lessons. Since none of them ranked age appropriateness a 5, it could follow the time frame would not be appropriate.

Implications

Teachers of grade 3, in general, had less favorable reactions to the guide as compared with teachers of other grades. It appears this might be a result of several factors or a combination of factors. Research has indicated that lower grade teachers felt the calculator belongs more in the upper grades and these teachers surveyed may feel the same way, despite the array of activities presented for their grade level. Moreover, teachers in this grade used the calculator
least frequently of all the grades surveyed and, therefore, would not be as able to judge the appropriateness and usefulness of calculator activities at their grade level. If more teachers in this grade were to attend a workshop on calculators, perhaps they would use calculators more frequently and be able to see how they can be integrated into their classes.

Lack of experience doing certain activities for the sixth grade teachers implies that these teachers may not be aware of the ways in which more advanced topics and problem solving activities can be more readily integrated in the sixth grade or that the teachers themselves may need more advanced workshops in mathematics to be able to incorporate the advanced topics comfortably in their classes.

Since several teachers noted the lessons looked too challenging for their students, the lessons may not be appropriate for certain groups. On the other hand, teachers who feel the lessons are inappropriate may never try them even if they are appropriate. Teachers could find out if their students are capable of completing the activities by trial testing them.

Finally, the biggest drawback to using calculators noted by the teachers seems to be lack of availability
of calculators to use. The researcher infers that if the teachers were given classroom sets of calculators to use that they would be utilized more frequently.

**Recommendations**

While the calculator guide has been rated highly overall by teachers of grades 3-6, it is clear that the guide alone will not assure the smooth integration of calculators into elementary school mathematics classes. This study has unfolded other issues which need to be researched and investigated before the calculator becomes an integral part of the elementary mathematics curriculum.

This researcher recommends that obtaining classroom sets of calculators be a priority for administrators and classroom teachers. Without calculators, it is impossible to implement them into the curriculum. For those situations where calculators are easily stolen, a way needs to be developed to keep the calculators secure for continued use. Once classroom sets are available, then it will be possible to do further research to see if student achievement increases as a result of regular use in the mathematics curriculum or if having calculators in learning centers may be a more effective approach for using calculators to increase achievement.

Another issue to be explored is to test the
activities provided with students of the grade levels listed. Doing so would provide more age specific information about student worksheets, age appropriateness, time frame appropriateness, and the completion of objectives of each activity.

Lastly, all teachers should attend workshops designed for calculator implementation in the elementary mathematics curriculum as well as for individual grade levels. Even if the teachers know the calculator should be a part of their curriculum, unless they see how it can be useful before presenting it to their classes, they may never even try any calculator activities. In conjunction with this, it would be beneficial to have a support person, possibly a mentor teacher, teachers can refer to when they need clarification or verification of the appropriateness of the activities used. After the workshops are given, the relationship between taking a workshop and using calculators frequently and appropriately by teachers should be assessed to learn if the correlation between them is positive. This could be done by follow-up observations and/or self-reports by the teachers.
WORKS CITED

Bell, Max S. Explorations into Ways of Improving the Elementary Mathematics Learning Experience. ERIC, 1976. ED 220 262.


ERICH 1980. ED 209 263.
Mathematics Model Curriculum Guide, Kindergarten Through Grade Eight. Sacramento: California State Department


SOURCES FOR CALCULATOR ACTIVITIES


Miller, Don. *Calculator Explorations and Problems.* New


APPENDIX A

Cover Letter and Questionnaire
April 18, 1988

Dear Teacher,

I am in the process of completing my Master's thesis, which includes the development of a booklet of activities based on using calculators in mathematics classes for grades 3-6. The activities I've collected and organized are intended to help elementary school teachers, especially those who have not used calculators extensively in their classrooms, to make the integration of calculators into mathematics classes more feasible and easier.

To assure that my goal for this booklet is met, I would appreciate your reading over the booklet and completing the attached questionnaire about it. The results are confidential. Your reactions will be reflected in an updated booklet to be developed over the summer, a copy of which I will send to you as an expression of my gratitude for your help.

I would greatly appreciate your completing the questionnaire by Friday, April 29, the day I plan to visit your school and pick up the results.

If you have any questions concerning any part of this study, please call me at 865-1642. Thank you very much for your cooperation and time.

Sincerely,

Linda M. Black
CALCULATOR ACTIVITIES QUESTIONNAIRE

Please answer the following questions by marking the appropriate space.

1. Which grade do you teach? __3 __4 __5 __6

2. At which type of school do you teach? ___Public ___Private

3. How do you enjoy teaching mathematics as compared to all other subjects you teach? Circle your answer. (5 is most enjoyable subject to teach. 1 is least desirable subject.) 5 4 3 2 1

4. About how many days a week do you currently use a calculator in your mathematics classes?
   ___ I don't use a calculator
   ___ 1 day a week
   ___ 2-3 days a week
   ___ 4-5 days a week

5. Have you ever attended a workshop or course on the use of calculators in mathematics classes? ___ yes ___ no

Please circle the number that represents your opinions on this booklet. 5 indicates full agreement, 1 indicates disagreement.

6. I can use these activities in my curriculum. 5 4 3 2 1

7. The objectives of the lessons are clearly stated. 5 4 3 2 1
8. The introductions/backgrounds are useful and appropriate.
5 4 3 2 1

9. The teacher instructions are clear and easy to follow.
5 4 3 2 1

10. The student worksheets are clear and easy to use.
5 4 3 2 1

11. The activities are appropriate for the listed grade level.
5 4 3 2 1

12. The activities can be completed in the time frame given.
5 4 3 2 1

13. The objectives are met upon completion of the activity.
5 4 3 2 1

14. The lesson extensions and/or cross-references will be helpful for other lessons.
5 4 3 2 1

15. What parts of this booklet were especially well presented?

16. What parts of this booklet need to be improved? How might this be done?

17. Other comments or suggestions:
APPENDIX B

Calculator Activities
MYSTERY NUMBERS

Find the missing numbers in each of the following.

1)  _ _ 1
   + 4 2 _
   ________
   _ 4 0 2

2)  _ 0 2 5
   + 3 1 4 8
   ________
   _ 6 6 _

3)  _ 6 9
   + 7 _ 6 4
   ________
   2 8 7 7 3

4)  2 _ 1
   4 5 _
   ________
   1 3 2 6

5)  8 7 6 9 3
   _ _ _ _ _
   ________
   _ _ _ _

6)  8 1 3 5
   4 6 8 2
   ________
   _ _ _ _

7)  3 _ _
   1 5 9
   ________
   _ 2 4

8)  1 _ _ _ 6
   8 3 0 9
   ________
   4 9 8 7
GRADE: 3  
STRAND: Number  

TIME: 30 Minutes  

PURPOSE: The students will use calculators to find missing numerals in addition and subtraction problems.  

MATERIALS: Worksheet, calculator.  

INTRODUCTION/BACKGROUND: The students will practice the problem-solving strategy of guess-and-check using a calculator. Students will make guesses as to what number to put in the blanks and then be able to check immediately without worrying about computation errors. If they are incorrect, they can quickly make changes and check the results. The students should begin to make successive approximations as they make more guesses to arrive at the correct answers. Students also practice addition and subtraction skills as they complete this activity.  

PROCEDURE: 1) Hand out worksheet to students. Do problem 1 with the class to demonstrate how to do the page.  
2) Let students complete the page independently. Walk around the classroom to see if students are using successive approximations to get answers or if they are easily able to figure out a simple technique to use, as in problems 5 and 6, which is just subtracting the smaller number from the larger.  
3) Go over results and strategies with the whole class.  

EXTENSION: Have students make up their own worksheets to give to classmates.  

CROSS-REFERENCE: Grades 4, 5 - develop similar worksheets using multiplication and division problems.
ROUNDING NUMBERS

Round these numbers to the nearest 10. Then, enter each rounded number and push +. Check your answer with the number.

91 + 142 + 416 +
87 + 216 + 478 +
43 + 159 + 197 +
64 + 87 + 204 +
28 = 353 = 523 =
310 960 1820

Round these numbers to the nearest 100. Then, enter each rounded number and push +. Check your answer with the number.

412 + 1435 + 25415 +
785 + 2715 + 27815 +
815 + 2562 + 42162 +
948 + 1969 + 36812 +
989 = 1888 = 29865 =
3900 10600 162100
GRADE: 3
STRAND: Number

TIME: 20-30 minutes

PURPOSE: The students will practice rounding to the nearest 10 and 100.

MATERIALS: Worksheet, calculator, overhead calculator.

INTRODUCTION/BACKGROUND: In the real world, adults do a great deal more estimating to solve problems than they use calculators or pencil and paper, so it's vital for students to be proficient estimators. Even when calculators are used to verify results, adults must be skillful estimators to know that the answer displayed is reasonable, since it is easy to punch incorrect entries into a calculator. This exercise is designed to give the students practice with rounding, a skill necessary for estimating, and by adding the rounded numbers on the calculator, the students have immediate feedback concerning their performance since there is a total which is obtained if they have rounded accurately.

PROCEDURE: 1) Hand the worksheet to the students and do the first exercise with them so they understand the procedure. Whether the exercise is done by the teacher alone or with students, it is a good idea to use an overhead calculator so the students may observe the procedure. The teacher may wish to purposely round incorrectly on one number to work through the process of correcting the problem. This also gives the teacher the opportunity to see who is comfortable with rounding.

2) Let the students complete the page alone or in small groups. If they are in a small group, the students can discuss what the rounded number should be. In the small group, make sure each student has the opportunity to punch entries into the calculator.

EXTENSIONS: - Worksheets can easily be made to work on rounding in the thousands or using front end estimating.

- Let the students challenge each other by making up their own problems to test on their classmates.

CROSS-REFERENCE: Grades 5, 6 - Create a similar worksheet for older children involving decimals.
GRADE: 4  
STRAND: NUMBER  
TIME: 5-15 minutes  

PURPOSE: The students will practice their skills in the place value of decimals using a calculator.

MATERIALS: One calculator per student.

INTRODUCTION/BACKGROUND: Understanding place value is important for students to manipulate numbers comfortably. Using a calculator is a fun way for students to do place value work, and it's an effective way for teachers to determine difficulties in understanding place value. This activity will be done with oral directions.

PROCEDURE: 1) Begin by having students punch in their own number with a specific digit in a certain place. ex) "Show me a 3 digit number with a 7 in the tenths place." Repeat several times, allowing several volunteers to write their numbers on the board.  
2) Orally name numbers with decimals and have the children enter the numbers into their calculators. Walk around the room, checking a few students' responses for each one and have a volunteer write the number on the board so each student can check his work.  
3) Extend step 2 so that students must add or subtract a certain numeral to or from the number on display. ex) If 48.28 is displayed, instruct students to add six tenths. ex) If 5.87 is displayed, tell students to eliminate the 7 on display. Go over results and strategies with each problem.

CROSS-REFERENCE: Grade 3- do the same process with whole numbers in the millions.
THE WITH AND WITHOUT CALCULATOR TEST

13 +15 30 x3 89 -9 36/2=

99 +99 100 -45 x10 100 8+8+8=

3x3x3x3 = 56 1/2 + 1/2 = 31 -50 +32

15 -12 1024+1024= 78 +22 - .5

93 / 3 = 1x2x3x4= 9+9+9= 150 x30
GRADE: 5  
STRAND: NUMBER  

TIME 10-15 minutes  

PURPOSE: The students will prove that using the calculator is not always the most efficient way to solve computational problems.  

MATERIALS: Test sheet, pencil, calculators for half the class.  

INTRODUCTION/BACKGROUND: Many students have the notion that using calculators to solve computational problems is much more efficient than using paper and pencil or mental arithmetic. However, in reality, use of the calculator is not always the best method to use in completing problems. Since the Framework states students need to learn the best tool for various activities, this exercise provides them with the opportunity to explore when a calculator may not be the best tool to use.  

PROCEDURE: 1) Divide the class into two groups. Tell the students that they will be taking a test and that half the class will use the calculator and half the class will only be permitted to use paper and pencil to complete the test.  
2) Hand out the calculators and tell the calculator users that they must use the calculator to solve every problem -- all numbers must be punched in.  
3) Give the students the test and tell them to raise their hands when they are done.  
4) When about half the class has finished, request all students stop working.  
5) Take an informal survey:  
a) How many using calculators finished?  
b) How many not using calculators finished?  
Have the students discuss if they would like to use the calculator if they were given a similar activity at a later date. Have the students verbalize their reasoning, encouraging them to talk over any frustrations or good feelings because of the method used to complete the work. Most of the students will conclude that the calculator was not the most efficient tool to use in this exercise.  

EXTENSION: This activity can be easily adapted for grades 3 and 4 by eliminating the problems involving fractions and possibly decimals.
NUMBER PLAY

Record your results.

1) Use only 4 to make 13.

2) Use 1 only 5 times to equal 100.

3) Use 8 only 8 times to equal 1000.

4) Display 111 by using 2.

5) Use 4 3 times to equal 20.

6) Use 3 4 times to equal 24.

7) Use 1 , 2 , 3 , 4 keys but only once in any order to display 25.

8) Use 1 , 2 , 3 , 4 keys but only once in any order to display 21.
GRADE: 6  
STRAND: Number  
TIME: 40 minutes  

PURPOSE: The students will use the calculator to explore different ways to make certain numbers.  

MATERIALS: Calculator, worksheet.  

INTRODUCTION/BACKGROUND: Although this activity is appropriate for a small group activity during a mathematics class, it is also ideal as a take-home problem-solving activity. The students will be developing their ability to perceive numbers in different ways since they are given specific numbers. Students are allowed to use any other operation keys.  

PROCEDURE: 1) Hand out the worksheets and do question 1 with the class to be sure they understand the activity. Then permit the students to work independently or in pairs to solve the problems. Make sure they record the results. Walk around the room as the students work to observe whether students are trying strategies or just guessing. This variation will be normal.  
2) At the end of the period, go over results. If a number of students are not finished, let them take the activity home and discuss results at another time.  

EXTENSION: Using only the __4__, make the numbers from 1 - 100.
MONEY MEASURE

1) How many centimeters (cm) long is a penny? _____ cm

2) If you were to place 100 pennies end to end, how long a line would you have in cm? _____ cm.

3) a) What would the length be if you used 1000 pennies? _____ cm.

   b) How much money would that be? _____

4) Now measure the approximate width of a penny in millimeters. _____

5) How many pennies would you need to make a stack 1 cm tall? _____

6) How many pennies would you use to make a stack 1 meter tall? _____

7) a) How many pennies would be needed to go along the width of your desk? _____

   b) How many would be needed to equal the height of your desk? _____ How many dollars is that?
GRADE: 3
STRAND: Measurement

TIME: 30-40 minutes

PURPOSE: The student will use metric measurement when measuring pennies and use calculator, to find lengths and heights using the measurements found.

MATERIALS: Worksheet, calculator, pennies, metric measuring devices.

INTRODUCTION/BACKGROUND: Have some pennies available so students can measure the length (diameter) and width of a penny. The students have the opportunity to do problems involving the measurement of length as well as money. At the end, the students use the information to determine the length and height of their desks.

PROCEDURE: 1) Distribute worksheets and group students in small groups. Distribute one penny to each group. Have them measure the length to the nearest centimeter.
2) The students now must answer question 2, but since they only have one penny per group, encourage them to think of how they could use a calculator to do the problem. Do the same for question 3, both parts.
3) Question 4 requires the students to use a different unit of measure, so check to be sure they detect this as they answer the question.
4) Questions 5 and 6 require students to know how many millimeters in a centimeter and meter. Review this information if necessary and have the groups use this information, their answer to question 4, and the calculator to answer 5 and 6.
5) Have the groups use the information gathered from the rest of the page to answer question 7. Have the students do it in their groups and discuss results and strategies as a whole class.

CROSS-REFERENCE: Strand - Number.
HOW BIG IS OUR ROOM?

Use a meter stick and a calculator. Pretend that your classroom is a big box.

Find these dimensions to the nearest centimeter.

Length (l) = ____ m
Width (w) = ____ m
Height (h) = ____ m

Use your measurements to calculate these:

a) Area of floor = ______
b) Area of sidewall = ______
c) Area of end wall = ______
d) Area of ceiling = ______
e) Volume of room = ______
f) Total surface area: ______
GRADE: 5  
STRAND: Measurement  

TIME: 30-40 minutes  

PURPOSE: The students will practice finding area and volume.  

MATERIALS: Meter stick, calculator, worksheet, shoebox.  

INTRODUCTION/BACKGROUND: Learning more readily occurs when it is connected to what is familiar to the students. Students will use their classroom to work on the concepts of area and volume.  

PROCEDURE: 1) Pass out the worksheet and let students measure the length, width, and height of the classroom in small groups and record their results. Bring them back as a group and check results. If there are discrepancies, have class recheck and discuss the importance of being accurate. For example, if the room were to be wall papered, exact dimensions are necessary so money is not wasted.  
2) Using their calculators have the students calculate a - d and record results. Check answers.  
3) Review how to find volume and have students find it using calculators. Be sure they label appropriately. Check results.  
4) Discuss how to go about finding the surface area of the room. If necessary, use the shoe box as a scaled down version of the room and cut out sides, floor, and ceiling. From this, they should conclude that they need to add 2 side walls, 2 end walls, and 1 ceiling and one floor. Have students calculate surface area and check results.  

EXTENSIONS: - Students can find out how much paint is needed to paint the room.  
- Have students calculate the weight of air in the classroom (1.2 grams per cubic decimeter at normal temperature).
DISCOVERING PI

1) Measure the circumference and diameter of circular objects in your room.

2) Record your findings in the table below.

3) Use your calculator to fill in the last column.

<table>
<thead>
<tr>
<th>Object</th>
<th>Circumference</th>
<th>Diameter</th>
<th>Circumference/Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock</td>
<td>47.8 cm</td>
<td>15.2 cm</td>
<td>3.144</td>
</tr>
</tbody>
</table>

Can you draw a conclusion from the results in the last column?
GRADE: 6
STRAND: Measurement

TIME: 40 minutes

PURPOSE: The students discover the value of Pi by measuring the diameter and circumference of various circular objects.

MATERIALS: Various circular objects, calculators, measuring tapes and rulers, worksheets.

INTRODUCTION/BACKGROUND: The Framework states that students should develop and be "able to explain formulas as an efficient method of obtaining some measurements" (p.9). Using objects found in their everyday life, such as bottle caps, records and soda can tops, the students will see that Pi is related to the circumference and diameter of circles. Pi will have meaning for them since they have discovered it versus being told what it is.

PROCEDURE: 1) Hand out worksheet and give each group several of the round objects. Instruct students to find the circumference and diameter of each object using the measuring devices and then to divide the given circumference by its diameter using the calculator. The calculator makes this portion of the work simple and accurate.
2) Have each group draw a conclusion about the final column on the sheet.
3) Bring the group together and have the class discuss the results. It is likely that the exact values in the last column will be different. This allows for discussion of human error when measuring objects. If a number appears to be really out of perspective, suggest the team remeasure the circumference and diameter. This encourages groups to check their work over since human error is inevitable. Inform the students that they have come up with the value of Pi and briefly introduce Pi as a value used in finding the area and circumference of circles. You may wish to discuss that the value of Pi is actually an approximation since it's non-terminating and non-repeating.

CROSS-REFERENCE: Strand-Measurement.
**PERIMETER**

The perimeter of a polygon is the total of the lengths of all its sides.

Solve the following problems. Draw pictures to help you solve them.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Picture</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The 8 sides of a regular octagon are congruent. If the length of one side is 632 cm, what is the perimeter?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) The 5 sides of a regular pentagon are congruent. If the length of one side is 0.86 km, what is the perimeter?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) The perimeter of a regular triangle (equilateral) is 135 cm. How long is each of the sides?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) A certain baseball player hit 660 home runs during his career. Suppose he ran about 90 feet from base to base. About how many miles (to the nearest tenth) did he run while hitting home runs (5280 feet equals one mile)?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GRADE: 4
STRAND: Geometry/Measurement

TIME: 30 minutes

PURPOSE: The students will use their calculators to find the perimeter of specific geometric shapes.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: Fourth graders know how to find the perimeter of shapes when pictures are given. In this activity, however, the students will use their knowledge of specific geometric terms to draw the pictures and then find the perimeter. The use of the calculator allows large numbers and decimals to be used comfortably.

PROCEDURE: 1) Before handing out the worksheet, informally check to make sure students understand the terms congruence and regular polygons. Review if necessary. 2) Hand out worksheets. Permit the students to work independently. Reinforce the idea of drawing pictures to help solve the problems. 3) When most students are finished, discuss the results and how they were obtained. Accept various strategies if students can justify them and have the correct answers.

EXTENSION: Have students make up their own problems and give them to other students.

CROSS-REFERENCE: Strand - Number.
TILING A FLOOR

Find out how much each type of tiling would cost to tile a floor as big as the one presented below. Write the cost for each in the space provided.

1) LUXURIOUS PRINT CARPET TILE!
   * Striking colors and patterns!
   * Easy to use self-sticking!  59¢ sq. ft._____

2) BOLD VINYL FLOOR TILE!
   * Embossed pattern, hides dust!
   * Install yourself and save!  13 3/4¢ sq. ft._____

3) RED QUARRY TILE
   * Rock-like tiles ideal for patios and fireplaces
     6 X 6 X 3/8''  32¢ each_____

4) PARQUET FLOOR TILE
   * Keeps traditional beauty without waxing
     4 X 4 X 5/16''  29¢ each_____
GRADE: 5
STRAND: Geometry

TIME: 40 minutes

PURPOSE: The students will figure the cost of tiling a room using different sized tiles and determine which is the most economical buy.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: Most people have to tile or carpet a room at some point in their lives. To be the most economical consumer, it is imperative that students know how to do such a task. In this exercise, the cost of the tiles varies as does the tile sizes. The students must take into consideration both variables when calculating the final cost. A calculator is an essential tool in solving the problem efficiently. However, cubes or paper squares in the different sizes might be available for those students who need concrete models to solve the problems.

PROCEDURE: 1) Create a story for the students concerning a family that is remodeling its family room and has decided to put in a new floor as well. When the parents went to buy tiles for the floor, they discovered that to order the correct number of tiles they needed to do some mathematics first. One problem they needed to solve was what was the total floor space to be covered. Next, they needed to calculate which of the tiles on sale was the best buy.

2) Hand the ditto to the students showing the shape and dimensions of the room. Inform the students that this isn't exactly the size of the room covered, but it is similar. Ask how they could use this to help solve the problem. The students should suggest using the scale. If the students are unable to do this, draw their attention to this feature.

3) Elicit from the students responses concerning how they could figure out the area since it is not a square or rectangle. They should state the room needs to be made into two rectangles. Instruct students to find the areas. Ask whether they need to use a calculator to do this or not. At this grade, multiplying those numbers should be mental, so the response should indicate this.

4) Using the information above, the students should be able to independently calculate the area of number 1 on the worksheet. Let them do it and discuss answers and strategies with each other before moving on, so slower
students can benefit.

5) Completing question 2 requires the students to change a fraction to a decimal before computing. Allow students to try to compute the cost independently. However, as they begin, quiz them informally as to whether they are using the same techniques as question 1 or if they need to employ other ideas, as well. For those who have not made the connection concerning a conversion, this should alert them to checking their strategies. As before, discuss answers and strategies.

6) Question 3 is sophisticated since it requires the students to figure out that a 6 X 6" tile is one fourth the size of a sq. ft. tile. Therefore, they need to multiply the result by 4. Have students look at the example and ask if they notice anything unusual about this problem. Elicit ideas on how to calculate with a tile with different dimensions. Discuss possibilities and give aid if necessary by using a tile or paper square to prove there are 4 - 6 X 6" squares in a square foot. Have students calculate and discuss results.

7) Repeat step 6 with question 4, but make sure the students recognize the difference in tile size and calculate what portion of a square foot it is.

8) Discuss with students which is the best buy and why.

EXTENSION: -Have students figure the cost of a tile with the dimensions 6 1/2 X 6 1/2 X 5/16" at 32¢ a tile. Discuss the results since some may choose to piece tiles, others may not care if parts of tiles are wasted.

CROSS-REFERENCE: Strand - Measurement

- Number.

Grades 3, 4 -Use rectangle shaped rooms.
SIMILAR TRIANGLES

The following set of triangles are similar. Compute the area and perimeter of each triangle.

A = _____  A = _____  A = _____  A = _____
P = _____  P = _____  P = _____  P = _____

1) How do the areas compare? ____________________________

2) How do the perimeters compare? ____________________________

3) If you double the perimeter of Triangle A, what would the area be for the new triangle? ____________________________

4) If you have a triangle 1/4 the size of Triangle D, what would its perimeter be? _____ How do you know? _____

What would its dimensions be? ____________________________

How did you find the answer? ____________________________
GRADE: 5  
STRAND: Geometry  

TIME: 40 minutes  

PURPOSE: The students will make comparisons between the area and perimeter of similar triangles.  

MATERIALS: Calculator, worksheet.  

INTRODUCTION/BACKGROUND: Using calculators allows students to draw conclusions more readily in all areas of mathematics, including geometry. In this exercise, students will calculate the area and perimeter of triangles, using the calculator if necessary. Students should be familiar with the formula for finding the area of triangles. Then, they will use their calculators to manipulate the numbers to find relationships between the area and perimeter of similar triangles.  

PROCEDURE: 1) If necessary review the term similar figures. Give such comparisons as doll houses, photographs, and model trains as being like real-life objects, just smaller.  
2) Hand out worksheet and explain that students are to find the area and perimeter of the similar triangles. Review finding the area of triangles if necessary. Allow students to do calculating. Verify results as a group.  
3) Now group students in groups of 2 or 3 and do questions 1 and 2. In groups, they should be more able to discuss strategies to determine how the areas and perimeters of the various triangles relate to each other. Compare answers as a whole class.  
4) Let students complete the page in small groups. Get together as a class and discuss answers and how they were found.  

EXTENSION: See if other geometric shapes have relationships between similar figures.  

CROSS-REFERENCE: Strand - Numbers.
DOUBLE OR WHAT?

A. Study the cubes your teacher has made to predict what happens to the surface area of a cube when the length of its edge is doubled.

What do you predict? _____________________________

_______________________________

Now calculate what happens.

If the edge = 1.25 inches the surface area is ______
If the edge = 2.5 inches the surface area is ______
If the edge = 5 inches the surface area is ______
If the edge = 10 inches the surface area is ______
What actually happens to the surface area as its edges double in length? ________________________________

_______________________________

B. Study the cubes your teacher has made to predict what happens to the volume of a cube if the length of its edge is doubled.

What do you predict? _____________________________

_______________________________

Now calculate what happens.

If the edge = 1.25 inches the volume is ______
If the edge = 2.5 inches the volume is ______
If the edge = 5 inches the volume is ______
If the edge = 10 inches the volume is ______
What actually happens to the volume as its edges double in length? ________________________________

_______________________________
GRADE: 6  
STRAND: Geometry  
TIME: 40 minutes  

PURPOSE: The students will find a relationship between surface area and volume of cubes as the length of their edges double.  

MATERIALS: Worksheet, calculator, four cubes made ahead of time with the edge lengths of 1.25 inches, 2.5 inches, 5 inches, and 10 inches respectively.  

INTRODUCTION/BACKGROUND: Teachers should make the cubes ahead of time. The pattern shown has the length of its edge as 1.5 inches. Use graph paper to make the other cubes. Tape cubes together. The students will probably predict that surface area doubles as edge length does but will perhaps make other predictions for volume after completing the information on surface area. The calculator permits students to figure the surface area and volume quickly, and they can then compare results more efficiently and effectively.  

PROCEDURE: 1) Hand the worksheets to the students and allow the students to view the cubes. Have them make their prediction in part A and ask volunteers to give their prediction.  
2) Have students find the surface area of the cubes. Review the formula if necessary. Check results as a group.  
3) Let students look over their results for a few minutes to find a relationship between surface area and the doubling of an edge length. Record results. Permit students to discuss how they arrived at their conclusions. You may want the students to double another cube to show the pattern continues.  
4) Repeat steps 1-3 with part B. The relationship is more difficult to figure with volume. If necessary, guide the students to look for various possible patterns such as the difference being a square number or all differences being multiplied by the same number. If this type of aid is needed, have them test the different theories to prove or disprove them.  

EXTENSION: Have the students find the difference, if any, between the surface area and/or volume of other regular shaped 3 dimensional figures when the edge lengths are doubled.  

CROSS-REFERENCE: Strand - Measurement.
FINDING PATTERNS

Row 1: \[ 1 + 2 + 3 = 6 \]
Row 2: \[ 2 + 3 + 4 = 9 \]
Row 3: \[ 3 + 4 + 5 = 12 \]
Row 4: \[ 4 + 5 + 6 = 15 \]
Row 5: \[ 5 + 6 + 7 = 18 \]
Row 6: \[ ? \]

1) 17 is the first number in Row ______.
2) 12 is the second number in Row ______.
3) What is the sum of the three numbers in Row 8? ______
4) What is the sum of the three numbers in Row 20? ______
5) Which row has a sum of 93? ______
6) Which row has a sum of 117? ______
GRADE: 3  
STRAND: Patterns and Functions  

TIME: 20-30 minutes  

PURPOSE: The students will use their calculators to help them find a pattern.  

MATERIALS: Worksheet, calculator, extra paper.  

INTRODUCTION/BACKGROUND: The calculator permits students to detect patterns more quickly than with paper and pencil, since they do not have to labor over the computational aspects of patterning problems. For this exercise the students will use the calculator to find sums quickly and to easily find the rows that have specific sums once they conclude that each sum increases by 3.  

PROCEDURE: 1) Hand worksheet to students and an extra blank sheet to tally results if they want. Some students may take a long time to discover the pattern, so they may need to write down the rows until they understand how to do a short cut. Others will see the patterns almost immediately and just need to write down tally marks to keep track of the row they are on as they add on the calculator.  

2) Let students make comments about their initial reactions to what they see. For example, they may observe that the 3 numbers being added are all counting numbers in a row or that if they look down one column, the numbers are in counting order. Encourage them to look for patterns as they work.  

3) Have students complete the sheet independently or in small groups. In small groups, they can share strategies. Walk around the room to observe students as they work. Question them on their strategies to see how quickly they are catching on to the pattern. If some students are having difficulty, point out the numbers 6 and 9 and ask how they compare to each other, how 9 and 12 compare, etc.  

4) When most of the class is together, discuss results and strategies and how the calculator was helpful and when they perhaps stopped using it. This is important since sometimes calculators do lose their efficiency compared to mental arithmetic at various times.  

EXTENSION: Make up similar worksheets using the sum of consecutive odd and even numbers.
CROSS-REFERENCES: Strand - Number.
Grade 4 - Make up a worksheet using decimals.
Grade 5 - Make up a worksheet using negative numbers.
MULTIPLYING BY POWERS OF TEN

1) Solve these:
   a) 3 x 10 = _______
   b) 7 x 10 = _______
   c) 4 x 10 = _______

2) Try to solve these problems. Check your results with a calculator.
   a) 12 x 10 = _______
   b) 15 x 10 = _______
   c) 42 x 10 = _______
   d) 386 x 10 _______
   e) 9,825 x 10 _______

3) What do you think a rule is for multiplying by 10?

4) Compute:
   a) 6 x 100 = _______
   b) 2 x 100 = _______
   c) 9 x 100 = _______

5) What do you think the answers for these are? Check your results with a calculator.
   a) 56 x 100 = _______
   b) 219 x 100 = _______
   c) 4,387 x 100 = _______

6) What happened when you multiplied by 100 that was different from multiplying by 10?
7) Predict the answers for these and check with the calculator:

   a) $5 \times 1,000 = \underline{\hspace{2cm}}$
   b) $71 \times 1,000 = \underline{\hspace{2cm}}$
   c) $7 \times 100,000 = \underline{\hspace{2cm}}$
   d) $629 \times 10,000,000 = \underline{\hspace{2cm}}$

8) Make a rule for multiplying by powers of ten.

9) Use your rule for finding which is more in each pair.

   a) $100 \times 100$ OR $10 \times 1,000$
   b) $1,000 \times 10,000$ OR $100 \times 10,000$
   c) $81 \times 100 \times 900 \times 10$

10) What do you think $9 \times 60$ is? \underline{\hspace{2cm}} Why?

    What do you think $4 \times 80$ is? \underline{\hspace{2cm}} Why?
GRADE: 4  
STRAND: Patterns and Functions  
TIME: 40 Minutes  
PURPOSE: The students will develop their own rule for multiplying by powers of 10.  
MATERIALS: Calculator, pencil, worksheets.  

INTRODUCTION/BACKGROUND: The Framework states that students should be encouraged to discover patterns and describe them. This exercise, through the use of calculators, allows students to more readily detect a pattern without fear of computational errors, hence expediting their ability to formulate a rule based on their experience. Once students understand the rule, these types of problems no longer require the use of paper and pencil or calculator to tabulate the answers. Instead, these become mental computational problems. This transition to mental computation is desired, as the Framework mandates that students learn the most efficient and effective way of solving problems.  

PROCEDURE: 1) Hand worksheets and calculators to the students. Have them solve step 1, using their calculators if necessary. Most students will be able to do these on their own, although a few students may choose to use the calculator.  
2) Discuss results with the class to confirm them. Allow the students to correct their own papers. This tends to lessen the anxiety students feel on this type of guided discovery lesson.  
3) Have the students do step 2. Since the numbers being multiplied by 10 are larger, most students will choose to use the calculator to arrive at the answers.  
4) Discuss results as before.  
5) Students should answer question 3. This question encourages children to start forming ideas about what it is they are doing and write them rather than just thinking they are just using a calculator to get answers.  
6) Allow several of the students to read their answers. It permits the teacher to hear their theories at this point. Additionally, it gives less able students the opportunity to hear ideas they might not have thought of yet and may help them reevaluate what they wrote. At this stage, all answers are accepted so the students feel comfortable with making conjectures.  
7) Have the students do questions 4 and 5 just as they did 1 and 3. On question 5, encourage the students to make a
guess first. Some already may have generalized a rule and this gives them the opportunity to try it mentally first and then with a calculator.

8) Students should do question 6. The question should focus their attention to not only differences but similarities as well. As before, discuss answers aloud to help refine ideas.

9) Do question 7. This gives the students experience with much larger numbers. In 'd' the students will discover most calculators can't handle the problem. However, most should feel confident enough to put down an answer which is correct.

10) Question 8 requires the students to make a general rule for multiplying by powers of 10. Discuss theories.

11) Question 9 extends the student's ability to apply the rule.

12) Question 10 is then done by the students. This question provides information on which students have been able to generalize their knowledge of multiplying by powers of 10 to multiplying by multiples of 10. The teacher can then make decisions on whether to teach multiplication by powers of 10 to the whole class or a small group.

EXTENSIONS: Grade 4 - Make up a similar worksheet for dividing by powers of ten.
- Make up worksheets for multiplying and dividing by multiples of ten.

CROSS-REFERENCE: Strand - Number.

Grades 5, 6 - Make up worksheets for multiplying and dividing decimals by powers of ten.
**LARGEST AND SMALLEST?**

A. Put the numbers 1, 2, 3, 4 and 5 in the blanks below and make the:

<table>
<thead>
<tr>
<th>___  ___</th>
<th>largest product</th>
<th>___  ___</th>
<th>smallest product</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

---

B. Now try these numbers:

<table>
<thead>
<tr>
<th>1. 5, 2, 4, 6, 0</th>
<th>2. C. 8, 9, 0, 4, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>___  ___</td>
<td>___  ___</td>
</tr>
<tr>
<td>largest product</td>
<td>largest product</td>
</tr>
<tr>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>3. D. 6, 2, 4, 38</th>
<th>4. E. 2, 7, 6, 1, 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>___  ___</td>
<td>___  ___</td>
</tr>
<tr>
<td>largest product</td>
<td>largest product</td>
</tr>
<tr>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

Did you discover a pattern for the largest product?  
For the smallest product?  
What is the pattern?
GRADE: 4  
STRAND: Patterns and Functions  

TIME: 40 Minutes  

PURPOSE: The students will use the calculator for discovering patterns for finding the largest and smallest products of any given set of numbers.  

MATERIALS: Worksheet, calculator, and extra paper for trials.  

INTRODUCTION/BACKGROUND: The students will employ the method of guess and check using a calculator to arrive at their conclusions. When students are required to generate their own conclusions, the concept tends to be learned and retained more readily.  

PROCEDURE: 1) Hand out the worksheets and extra paper to the students. Demonstrate use of the extra paper for recording the guess and check work. Emphasize the importance of keeping organized records of what has been done for future student reference. These records will be useful to the students when they need to support their answers.  
2) Have the students work independently. Stress that an answer may not be found simply, that many trials may be needed to arrive at the correct answer.  
3) Discuss results and have the class come to a general consensus about how to find the largest and smallest products of a given set of numbers.  

CROSS-REFERENCES: Strand-Numbers.  
Grade 3-Make a similar worksheet for addition and subtraction to find the largest and smallest sums and differences.
Use a calculator to solve the problems until you see a pattern. Then try to do the rest in your head.

A. \[ 9 \times 12345679 = \]
\[ 18 \times 12345679 = \]
\[ 27 \times 12345679 = \]
\[ 36 \times 12345679 = \]
\[ 45 \times 12345679 = \]
\[ 54 \times 12345679 = \]
\[ 63 \times 12345679 = \]
\[ 72 \times 12345679 = \]
\[ 81 \times 12345679 = \]

B. \[ 11 \times 11 = \]
\[ 111 \times 111 = \]
\[ 1111 \times 1111 = \]
\[ 11111 \times 11111 = \]
\[ \vdots \]
\[ 9 \times 9 = \]
\[ 99 \times 99 = \]
\[ 999 \times 999 = \]
\[ 9999 \times 9999 = \]
\[ \vdots \]

Will the pattern continue or end? \[ \text{______} \]
If it ends, when will it?

C. \[ 101 \times 222 = \]
\[ 101 \times 2222 = \]
\[ 101 \times 333 = \]
\[ 101 \times 3333 = \]
\[ 101 \times 33333 = \]
\[ 101 \times 55 = \]
GRADE: 5  
STRAND: Patterns and Functions

TIME: 30 minutes

PURPOSE: The students will use the calculator to find several products which follow a pattern and then try to predict the answers for the rest of the problems.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: Mathematics is full of patterns but many times these patterns are not discovered by students because they are spending a great deal of energy and time doing the calculations necessary to see the patterns using pencil and paper. The calculator frees the student's time and energy so that he can focus on the results. The calculator only does computing: the student must look for and discover what patterns are generated.

PROCEDURE: 1) Hand the worksheet out and instruct the students that they should only use the calculator to solve problems until they see a pattern that can help them solve the rest of the problems. When they have reached that point, instruct them that they should write down their hypotheses of what the pattern is before solving the rest of the problems.  
2) When they have written an hypothesis, tell the children to solve the rest of the problems mentally, following the pattern they discovered.  
3) Let the children now pair up to compare strategies and answers. Then check the results with the calculator.  
4) When the class is done, discuss with the whole group the advantages of using patterns to solve mathematics.

CROSS-REFERENCES: Strand - Number. 
Grade 6 - create worksheets using fractions and see if a pattern can be discovered.

ex) \[
\begin{align*}
\frac{1}{11} &= \frac{2}{11} &= \frac{3}{11} \\
\frac{1}{111} &= \frac{2}{111} &= \frac{3}{111}
\end{align*}
\]
To find 6 to the fourth power on the calculator, perform the following steps:

Enter 6

Press \( x = = = \)

The display shows 1296. So \( 6^4 = 1296 \)

Find the pattern shown by the digits in the ones place of the powers of each number.

**Examples:**

<table>
<thead>
<tr>
<th>Ones Digit</th>
<th>Ones Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 6^1 = 6 )</td>
<td>( 4^1 = 4 )</td>
</tr>
<tr>
<td>( 6^2 = 36 )</td>
<td>( 4^2 = 6 )</td>
</tr>
<tr>
<td>( 6^3 = 216 )</td>
<td>( 4^3 = 4 )</td>
</tr>
<tr>
<td>( 4^4 = ? )</td>
<td>( 9^1 = 9 )</td>
</tr>
<tr>
<td>( 4^4 = ? )</td>
<td>( 9^2 = 81 )</td>
</tr>
<tr>
<td>( 9^3 = 729 )</td>
<td>( 9^3 = 729 )</td>
</tr>
<tr>
<td>( 9^4 = ? )</td>
<td>( 9^4 = ? )</td>
</tr>
</tbody>
</table>

Describe the pattern:

\[ \boxed{9, 9, 9, \ldots} \]
Write the ones digit for each power. Find the pattern.

<table>
<thead>
<tr>
<th></th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $7^1$</td>
<td>$7^2$</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2. $8^1$</td>
<td>$8^2$</td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3. $5^1$</td>
<td>$5^2$</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4. $3^1$</td>
<td>$3^2$</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5. $2^1$</td>
<td>$2^2$</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Use the patterns to solve the following equations. Make a guess and then test your guess.

6. $x^9 = 1 953 125$  
7. $x^8 = 65 536$  
8. $x^6 = 117 649$  

$x = \square$  
$x = \square$  
$x = \square$
GRADE: 6
STRAND: Patterns and Functions

TIME: 40 minutes

PURPOSE: The students will become aware of the patterns found in the ones digit in successive powers of a number.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: Students learn that multiplying numbers to a certain power quickly increases the answer. However, rarely are they allowed to explore relationships among powers of one number. This activity allows them to quickly see these.

PROCEDURE: 1) Make sure all students' calculators have the constant feature. Show students what it does if they don't know.
2) Hand out worksheet and go over examples with students. Have them orally talk over how they arrived at the pattern. Encourage students to keep on going if they can't figure out the pattern with problems shown. Suggest they calculate a few more to check if the pattern does continue.
3) Let students complete examples 1-5 independently or in groups of 2.
4) Gather group together to discuss various patterns and how many problems they solved to figure out the pattern.
5) Questions 6-8 require the students to use what knowledge they gained from completing 1-5. Have them write their answers and explain their strategies.

EXTENSION: Have students predict the digit in the ones place for any power of any whole number.
BOY, ARE YOU HUNGRY!

If you don't think you eat much now, you may change your mind after finishing this!

Answer the following questions to see about how many meals you've eaten in your life so far.

1) About how many times a day do you eat?

2) Use your answer in question 1 to find how many meals you eat in a week. ______

3) How many weeks are in a year? ______

4) Use your answers in question 2 and 3 to find how many meals you eat in a year ______.

5) a) How many years old are you? ______ b) Take this answer and the answer from question 4 to find out how many meals you've eaten in those years ______.

6) a) How many months since your last birthday? ______ b) If there are about 4 weeks in a month, use your answer from a) and find how many meals you've eaten in those months. ______

7) a) How many has it been since the day of the month you were born? (ex - if you were born on the 12th day of a month and it's the 18th day of the month, it's been 6 days) ? ______ b) Use your answer from a) and question 1 to find how many meals you've eaten since the day of the month you were born. ______

8) Use your answers from 5b, 6b, and 7b to find out how many meals you've eaten in your life so far! ______

-Who has eaten the most meals in your class? 
-Who has eaten the fewest meals? 
-What is the average number of meals eaten in your class?
GRADE: 3
STRAND: Statistics and Probability

TIME: 30-40 minutes

PURPOSE: The students will use the calculator to find some interesting facts easier to find. The students can work with larger numbers without worrying about mistakes in calculations.

MATERIALS: Worksheet, calculator, calendar.

INTRODUCTION/BACKGROUND: The calculator makes figuring interesting facts easier to find. The students can work with larger numbers without worrying about mistakes in calculations. This exercise is broken into very small increments so the task is more manageable to the students.

PROCEDURE: 1) Ask the students if they consider themselves people who eat a lot. Have them volunteer guesses on how much they've eaten in their life.
2) Hand out the worksheet and read over the top portion. Make sure the students are multiplying to get the answers in questions 2, 4, 5, 6, 7 and 8. Have a calendar available for students to use as a reference, particularly when solving question 7.
3) Go over results. Answer questions at the bottom of the page. Compare estimates with actual results.

EXTENSIONS: -Graph the results.
-Find out about how many meals will be eaten by age 18 or any other age.
-Find how many heartbeats the students have had in their life so far.

CROSS-REFERENCE: Strand - Number.
Fill out the following information about yourself.

<table>
<thead>
<tr>
<th>Height ______</th>
<th>Circumference of head in centimeters ______</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight ______</td>
<td>Number of brothers and sisters ______</td>
</tr>
<tr>
<td>Lucky number ______</td>
<td>Number of pets ______</td>
</tr>
<tr>
<td>Hours spent watching T.V. a night ______</td>
<td>Number of letters in your first name ______</td>
</tr>
<tr>
<td>Hours spent doing homework a night ______</td>
<td>Approximate distance of your house to school in miles ______</td>
</tr>
<tr>
<td>Foot size in centimeters ______</td>
<td>Average number of books read in a month ______</td>
</tr>
</tbody>
</table>
GRADE: 4
STRAND: Statistics and Probability

TIME: 1-2 40 minute periods

PURPOSE: The students will collect data and analyze it to find the "average" fourth grader in their class.

MATERIALS: Yardsticks, pencils, fact sheet, bathroom scale, clock.

INTRODUCTION/BACKGROUND: The activity requires the students to measure and record certain parts of their bodies and facts about their life. Because the activities involve themselves, the motivation will be higher since it is easier for the students to get excited about their own bodies and lives. The Framework advocates that the students use their "knowledge and experience when encountering new and unexpected situations." (Mathematics Framework, 1985). With the data collected, the students, in small groups, will average the information to find the "typical" student in the class.

PROCEDURE: 1) Hand the fact sheet out to each student. Inform the students that each one of them is responsible for completing each item on the list. Tell them that they will be using the information to find the average fourth grader in the class.

2) Allow the students time to complete the fact sheets. Undoubtedly there will be some conflict as to how accurate different answers should be. This gives the students the opportunity to make their own decisions and judgement calls, just as professional data collectors must do. For example, most students do not have homework over the weekend so they may ponder how to tabulate the numbers of hours spent doing homework a night. In essence, they may need to average. Permit the students to explore ideas with each other and even stop the group from time to time for group discussion of how to interpret and resolve some questions.

3) When all the students have completed the fact sheet (this sheet may be completed over the course of several days, since you might want the children to go home and measure such things as distance to school) have the students cut their sheet into strips, one strip per piece of information. Then break the class into groups of two or three, and have each group be responsible for finding the average for that fact, using their calculators. As each group finishes, you may encourage the groups to check with each other's results as a system of checks and balances as well as for additional averaging work.

4) Finally, bring the class together again to discover
what the average student in the class is like. You may wish to do this as a bulletin board display. Allow for discussion of whether there actually is this "average" student in the class. This will make the students aware of discrepancies in statistics that may be given in the media.

EXTENSIONS: This may be adapted to any grade level by increasing or decreasing the difficulty of the items to be measured and averaged. Fifth and sixth grade students may get into measuring volume or surface areas of objects in their home. Younger students may calculate the number of stuffed animals they have or pencils in their desks. The activity can be adapted to just measure and average only a student's body parts as well.

CROSS-REFERENCES: Strands - Measurement.
- Geometry.
PERSONAL DATA SHEET

Use the calculator to help you find the following information about yourself.

1) Find your age:

Months _____ Weeks _____ Hours _____

Minutes _____ Seconds _____

2) Find your pulse rate for 30 seconds. 

At that rate, how many times does your heart beat in:

1 Hour _____ 1 Day _____ 1 Year _____

At the present rate, how many times has your heart beaten since you were born? _____

3) Find out how far you can count in 30 seconds? _____

At that rate, how long would it take you to count to:

50,000 _____ 1 Million _____

4) Estimate the amount you consume in two weeks:

Hamburgers _____ Cans of soda _____ Candy bars _____

Glasses of milk _____ Cookies _____

(Other) __________________________________________

Now find out how much of each you would consume in:

1 Year _____ 5 Years _____ 65 Years _____

5) Find out how far you can walk in 15 seconds. _____

Walking at that rate without stopping, how long would it take you to walk:

1 Mile _____ 1 Kilometer _____

6) Estimate the amount of money you spend on entertainment each week. _____

At that rate, how much entertainment money would you spend in:

1 Year _____ 3,192 Days _____ 8,753 Months _____
GRADES: 4, 5, 6
STRAND: Statistics and Probability

TIME: 2-30 minute periods or several shorter lessons

PURPOSE: The students will use the calculator to solve problems concerning themselves.

MATERIALS: Worksheet, calculator, stop watch, yardstick.

INTRODUCTION/BACKGROUND: This activity gives students the opportunity to look at themselves in a different perspective. They will reclassify their ages and make long term projections about various parts of their lives. This activity may be easily done in a work station or as a long term assignment. Whichever way it is done, teachers may want the students to try to get information on question 4 in advance. Question 5 may begin as a group activity, or in pairs outside the classroom. The calculator permits the students to solve these problems with very large numbers easily.

PROCEDURE: 1) Hand out the worksheet and let the students read over the items to be calculated. Group the students in teams of 3 or 4 so they can have others to help them work on the problems if they get confused. Doing activities this way encourage the students to be more self-reliant and allows the teacher more of an opportunity to observe groups more closely since she is not having to teach everyone. The teacher is able to give specific help when needed.

2) As the teacher observes the groups have the students explain how they solved each problem. Since several problems require the students to complete multiple steps, check to be sure they have done each step to arrive at their conclusions. For example, in problem 4, the students must either half the amount consumed in two weeks to calculate the yearly consumption or half the number of weeks in a year.

3) When all groups have finished, bring the class together to discuss the accuracy of results. Concerns that come up may include that people may get tired after walking awhile, so they may actually slow down as in question 5, or that students may spend more money on entertainment during vacation periods as compared with school weeks. These types of observations indicate the students are aware of inherent difficulties in doing statistical work and should be encouraged.
EXTENSIONS: - The class may choose one or more questions to graph.
- Let the students come up with their own questions to tally, such as how often they blink in a minute.

CROSS-REFERENCES: Strand - Measurement.
- Number.
Fill in the worksheet using your bag of candy and your calculator.

Type of product _____

Cost of product _____

Predicted number of candies _____

Actual number of candies _____

% of error:

\[
\left( \frac{\text{difference between actual cost and est'd cost}}{\text{actual cost}} \right) \times 100 =
\]

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<tr>
<th>Colors</th>
<th>Predicted # of that color in bag</th>
<th>Predicted % of that color in bag</th>
<th>Actual # of that color in bag</th>
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<th>Actual #</th>
<th>Actual%</th>
<th>%Error</th>
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Cost per candy ____________________________
GRADE: 6
STRAND: Statistics and Probability

TIME: 1-2 40 minute periods

PURPOSE: The students will find percentages and unit price of edible items in a bag.

MATERIALS: Calculator, worksheet, small bags of M + M's, jelly beans, foil covered eggs, etc. (1 bag of one kind for each child).

INTRODUCTION/BACKGROUND: Food is always a motivation for students and this activity makes it possible for students to eat and learn at the same time. The students will be sorting their goodies by color and determine the percentage of each color candy in their bags. This will lead into some good discussions about marketing decisions. In addition, the students will practice consumerism by determining the best buy for their money. To do this, the teacher will need at least 2 different types or sizes of candy for comparing prices. The students will also practice finding out percentage error in their estimating.

PROCEDURE: 1) Distribute one bag of candy to each student. Instruct the students to wait until the end of the lesson to eat the candy.
2) Have students estimate the number of candies in their bags and the colors in their bags, which gives them estimating practice. Record the results. Have students volunteer answers and discuss the possibility of everyone having the same number of candies or the same number of each color. Ask students how they decided upon their prediction. It helps the students to clarify their thought processes by explaining their strategies.
3) Work with students to find the predicted percentage of each color using calculators. Remind them the dividend is the total number of candies predicted in the bag and the divisor is the predicted number of candies of one color. The quotient is then multiplied by 100 to arrive at the predicted percentage.
4) Tell students to now open their bags and find the actual number of candies in each bag, the actual number of each color, and the actual percentage of each color in the bag. This process should be familiar enough for the students to complete those portions of the worksheet independently.
5) Let the students discover the percentage error in their estimates by following the formula:

\[
\left( \frac{\text{difference between actual number and est'd cost}}{\text{actual cost}} \right) \times 100 =
\]

6) Bring the class together to discuss results and the differences and similarities. The data is a good springboard for discussing why people had different numbers or amounts of a certain color. Students become aware of manufacturing and marketing processes, which is important so they can make the connection to real situations. Let students explore the idea of being the people who decide what colors to put in the bags and how to determine percentages. Discuss how the students might decrease percentage errors in estimating.

7) Finally, using their calculators, have the students calculate the cost per candy by dividing the price of the candy by the number of candies in each bag. Let them conclude which candy would be the best buy and why. Answers may vary but if the students can explain their answers (for example, one student may not like a particular candy, so he would never choose it despite a low cost) accept it.

EXTENSION: Students may graph their results using bar, line, circle, and/or pictographs. Have them ask questions of other students about the results.

CROSS-REFERENCE: Strand - Number.
USING LOGIC

Circle the number that fits all the clues in each example.

1) 297  374  286  312  298

   Clues: It is even.
           It is greater than 25 x 12.
           It is not equal to 34 x 11.

2) 1089  1163  1098  955  1179

   Clues: It is odd.
           It is less than the sum of 347 + 828.
           It is greater than the product of 9 x 11 x 11.

3) 1687  1723  1697  1738  1680

   Clues: It is not divisible by 6.
           It is not equal to 3876 - 2189
           It is odd.
           It is less than 987 + 734.

4) 459  517  735  585  501

   Clues: It is divisible by 3.
           It is greater than the sum of
           123 + 97 + 45 + 236.
           It has a 5 in the hundreds place and ones place.
GRADE: 3
STRAND: Logic

TIME: 40 minutes

PURPOSE: Using the calculator to help solve problems with clues, the students will find the number that satisfies the requirements of all the given clues.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: The students will be practicing their deductive thinking skills in this activity. They will use the given clues to eliminate possible answers one by one. The use of the calculator permits large numbers and multiplication to be a part of the clues, since it will do the calculating for the students. The students should be familiar with the terms greater than, less than, divisible by, and sum.

PROCEDURE: 1) Hand out worksheets. Do the first exercise with the students. Show them ways to indicate when answers are acceptable according to the clue (possibly circle them) and when they don't fit (possibly cross it out). Continue the process with all the clues, asking students to do the calculations and indicate possible answers and wrong answers, until correct the answer is left. 2) If this is the first time your class has done this type of activity, finish the page as a group. Otherwise, let the students work in pairs.

EXTENSION: Let those who finish early to try to create their own examples.

CROSS-REFERENCE: Grades 4, 5 – make similar sheets including clues with division, fractions, and decimals.
WHERE DO I BELONG?

Choose any twenty 3 or 4 digit whole numbers. List them below.

_____  _____  _____  _____  _____  _____  _____  _____

_____  _____  _____  _____  _____  _____  _____  _____

Now sort them into categories:

A. Primes -

B. Multiples of 5 and 9 -

C. An even number or multiple of 9 -

Can a number belong to more than one of these categories?
GRADE: 5
STRAND: Logic

TIME: 30 minutes

PURPOSE: Using a calculator, students will sort large numbers into given categories.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: The idea of sorting things tends to be thought of as an activity for students in grades K-2. However, this ability to discriminate objects according to their attributes is important at any age. This activity is adapted for older students to practice this skill. Instead of objects, numbers will be used.

PROCEDURE: 1) Hand out the worksheet and have students list the numbers.
2) Pick a number of your own and demonstrate how to go through the process of finding the appropriate category. Do this by checking your number for divisibility by the numbers given in B and C. The test for primes will be a bit more complicated, since you need to test for divisibility for many numbers. Remind the students to try to be as thorough as possible, checking all categories to see if the number belongs in each.
3) Allow the children to work independently or in small groups.
4) If you want to give the students more practice, on another day have students exchange papers and check results. Otherwise, go over any numbers that gave students difficulty. Discuss the connection to the real world—that many things may belong to more than one category at a time. For example, a person may be categorized as a father and a son at the same time.

EXTENSIONS: - Use venn diagrams to post results.
- Have class pick numbers and do activities together.

CROSS-REFERENCE: Grade 4 - Use smaller numbers.
- Sort numbers into 2 categories.
MAKING CONJECTURES

1) Multiply some two-digit numbers by 99. Record your results and make a conjecture.

2) Multiply some three-digit numbers by 999. Record your results and make a conjecture.

3) Multiply some two-digit numbers by 999. Record your results and make a conjecture.

4) Multiply some one-digit, some two-digit, and some three-digit numbers by 9999. Record your results and make a conjecture in each case.
GRADE: 6
STRAND: Logic

TIME: 30-40 minutes

PURPOSE: The students will make conjectures about possible patterns they discover when they multiply certain numbers together.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: The students will try to discover certain patterns about numbers they multiply. The key to success in discovering the patterns is that the students must come to their own conclusion that the numbers they choose must follow a pattern as well. If they haphazardly choose numbers, it will be much more difficult to come up with results which lead to a conjecture.

PROCEDURE: 1) Hand worksheets to students and let them work on the activity independently. Observe students as they work. It will be interesting to see which students arrive at the strategy to effectively get results which lead to a conjecture and which students have more difficulty doing so.
2) Go over results in a group. Discuss how many numbers students listed and multiplied by before deciding on a strategy. You may choose to delay this step if many students need more time.

EXTENSION: Repeat this activity with 101, 1001, and 10001.

CROSS-REFERENCE: Strand - Patterns.
TO USE A CALCULATOR OR NOT TO USE A CALCULATOR

You may use the calculator to work any three exercises in a game. You receive 10 points at the beginning of the game. You lose 5 points for each time you use the calculator beyond the three free uses. You cannot use paper and pencil to compute. Use your pencil to write answers only. You get 2 points for each correct answer.

In each game, first study each of the six exercises. Then choose three you will do with the calculator.

Game 1  M = 8473, N = 972

1. M plus N
2. M times N
3. N plus M
4. Zero plus N
5. (900 + 72) times M
6. (8400 + 73) times (900 + 72)

Game 2  A = 575, B = 75, C = 500

1. 6675 times A
2. (B + C) times 6675
3. A minus C
4. 6675 divided by B
5. 6675 x B + 6675 x C
6. (599 x 681) - (681 x 599)

Game 3  A = 899, B = 901

1. A + B
2. A x B
3. B - A
4. B x A
5. 100 times A
6. $A \times 900 + A$

**Game 4** $M = 473, N = 2838$

1. $N$ divided by $M$
2. $M$ times $N$
3. Zero divided by $M$
4. One times $M$ times $N$
5. Ten times $M$
6. One hundred times $N$
GRADE: 4
STRAND: Algebra

TIME: 30 Minutes

PURPOSE: The students will practice substituting numbers for variables and complete the given equations. To solve the equations, students must determine the best method to use, either the calculator or mental arithmetic.

MATERIALS: Worksheet, calculator.

INTRODUCTION/BACKGROUND: This activity involves the use of several skills and concepts. First the students must be able to substitute a variable for the appropriate number value to solve the equations in which the variables occur. Second, they must be able to mentally switch the written word into appropriate mathematical symbols or numbers. Finally, students must analyze a set of problems prior to working on them to determine what method to use to solve them, since the students are allowed only 3 free uses of the calculator. This forces the students to think before they act as well as gives them practice ascertaining how to approach a problem most effectively.

PROCEDURE: 1) Hand out the worksheets and go over the directions with the students. Tell students to put a star next to the exercises for which they used the calculator.

2) Have students play game 1 independently. When finished, discuss results as a class and have students tally scores. Have students discuss how they decided which exercises to complete with the calculator. This helps the slower students learn strategies to use.

3) Continue the activity in this way or group students in pairs. Still discuss strategies used at the end.

EXTENSION: Use decimals for the variables.

CROSS-REFERENCES: Strand - Number.
Grade 3 - Use smaller numbers to replace variables and/or use only addition and subtraction.
**ONLY ONE ANSWER?**

Use your calculator to replace the variables in the number sentence to see if the given values of \(a\), \(b\), and \(c\) make the sentence incorrect.

1) \(5a + 4b = 45\)

a) \(a = 5\) \( b = 5\)

b) \(a - 6\) \( b = 3.75\)

c) \(a = 4\) \( b = 7\)

d) \(a = 1\) \( b = 10\)

e) \(a = 2.5\) \( b = 8.125\)

2) \(2a + 6b = 96\)

a) \(a = 24\) \( b = 8\)

b) \(a = 46.5\) \( b = .5\)

c) \(a = 12\) \( b = 12\)

d) \(a = 17.25\) \( b = 10.25\)

e) \(a = 15\) \( b = 7\)

3) \(12a + 4b + 2c = 426\)

a) \(a = 30\) \( b = 2\) \( c = 8\)

b) \(a = 9\) \( b = 52\) \( c = 55\)

c) \(a = 15.5\) \( b = 21.25\) \( c = 50.5\)

d) \(a = 24.75\) \( b = 16\) \( c = 32.5\)

e) \(a = 43\) \( b = 20\) \( c = -5\)

Challenge: Can you find other replacements for the variables that will make the sentences true?
GRADE: 5
STRAND: Algebra

TIME: 20-30 minutes

PURPOSE: The students will use the calculator to prove that many numbers may replace variables in a number sentence and still make the sentence true.

MATERIALS: Calculator, worksheet.

INTRODUCTION/BACKGROUND: Students sometimes have the false notion that there is only one way to solve a problem and make it true. This activity helps dispel that belief. The calculator allows the students to efficiently replace numbers for the variables and obtain results. The students begin to see the connection between a variable and the concept that it can represent whatever value the person assigns it.

PROCEDURE: 1) Hand worksheets to students and go over directions with them. Do the first part of question 1 with them, preferably using an overhead calculator if one is available.
2) Have students complete the page independently. Students who finish early should attempt the challenge question.
3) Go over results as a group.

EXTENSION: Show students how to use the memory key to do this problem.

CROSS-REFERENCE: Strand - Number.
FIND THE MISSING VALUES

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<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
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<th>a + b</th>
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<td>a</td>
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</table>
GRADE: 6
STRAND: ALGEBRA

TIME: 20-30 minutes

PURPOSE: The students will practice substituting numbers for variables and use inverse number operations to complete the chart.

MATERIALS: Calculator, worksheet.

INTRODUCTION/BACKGROUND: This exercise requires use of several concepts and skills. First, the students must be familiar with the idea that letters are just replacements for numbers. Secondly, the students, with the calculator, will use the concept of inverse operations to find the numerical value of the unknown variables or algebraic terms. Finally, the problem solving skill of guess and check will be important to solve examples like the third one. The calculator is a great asset for this activity. It permits calculations to be done more quickly than with the paper and pencil.

PROCEDURE: 1) This activity is easily done alone or in small groups. Hand out the worksheets and go over one example with the students. Let the students answer how they would go about finding the value of "a" given the information that is given. The students should realize that since 1495 is the product of 65 and another number, "a", that they must divide to find "a". If this is too difficult, give an alternate problem which is similar. For example:

\[
\begin{array}{c|c|c|c}
 a & b & axb & a+b \\
 \hline
 5 & 30 &
\end{array}
\]

Since this example involves a basic number fact, the answer should be more readily obvious. Going to a simpler problem generally takes away any apprehension surrounding the use of larger numbers.

2) Once the class feels comfortable with the first problem, let them complete the page independently. If the students are working in small groups, circulate around the room to listen to the conversations, particularly concerning problems like number 3. The students must do some guessing and checking, and the teacher can learn about the student's ability to make reasonable guesses this way by using estimating. For example, on question 3, if a student guesses the "a" and "b" are 2 and 18, he has some difficulty with estimating since 2 x 18, when rounded, would be 2 x 20
or 40. 40 is not within a reasonable range for this answer.

3) Discuss results and strategies for various problems when most of the class is done.

EXTENSION: Use decimal numbers.

CROSS-REFERENCES: Strand - Number.
Grade 5 - Use smaller numbers as in the example in step 1 of the procedure section.