Some Cognitive and Affective Aspects of the Use of Hand-Held Calculators in High School Consumer Mathematics Classes.

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SOME COGNITIVE AND AFFECTIVE ASPECTS OF THE USE OF HAND-HELD CALCULATORS IN HIGH SCHOOL CONSUMER MATHEMATICS CLASSES

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

The Department of Education

by

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M.Ed., Mississippi State University, 1959
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ABSTRACT

New approaches to the teaching of verbal problem solving in mathematics have long been sought, as have strategies for the improving of pupil attitudes toward mathematics. This study researched the use of a teaching aid—the hand-held calculator—that could possibly perform both of these functions. The following hypotheses were tested:

1. The use of the hand-held calculator in high school consumer mathematics classes does not result in significant gains in student achievement in mathematical verbal problem solving.

2. The use of the hand-held calculator in high school consumer mathematics classes does not result in improvement of student attitudes toward mathematics.

Fifty-one twelfth-grade consumer mathematics students comprised the experimental group, in which Novus 850 hand-held calculators were used to perform all computations; forty-three twelfth-grade consumer mathematics students made up the control group, in which traditional paper-and-pencil methods of computation were used. The study was conducted for a period of nineteen weeks.

Pre-tests and post-tests were administered to measure changes in achievement in verbal problem solving in
mathematics and attitude toward mathematics. The achievement test was the "Mathematics: Problems" section of the California Achievement Tests, Level 5, Form A; the attitude scale was a modified version of The A-V Scale of Attitude Toward Mathematics. At the end of the school year an opinion poll on the use of hand-held calculators in the classroom was taken of the members of the experimental group, and the results were presented in tabular form.

An analysis of covariance was performed on the achievement test and attitude scale data. This was supplemented, in the case of the achievement test, by an analysis of variance, as there were such slight initial differences between the pre-test scores of the two groups. All analyses resulted in small, non-significant F-ratios; thus both null hypotheses tested in the study were supported by the data. The members of both groups progressed in verbal problem solving ability during the course of the study.

The opinion poll revealed strong positive attitudes toward the use of calculators in the classroom. Nearly all the students expressed strong support for the continued use of calculators in the classroom, appreciation for the speed with which they could finish problems using the devices, and greater confidence in and enjoyment of their work during the time the calculators were in use.

There were no significant differences in achievement or attitude between members of the control group and members
of the experimental group that were attributable to the use of hand-held calculators. Computation, as affected by the use of the calculators, did not thus appear to be a major factor in verbal problem solving ability of the students involved in this study. The use of calculators did not improve the attitudes of the students toward mathematics, though positive feelings were expressed toward use of the devices in the classroom.

As a result of this research, it is recommended that further studies be undertaken using hand-held calculators in the classroom, with a population more normally distributed as to mathematical ability and with tests designed specifically for consumer mathematics course content. It is also recommended that proper calculator operation be taught in consumer mathematics classes and that curriculum materials be developed for use with the devices. The use of calculators, particularly by under-achievers, should be encouraged as a means of developing confidence in students' mathematical abilities.

Further observations by the teachers involved in the study were that calculator use enabled material to be covered faster, encouraged cooperation and responsibility among the students, and appeared to improve classroom discipline.
Chapter 1

BACKGROUND TO THE STUDY

Educational technology is infiltrating the classrooms of the United States and other nations, changing the methods of teaching of classroom teachers each year (Longstaff, Stevens and King, 1968). One of the major technological advances of the past twenty years is the refinement of computing machines. The most recent progress directly affecting the general public is the development and retail marketing of the small hand-held calculator at prices that are within the purchasing power of most consumers. A recently advertised price at a discount store was $6.77 for a basic four-function machine.

In the February, 1974, issue of The Instructor, the following statement was made:

Calculators are fast becoming accepted as needed household appliances. Certainly, children in school now will, as adults, look on calculators as being as necessary to everyday life as telephones (Denman, 1974:56).

The December, 1974, issue of Educational Technology included an article on the electronic calculator in which the prediction was made that "An electronic calculator, priced well below $50.00, will soon be an integral part of many school mathematics programs" (Etlinger, 1974:43).
Apparently, access to inexpensive calculators in the mathematics classroom will influence the types of mathematical skills emphasized and the methods by which they are presented. Many mathematics educators are voicing the opinion expressed by Max Bell (1974:197):

Finally, I have become convinced during just this past year that the widespread availability of cheap electronic calculators will have profound effects and must move us very soon to reevaluate many of our current practices in the teaching of school mathematics.

In the process of examining such practices (Higgins, 1974:56), the question of when Johnny should add will probably become more important than "Why can't Johnny add?"

The Instructional Affairs Committee of the National Council of Teachers of Mathematics (NCTM) recognizes the hand-held calculator to be a valuable instructional aid and, in the January, 1976, *The Mathematics Teacher*, published a list of suggested ways to use the calculator in the mathematics classroom. Included in the list are suggestions for use in consumer mathematics situations, for use as a device to decrease time consumed in doing difficult computations, and for use in the promotion of student independence in problem solving.

In an article in the February, 1976, *The Mathematics Teacher*, Eleanore Machlowitz (p. 104) said of calculators, "Recommended mathematics classroom uses have often been confined to eliminating lengthy computations in such areas as trigonometry, statistics, probability, and business
problems." She (p. 104) further noted, however, that calculators may offer even more significant "opportunities for learning in discovery, demonstration, and reinforcement in the general mathematics classroom with even the lowest-ability student." Machlowitz also presented various ideas for the classroom use of calculators in the teaching of mathematics and offered tips on buying calculators.

Mathematics educators should investigate ways in which electronic calculators can enhance the study of mathematics (Etlinger, 1974; Machlowitz, 1976). As a secondary mathematics teacher, the experience of this writer has been that the greatest problem facing the general mathematics teacher is that of teaching the solving of verbal problems in mathematics. Problem solving involves intuition and the ability to recognize patterns and make generalizations, but these qualities in turn depend upon a certain level of mastery of the basic skills of mathematics, including computational skills.

The degree of mastery of the required computational skills in relation to the use of computing machines remains in doubt, as does the role of the machines in the mathematics classroom. It might be that the title of an article in the October, 1974, issue of The Mathematics Teacher, "Computational Skill is Passe," is an accurate statement of a future trend in mathematics. Students may be more inclined to concentrate on mastering problem solving if
they are freed from arduous computation. Denman (1974:56) declared that:

The calculating speed of the electronic machines stimulates able learners to solve long complex problems, while allowing less able students to check the correctness of their computations quickly and thus gain confidence in their ability.

Calculators may also serve as a motivational force in the classroom (Denman, 1974; Etlinger, 1974). Mathematics teachers are frequently confronted with the "I hate math" attitude, sometimes referred to as "mathemaphobia," that many students seem to possess. Though most studies have shown that attitudes and achievement are not significantly related, the intrinsic importance of student attitudes toward mathematics should be worth considering (Aiken, 1970). If calculators can improve the attitudes of students toward mathematics, they may make a very significant contribution to mathematics education.

THE LITERATURE SURVEY

The literature survey included selected research studies pertaining to verbal problem solving in mathematics, the use of calculators in the mathematics classroom, and attitudes toward mathematics. Because of the impact of "new mathematics" and technological advances in calculator production, no studies done prior to 1956 were included.
Research on Verbal Problem Solving in Mathematics

The necessity of the ability to solve verbal mathematics problems surrounds one in the complexities of everyday life. The National Assessment of Educational Progress recognized the importance of solving mathematical problems by identifying problem solving in two of the five listed abilities for the national mathematics assessment (Carpenter, Colburn, Reys and Wilson, 1975:455). Those two abilities were defined as follows:

IV. Solving mathematical problems—social, technical and academic

V. Using mathematics and mathematical reasoning to analyze problem situations, define problems, formulate hypotheses, make decisions and verify results.

A verbal problem in mathematics is a written problem that is stated in words instead of in symbols and is constructed so that the operations necessary for solving the problem must be determined. The problem is generally one of applied mathematics. Problem solving is perhaps best described in the following statement by Wilson and Becker (1970:293):

Solving a mathematics problem should involve the systematic application of one's knowledge to the novel situation, lead to the complete understanding of the problem and its solution, and in turn, increase one's knowledge through learning new information (the solution), enhancing problem-solving skills (the process), and discovery of new relationships.

Researchers have been most interested in seeking to delineate the nature of the various and complex relationships that seemingly exist among the components of the
ability to solve mathematical problems, especially verbal problems. Many researchers have found that general intelligence, reading skills, and computation skills surface as major components of mathematical problem solving ability. A deemphasis on Intelligence Quotient (I.Q.) scores in recent years has probably been a factor in the widespread dearth of current research on the effect of I.Q. on problem solving ability. Contemporary researchers have concentrated on specific mental abilities, such as reasoning ability and verbal facility, and their influence on verbal problem solving. The bulk of research in the area of verbal problem solving, however, has been centered on the interaction of reading and computation skills with problem solving ability.

After analyzing the results of several studies on the effects of verbal and other language factors on performance in mathematics, Aiken (1971:306) stated, "Certainly both mathematical ability and verbal ability are substantially correlated with scores on general intelligence tests," and (p. 308) "...the correlation between reading ability and mathematical ability falls markedly when their common overlap with general intelligence is partialled out."

Computation skills consistently seem to show a much closer relationship with problem solving ability than any of the other factors studied by researchers. In an interpretative study of research and development in elementary
school mathematics, Suydam and Weaver (1970:1) noted not only that skill in computation is a characteristic of successful problem solvers, but also that "Reasons for difficulty with problem solving generally focus on computation, reading, and knowledge of fundamental concepts."

In a 1956 doctoral dissertation study of the relation between children's understanding of computational skills and their ability to solve verbal problems in arithmetic, approximately four hundred seventh- and eighth-grade students were tested, and the results were analyzed by correlation and multiple regression statistical techniques. The results of the path coefficient technique attributed 39.69 percent of the influence in problem solving ability to computing ability (Butler, 1956).

Alexander's (1960) study of seventh graders identified skill in computation as making a significant difference between high and low achievers in problem solving when tested at the .05 level of significance. Alexander (p. 604) stated that the students' problem solving ability appears to depend primarily upon their quantitative ability to "(1) interpret and use the number system, (2) employ the fundamental processes with various types of numbers, and (3) comprehend and use concepts of measurement." It was further noted that "Accuracy in rapid addition of whole numbers alone, however, is insufficient to insure success in problem solving."
Chase (1960) concluded from his research with sixth-grade students that the ability to compute is one of three major variables that can be used to predict problem solving ability. Martin (1963) noted that there is a complex interaction among the variables involved in the ability to solve verbal problems. She commented on the computation variable as follows: "A basic facility in arithmetic computation is necessary in problem solving, but when computational steps are placed in verbal context certain additional complex abilities are required" (p. 4548-A).

Balow (1964:19) declared that "Problem solving requires computational skill--the child who is unable to compute is unable to solve problems requiring computation." This conclusion was reached in a study of fourteen hundred sixth-grade pupils that explored reading and computational skills as determinants of problem solving. Scores on the reasoning test administered in Balow's study were more closely related to computation ability than to reading ability after the effects of I. Q. were controlled. The research results (p. 22) implied "...that for a given level of computation ability, problem solving increases as reading ability increases, and that for any given level of reading ability, problem solving increases as computation ability increases." Thus Balow's final conclusion was that both reading ability and computation ability must be considered when problem solving is being taught.
Tucker (1975) came to much the same conclusion as Balow in a dissertation study of eighty fourth-grade pupils that explored the identification of the primary skills that distinguish good problem solvers and the extent to which these skills are related to problem solving ability. Tucker added another dimension to successful problem solving—that of modeling—that appeared to bear a significant relationship to pictorial and verbal problem solving. The modeling skill, i.e., "...the ability to identify models which are analogous to problems and situations" (p. 2620-A), was found to have a stronger relationship to problem solving skill than either skill in computation or skill in reading.

The conclusions of Alan Riedesel are not consistent with the majority of research results on the effects of computation on problem solving. Riedesel (1969:54) wrote: "While the improvement of computation is important to problem solving ability, the improvement of computation alone has little, if any, measurable effect upon reasoning and problem solving." Therefore, the role that computation plays in the solving of verbal problems in mathematics is yet to be well defined.

Research on the Use of Calculators in the Classroom

If the improvement of computation does significantly affect problem solving ability, then the use of calculators to perform the necessary computations should promote more efficient solving of verbal mathematical problems. Most of
the research studies on the use of calculators have been performed on fifth- through ninth-grade populations and have detected no significant differences in attitude toward or achievement in mathematics that could be attributed to the use of the calculator.

Several studies were conducted using large desk calculators of the models commonly used during the nineteen fifties and sixties. Lois Beck, in her article "A Report on the Use of Calculators" in The Arithmetic Teacher, February, 1960, reported on an in-progress experiment in several intermediate grades of the Riverside City School District, Riverside, California. She observed that elementary school children could operate desk calculators effectively and that the calculators tended to motivate the students to work math problems more efficiently and with greater enjoyment and enthusiasm. The calculators further seemed to reinforce basic computational skills, to promote the ability to follow directions, and to encourage an atmosphere of cooperation among the children. The final results of the experiment were not in, but Beck disclosed that the school district was ordering more machines for classroom use in the future.

During the early 1960's Durrance (1964) investigated the effect of the use of rotary calculators on achievement in arithmetic of selected sixth- through eighth-grade pupils of the Peabody Demonstration School in
Nashville, Tennessee. The hypotheses tested in Durrance's study were that use of calculators would not affect arithmetic achievement in any of the grades participating in the experiment. The only phase of the hypotheses that was rejected when tested at the .05 level of significance was that of reasoning at the seventh-grade level. Durrance (p. 6307) thus cautiously concluded that "there is no proof that the use of the calculator will significantly enable a student to achieve in arithmetic."

The overall results of Durrance's research have seemingly been borne out in the majority of more recent research studies on the use of various types of calculators in mathematics classrooms. The literature search revealed that, of eleven such studies, only four report any significant differences in mathematical achievement in any area between student groups who were allowed to use calculators and those groups who were not allowed the use of calculators.

A Canadian research team investigated the use of electric desk calculators in ninth-grade mathematics classes in a technical secondary school and in a vocational school, as well as in a regular fifth-grade elementary school class (Longstaff, Stevens and King, 1968). Experimental and control groups were used, with a Hawthorne group added at the technical school. Teacher differential was controlled by having the same teacher instruct both experimental and
control groups when possible. T-tests were employed to evaluate the statistical data. No significant differences in ability to solve mathematical problems traceable to the use of the calculator were detected between the experimental and control groups, or between them and the Hawthorne group. Significant differences were recorded, however, in the areas of self-confidence and attitude toward mathematics. These differences favored the experimental group at the technical school on the attitude rating, the control group at the vocational school and the experimental group at the fifth-grade level on both self-confidence and attitude scores. Therefore, the results of this study were equivocal on the achievement, attitude, and self-confidence tests.

Sol Mastbaum (1969) conducted a dissertation study involving seventh- and eighth-grade slow learners in mathematics, with the use of desk calculators as one facet of the study. He investigated the effects of his various treatments on attitude, achievement, computation skill, mastery of mathematical concepts, and ability to solve mathematical problems. The use of the calculator as a teaching aid did not significantly improve any of the foregoing five aspects of the students' mathematical experience.

Cech (1972) and Ladd (1974) researched the effects of the use of desk calculators on attitude and on achievement in mathematics of low-achievers at the ninth-grade
level. Analysis of the test scores on the pre-test and post-test forms of the achievement and attitude tests used in both studies revealed no significant differences between the experimental and control groups. Cech concentrated on achievement in computational skills, whereas Ladd's focus was on achievement in the mathematics necessary to function in everyday life, including verbal problem solving from the world of business.

O'Loughlin (1975) and Zepp (1976) investigated various aspects of college mathematics and the interaction of these aspects with the use of the hand-held calculator. O'Loughlin tested calculator use in college calculus classes, while Zepp tested not only college students, but some ninth graders as well, on the effects of calculator use on reasoning patterns and computation employed to solve proportion problems. Neither investigator found any significant differences in achievement between the experimental and control groups. O'Loughlin also incorporated an attitude test in his research, but it, too, showed no significant mean gains in favor of either group's test scores. The students in his experimental group did, however, express a strong preference for the continued use of the hand-held calculator as a teaching aid in the calculus class.

Warren Nichols (1975), in a research study conducted for the Northwest Oklahoma Education Service Center, studied the use of the hand-held calculator in eighth- and ninth-grade mathematics classes. He investigated the
relationship of calculator use to both attitude and achievement of the groups of students involved in the study. No significant differences between the gains made by students in the experimental group and those made by members of the control group were detected through an analysis of covariance that was applied to the statistical data; however, attitude and achievement both improved somewhat in the eighth-grade experimental group when compared with the control group.

Among the studies reporting significant gains in favor of students who were allowed to use calculators is one researched by Keough and Burke (1969) for the Suffolk County, New York, Regional Center for Supplementary Educational Services. Thirteen eleventh- and twelfth-grade mathematics classes from two high schools, including several accelerated classes, comprised the population for the study. The Sequential Tests of Educational Progress were used for both pre- and post-tests, with the results being analyzed by use of a t-test. Upon analysis of the post-test, a significant difference was found to exist between the experimental and control groups at the .01 level of significance. The calculators used were electronic desk calculators and were housed in a mathematics laboratory. The lesson sequences were composed of higher topics in mathematics. It was recommended by students and by the investigators that calculators continue to be used and that their use be expanded in the schools of Suffolk County, with curriculum
materials to be developed explicitly for use with calculators. This study was the only study on calculator use in high school grades that was found in the literature search.

Gaslin (1975) designed a program to be used in ninth-grade mathematics for the teaching of positive rational numbers, with emphasis on operations involving fractions, in which he developed a group of calculator-dependent algorithms for working the problems. One group in Gaslin's study used these algorithms with desk calculators; another group used conventional algorithms for performing operations on rational numbers, but also used calculators. A third group used the conventional algorithms, but without calculators. Mastery learning techniques were employed in the teaching of the material used in the investigation. Gaslin found no significant differences among the groups with respect to mean scores of attitude toward studying operations on rational numbers, but differences were discovered in favor of calculator use on several objectives of the rational number unit, including a retention factor. The calculator-based algorithms seemed to produce better results than the conventional algorithms used with calculators.

Advani (1972) presented a paper to a conference of the Ontario Educational Research Council at Toronto, Canada, on the effect of the use of desk calculators on attitude and achievement of children with learning and behavior problems. He noted that the students involved in the
experiment displayed significant increases in interest and positive attitudes toward mathematics, as well as a reduction of their disruptive behavior. Advani concluded that calculators can help release frustrations of children with inaccessible numbers and can aid teachers in individualizing instruction.

A study involving the use of the hand-held calculator was done recently by Joann Nora Spencer (1974). She examined the use of these small devices for computing in fifth- and sixth-grade arithmetic classes. Spencer tested mathematical reasoning ability and computational skills. The fifth-grade results (p. 51) showed that "there was a significant difference between the treatment groups in favor of the experimental group on the gain scores in reasoning ability" and that there existed "no significant difference between the gain scores of the treatment groups in computational skills or total arithmetic achievement." The sixth-grade results indicated the reverse to be true, for they showed no difference in favor of the experimental group on reasoning ability but did show such a difference in computational skills and total arithmetic achievement. Spencer further found no differences to exist as a function of the sex of the student and its interaction with the treatment.
Research on Attitudes Toward Mathematics

Most of the foregoing studies explored the effects of the treatments used in the experiments on the students' attitudes toward mathematics. Researchers seem to have the feeling that attitude and achievement in mathematics are closely related. Attitude is an elusive quality that is difficult to measure; however, recent emphasis on the affective domain of learning has renewed efforts to improve research into attitudes and their effects upon the cognitive domain of learning. Most people agree that attitude is an important part of learning, but they are not sure why or how.

Lewis Aiken, Jr. has done extensive research on attitudes toward mathematics. In a 1970 review of literature on the subject, he concluded that negative attitudes toward mathematics usually develop in junior high school and that the most consistent factor in shaping students' attitudes toward mathematics is the classroom teacher. Support for Lewis' conclusion pertaining to the period of crucial attitude formation can be found in Anttonen's longitudinal study of the development of attitudes toward mathematics (1969). Support for the conclusion that teachers are most influential in determining student attitudes can be found in a 1973 article by Robert Phillips, Jr. in School Science and Mathematics.

In commenting upon mathematics attitudes, Lazarus (1975:7) said, "The dislike is usually irreversible." He
further stated, "Trouble in any year, for any reason, is nearly certain to spell trouble in all the years to come."

In attempting to find a causal predominance in the relationship between attitude toward and achievement in mathematics, Burek (1975) produced very few statistically significant results. However, there seemed to be some support for the probability that cognitive achievement predominated over attitude for the subjects studied in grades six and seven, but the direction of predominance reversed in grade eight. The significant differences indicated (p. 2155-A), generally, that "attitude toward mathematics predominated over cognitive achievement in mathematics," especially "for students who exhibited a definite attitude toward mathematics."

Gordon (1975:7746-7747-A) found that, "Students who in the fall had a high attitude toward mathematics as a process tended to score high on the eleventh year Regents examination: similarly, for final grades, in the spring." He also presented evidence to the effect that students who prefer low classroom structure tend to obtain high grades and are more comfortable in mathematics classes and, also, that students who score high on attitude toward mathematics as a process are likely to favor low classroom structure.

Roberts (1969) and Anttonen (1969) noted the need for further study of attitudes toward mathematics. They felt additional research was needed in order to determine
practices that might lead to attitude changes and the effect of such changes on achievement in mathematics.

Summary

Thus the literature reveals conflicting evidence of factors involved in learning mathematics and supports the need for further research in many areas of mathematics education. The role of computation in verbal problem solving and the usefulness of calculators in aiding the solving of verbal problems and in overcoming "mathemaphobia" are yet to be determined.

STATEMENT OF THE PROBLEM

This experimental study was designed to determine if there was a significant difference between scores of students in the experimental group, who used the calculators, and students in the control group, who used the standard paper-and-pencil method of computation, using two areas of measurement: problem solving achievement and attitudes. The study attempted to answer the following questions:

1. Does the use of the hand-held calculator in high school consumer mathematics classes result in significant gains in student achievement in mathematical verbal problem solving?
2. Does the use of the hand-held calculator in high school consumer mathematics classes result in improvement of student attitudes toward mathematics?

ORGANIZATION OF THE STUDY

A randomized design was used and examined statistically by analysis of covariance techniques to investigate the outcomes of the experiment. The design of the study will be discussed in detail in Chapter 2, with the analysis of the data to be presented in Chapter 3. Conclusions and recommendations based on the results of the study will be given in Chapter 4, along with a few observations that were made during the course of the study.
Chapter 2

DESCRIPTION OF THE STUDY

As previously noted, new approaches to the teaching of problem solving have long been sought, as have strategies for the improving of pupil attitudes toward mathematics. This study researched the use of a teaching aid—the hand-held calculator—that could possibly perform both of these functions.

CONCEPTUALIZATIONS

A calculator is "a keyboard-operated machine used to perform arithmetic computations" (Good, 1973:76). The hand-calculator is a small, light-weight, portable, electronic calculator. The results of the computations are displayed on a lighted electronic register. A desk calculator is a larger calculator than the hand-held calculator. Older model desk calculators are electric, whereas newer ones are electronic; therefore display facilities vary. Portability is a problem with most desk calculators because of their bulk and weight. They are not as common or convenient to use as the hand-held calculators.

A verbal problem in mathematics, as used in this research, refers to a problem in mathematics as that subject is applied in everyday life. A complete definition
of this type of mathematics problem is given in Chapter 1, page 5.

**Basic skills of mathematics** refers to facility in the operational techniques of mathematics. These techniques are generally considered to be those involved in addition, subtraction, multiplication, and division of rational numbers.

Attitude is "the predisposition or tendency to react specifically towards an object, situation, or value: usually accompanied by feelings and emotions" (Good, 1970:49). Thus **attitude toward mathematics** denotes the feelings mathematics invokes in one.

**Consumer mathematics** is a branch of applied mathematics which consists of mathematical skills that are useful to the consumer in life situations such as banking, shopping, installment buying, tax paying, and purchasing of insurance. The high school consumer mathematics course in the Jackson Public Schools is designed to be a terminal course in mathematics and is available primarily to twelfth-grade students as an elective course.

**Emergency School Aid Act mathematics classes** were established in Jackson, Mississippi, in 1973 as a result of the Title VII amendment to the Elementary and Secondary Education Act of 1964. The Jackson ESAA program for high school mathematics requires that the students in the program be underachievers and that the mathematics curriculum
to which they are assigned be designed to motivate them and to increase their achievement in basic mathematics. An underachiever, according to the program requirements, must be a student of average or above average ability, as determined by local school personnel, who has consistently achieved below his or her ability level in mathematics. Intelligence Quotient (I. Q.) test results, previous grades in mathematics, and teacher recommendations are the principal factors utilized in the placing of students in the ESAA classes. The local school personnel set up the mathematics program to be followed by the students; teachers are hired specifically to teach in this program.

DELIMITATIONS OF THE STUDY

The population of this study was composed of ninety-four students assigned to seven classes of consumer mathematics at a high school in the Jackson, Mississippi, Public School District. Five of the seven classes were made up of sixty twelfth-grade students assigned to ESAA mathematics classes; the two remaining classes contained thirty-four twelfth-grade students assigned to regular consumer mathematics classes. The five ESAA classes were taught by this investigator, while the two regular classes were taught by another mathematics teacher on the high school faculty.

The I. Q.'s, as given by the Primary Mental Abilities Test administered in earlier grades, ranged from
approximately 60 to 130, with by far the majority of the I. Q.'s falling in the 80 to 110 range. The mean I. Q. was approximately 95 for each of the two groups into which the students were divided for the purposes of this study—the experimental group and the control group. The grade average for all the mathematics courses taken by the students in each group from the ninth through the eleventh grades was D on an A, B, C, D, F grading scale, as was the overall average of all their high school academic class grades. The experimental and control groups were relatively homogeneous in this respect.

The research was done during the academic year 1975-1976, between the dates of November 10 and April 8. This was a period of approximately nineteen school weeks.

EXPERIMENTAL DESIGN

Thirty-five students in three of the five ESAA classes and sixteen students in one of the two regular classes comprised the experimental group, which used handheld calculators to perform the mathematical computations required in the process of solving problems. The control group was composed of twenty-five students in the two remaining ESAA classes and eighteen students in the remaining regular consumer mathematics class. These students used the traditional paper-and-pencil method of computation.
The ESAA consumer mathematics classes were scheduled first, second, third, fifth, and sixth periods each day, while the regular consumer mathematics classes were scheduled first, second, and third periods. The school principal did all teacher-class scheduling. Since only one of the regular consumer mathematics classes was to be in the experimental group and one in the control group, it was decided to select these first, for only one class set of calculators was available and had to be shared by both teachers. Two experimental classes could not therefore be assigned during the same time period. The numerals 1, 2, and 3 were written on pieces of paper, and one piece of paper was drawn for the determination of the experimental class; then one was drawn to determine the control class. The pieces containing the numerals 3 and 2, respectively, were drawn, selecting the third period regular consumer mathematics class to be in the experimental group and the second period to be a part of the control group. This drawing eliminated the researcher's third period ESAA class from consideration as an experimental class. Next three of four pieces of paper containing only the numerals 1, 2, 5, and 6 were similarly drawn one at a time to determine the three ESAA experimental classes. By this method of random selection, first, second, and sixth periods were selected as the ESAA experimental group classes, leaving third and fifth periods in the control group.
Testing of the Hypotheses

An achievement test and an attitude scale were administered to all students at the beginning of the study and again at the end of the study, at which time the members of the experimental group were allowed to use the calculators to work the post-test problems on the achievement test. An analysis of covariance was performed on both achievement and attitude test data in order to adjust for initial differences between the two groups; the covariants to be controlled were the achievement and attitude pre-test scores, respectively. The following null hypotheses were tested, using the .05 level of significance:

1. The use of the hand-held calculator in high school consumer mathematics classes does not result in significant gains in student achievement in mathematical verbal problem solving.

2. The use of the hand-held calculator in high school consumer mathematics classes does not result in improvement of student attitudes toward mathematics.

At the end of the school year, the pupils in the experimental group were requested to express their opinions about the use of the calculators. The results of this poll were analyzed and reported in tabular form. All data used in this study were analyzed by the researcher.
The course of study for consumer mathematics was based on the textbook *Business and Consumer Arithmetic* by Milton A. Olson and A. C. McNelly (Prentice-Hall, 1969) and supplemented by teaching aids, including *The How and Why of Banking* by the Mississippi Bankers' Association; an income tax unit, *Understanding Taxes*, donated by the Internal Revenue Service; and a series of booklets and accompanying filmstrips on paychecks, household budgets, and general money management published by Educational Projects Corporation, 1970, from their unit entitled *Handling Finances: Budgeting, Buying, Saving*. Chapters 8 through 11, 17, 18, and 20 in the Olson and McNelly textbook provided the source for most of the actual mathematics problems that were worked by the students during the time the experiment was underway. Topics covered in these chapters are interest rates, savings and checking accounts, consumer credit, taxes, and monthly paycheck problems. Each of the main topics was covered in a two- to four-week time period. A schedule for instruction in each topic is found in Appendix C.

Supplementary verbal problems from the areas of consumer shopping and budgeting were also included in the course of study. These problems were selected primarily from earlier chapters of the textbook.
The Calculating Devices

The calculators used by the experimental group were Novus 850 models, which performed only the four basic operations. There was one calculator per student in each class. On the back of each calculator was a serial number, the last four digits of which were used in assigning a calculator to each student for use during his or her particular class period. The teachers checked the calculators out and in each class period. No outside assignments involving computations were given the students by either teacher. The calculators were purchased initially by the writer and were sold to students and to other teachers on the faculty upon completion of the study. The students who used the calculators donated money to buy the necessary batteries that were required to keep the devices operating.

The students in the experimental group were given one and one-half class periods of instruction in the rudiments of calculator use at the beginning of the study. Otherwise, questions were answered as problems arose during the course of the experiment.

DESCRIPTION OF TESTING INSTRUMENTS AND PROCEDURES

This study was designed to measure any differences in achievement or attitude toward mathematics that might be attributable to the use of hand-held calculators in the classroom. Thus an achievement test and attitude scale,
supplemented by an opinion poll, were administered to participants in the study.

The Achievement Test

The instrument used to pre-test and post-test student achievement in problem solving in both the control and experimental groups was the "Mathematics: Problems" sub-test of the 1970 edition of the California Achievement Tests (CAT), Level 5, Form A, designed by Ernest W. Tiegs and Willis W. Clark and published by the California Test Bureau/ McGraw-Hill, Inc. The CAT is a standardized battery of tests in reading, mathematics, and language skills. The coefficient of reliability for the entire battery of tests is approximately .98 at each grade level for which the test was designed. The reliability coefficient was computed by use of the Kuder-Richardson Formula 20, a split-half statistical technique. The particular fifteen-item sub-test used in this study focuses on verbal problem solving in grades eight through twelve and has a reliability coefficient of approximately .92 when combined with the "Mathematics: Concepts" sub-test. No separate coefficient of reliability is available for the "Mathematics: Problems" sub-test. A copy of the problems sub-test may be found in Appendix A.

The pre-test and post-test were administered as a part of the Jackson Public Schools' ESAA testing program. The testing dates were set by the program's coordinators
for the last week of September, 1975, and the first week of April, 1976. The sub-test used in this study was administered on September 25, 1975, and again on April 7, 1976, as a part of the mathematics section of the CAT battery. The students recorded their answers to the problem solving sub-test on two answer sheets—one provided for the ESAA testing program and one for the use of the investigator. The time limit of twelve minutes for the sub-test was observed on the ESAA answer sheets, but the pupils were allowed to continue, with no time limit, on the answer sheets that were used for the purposes of this study. It was felt that the time limit might unfairly bias the test results in favor of the experimental group on the post-test, since this group would be allowed to use the calculators on the post-test and the control group would not have that advantage. The students were asked to show the work done on each problem, then to write down the letter of the answer they chose.

There was a delay of about six weeks between the achievement pre-test and the beginning of the study. The ESAA program requires that computation using rational numbers be taught to all students in the program. The pre-tests and post-tests for the program include a computation section. Thus, the investigator had to complete a unit on rational numbers with the classes before letting any of the students use calculators for computation purposes. No
verbal problems were assigned as a part of the rational number unit. Therefore, because of the curriculum material and the length of time involved in this study, the time differential between the pre-test and the beginning of the study should have had no effect on the outcome of the experiment. ESAA and non-ESAA classes were both taught according to the same curriculum requirements and lesson assignments for the entire school year.

The Attitude Scale

The attitude scale employed in this study was a modified version of The A-V Scale of Attitudes Toward Mathematics by Sam Adams and Robert Von Brock. The scale was validated through administration of the twenty test items to a consumer mathematics class at Baton Rouge High School, Baton Rouge, Louisiana, in July of 1975. Agreement of the total score of each individual student with the response to the item "I like math" was used as the primary evaluation criterion. Based upon this criterion, the scale has a high degree of validity. The attitude test was administered to each group involved in the study on November 11 and again on April 8. Appendix B contains a copy of this test.

All testing was done during the regular class periods, with those students who were absent on the day of testing being given the tests upon returning to school. All absentee students took the tests within three days of
the test dates of both the pre- and post-tests. Students not included in both the pre-test and post-test sessions—that is, drop and add students leaving and entering during the time period that the experiment was underway—were not counted in the final study results.

The Opinion Poll

At the end of the school year, after all students had returned to the paper-and-pencil method of calculation, an opinion poll was taken of the experimental group members. Response to the poll was anonymous and entirely voluntary. Forty-eight of the fifty-one students in the experimental group responded to the questions asked of them. One student in this group left school between the end of the study and the end of the school year, while two students did not choose to answer the questions at all. The following questions were asked orally of the students:

1. How do you feel about using calculators in math class?

2. Do you feel you did better using the calculator or did it make any difference?

3. Did you enjoy the work more when you used the calculator than when you did not use it?

The results of this poll were analyzed by tabulation of answers favoring the use of calculators in the classroom and answers that were not favorable to classroom use of the devices.
Chapter 3

PRESENTATION AND ANALYSIS OF THE DATA

This study was designed to investigate the effects of the use of the hand-held calculator upon achievement and attitude of students in high school consumer mathematics classes. Two groups of students participated in the study: an experimental group which used calculators and a control group which used traditional paper-and-pencil methods of computation to solve verbal problems in consumer mathematics. Data used in the investigation were gathered primarily from an achievement test and an attitude scale administered to members of the two groups at the beginning of the experiment and again approximately nineteen school weeks later at the close of the experiment. Additional data were gathered from an opinion poll on calculator use which was administered to members of the experimental group at the end of the school year.

RESULTS OF THE ACHIEVEMENT TEST

Pre-test and post-test raw scores from the "Mathematics:Problems" achievement test are given in Table 1, page 34. The scores represent the number of correct answers given to the fifteen test items, with a possible high score of fifteen and a possible low score of zero.
Table 1

Distribution of Raw Scores: "Mathematics: Problems" Test

<table>
<thead>
<tr>
<th>Raw Score</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group E</td>
<td>Group C</td>
<td>Group E</td>
<td>Group C</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>4</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>6</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

N = 51   N = 43   N = 51   N = 43
The unadjusted means and standard deviations of both pre- and post-test results for each group and the variance of the pre-test scores are given in Table 2. The experimental and control groups, hereafter referred to as Group E and Group C, respectively, are obviously relatively homogenous with respect to these test results.

Table 2


<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Pre-test Var</th>
<th>SD</th>
<th>Post-test Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group E (N= 51)</td>
<td>4.392</td>
<td>10.67</td>
<td>3.27</td>
<td>6.784</td>
<td>3.41</td>
</tr>
<tr>
<td>Group C (N= 43)</td>
<td>4.535</td>
<td>7.551</td>
<td>2.75</td>
<td>6.860</td>
<td>3.55</td>
</tr>
</tbody>
</table>

An analysis of covariance, using the pre-test scores as the covariant, resulted in a very small, non-significant F-ratio of .001. The results are presented in Table 3. This F-ratio, when examined in conjunction with the information in Table 2, led to the suspicion that differences between the pre-test scores made by members of Group E and those made by Group C were small enough to warrant further analysis.

The mean gain scores from pre- to post-test were used as the basis for an analysis of variance. Results of
this analysis are give in Table 4, page 37. Again, a small, non-significant F-ratio, .001, was obtained. A ratio of approximately 3.95 is necessary for the differences between the variances of the scores used in the analysis to be significant at the .05 level (Garrett, 1966).

Table 3
Analysis of Covariance of Scores: "Mathematics: Problems" Test

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SSy.x</th>
<th>MSy.x</th>
<th>SD</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Means</td>
<td>1</td>
<td>.0082</td>
<td>.0082</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>91</td>
<td>735.2</td>
<td>8.079</td>
<td>2.84</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key

- df = Degrees of freedom
- SS = Sum of squares
- MS = Mean squares
- y.x = Post-test results adjusted for effects of pre-test results

The null hypothesis was thus supported in this case, as there were no significant differences between the mean gains in scores made by Group E and those made by Group C on the "Mathematics: Problems" achievement test. Both groups, however, progressed in achievement in verbal problem solving from pre-test to post-test as measured by the gain scores. The members of both groups were able to correctly work an average of approximately two more problems
on the post-test than they were able to correctly work on the pre-test (see Table 2).

Table 4

Analysis of Variance of Mean Gain Scores: "Mathematics: Problems" Test

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS(Var)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>.0846</td>
<td>.0846</td>
<td>.011</td>
</tr>
<tr>
<td>Within Groups</td>
<td>91</td>
<td>711.1</td>
<td>7.729</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS OF THE ATTITUDE SCALE

The pre-test and post-test scores from the attitude scale are given in Table 5. The test scores have a possible range of negative twenty for extremely negative attitudes toward mathematics to positive twenty for very positive attitudes toward mathematics. Scores in the neighborhood of zero represent neutral attitudes toward mathematics. The lowest score made on the pre-test was negative eighteen and the highest was a positive nineteen. The post-test scores ranged from negative fifteen to positive twenty.

Analysis of covariance, with the pre-test scores as the covariant, resulted in an F-ratio of .79. This ratio is not significant when tested at the .05 level of significance; thus the experiment revealed no significant differences between the variances of the attitude post-test scores of Group E and the attitude post-test scores of Group C.
The null hypothesis was not rejected for this section of the study. The supporting data for this position are presented in Table 6, page 39.

Table 5

<table>
<thead>
<tr>
<th>Range of Raw Scores</th>
<th>Pre-test Group E</th>
<th>Group C</th>
<th>Post-test Group E</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 - 20</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>11 - 15</td>
<td>6</td>
<td>4</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>6 - 10</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>1 - 5</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>-4 - 0</td>
<td>16</td>
<td>10</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>-9 - 5</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>-14 - -10</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>-19 - -15</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

N= 51  N= 43  N= 51  N= 43
Table 6

Analysis of Covariance of Scores: Attitude Scale

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS_{y.x}</th>
<th>MS_{y.x}</th>
<th>SD</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Means</td>
<td>1</td>
<td>58</td>
<td>58</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>91</td>
<td>6648</td>
<td>73.05</td>
<td>8.55</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS OF THE OPINION POLL

The results of the opinion poll are given in Table 7. Positive answers are considered to be answers that favor calculator use, whereas negative answers express unfavorable attitudes toward the use of the devices. No neutral opinions were expressed in answer to any of the questions in the poll.

The responses to all three questions on the use of the calculator in the classroom were very positive. The students in the experimental group overwhelmingly favored the continued use of calculators in their mathematics classes, seemed to feel more confident when allowed the use of the devices, and seemed to enjoy the classwork more when using the calculators, according to the majority of the replies to the opinion poll.

The first question was "How do you feel about using calculators in math class?" There was only one negative reply to this question. The question elicited more varied
types of responses than the other two questions. Some of the typical replies to this question follow:

"I like using calculators because they save time."
"I enjoyed it."
"I like it very much."
"It's good. It makes math problems easier to do."
"They are very good to use, especially on long problems."
"They are more accurate than I am."

The first reply, mentioning the time-saving factor of the calculators, was the most frequent response to the use of calculators that emerged from the answers to all of the questions in the poll, but was especially foremost in the students' minds when they answered this first question.

Table 7
Results of the Opinion Poll on Calculator Use

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Number of Positive Answers</th>
<th>Number of Negative Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>7</td>
</tr>
</tbody>
</table>

The second question asked was "Do you feel you did better using the calculator or did it make any difference?" The replies were not as positive to this question as they
were to question number 1, but were still quite favorable to calculator usage. The thirty-nine positive replies revealed that the students felt they did better work using the machines, especially in the areas of accuracy and speed, though they seemed to realize that their grades were not greatly affected by use of the calculator. Greater confidence in the work seemed to be the principal element to emerge from the answers to this question. Each of the nine negative answers to the question expressed the feeling that the devices had made no difference in the student's work.

Question 3 was "Did you enjoy the work more when you used the calculator than when you did not use it?" This question invoked many responses of "yes," with forty-one students declaring that they enjoyed the work more when using the calculators and only seven students not enjoying the work more when using them.

SUMMARY

Examination of the scores on the "Mathematics: Problems" subtest of the California Achievement Test revealed that the experimental and control groups were very homogeneous as to achievement in mathematical verbal problem solving, according to scores made on the pre-test. The data were therefore analyzed by the covariance method, with this technique being supplemented by an analysis of variance. The F-ratios obtained in both analyses were not
significant when tested at the .05 level of significance, thus revealing no significant differences between the gain scores of the experimental group and those of the control group. Both groups made significant gains from pre-test to post-test scores, however.

An analysis of covariance was performed on the attitude scores. The F-ratio was not significant when tested at the .05 level; therefore the use of the hand-held calculator did not result in significant improvement in attitudes toward mathematics.

Most of the students in the experimental group expressed positive feelings toward the use of the calculators in the classroom, according to an opinion poll taken at the end of the school year. These pupils were especially appreciative of the speed with which they could finish the work when using the calculators and the degree of accuracy obtained with the devices. They also expressed a feeling of greater confidence in and enjoyment of the mathematics work done during the time the calculators were in use.
Chapter 4
CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate some cognitive and affective aspects of the use of the hand-held calculator in high school consumer mathematics classes. In particular, the study was designed to provide answers to the following questions:

1. Does the use of the hand-held calculator in high school consumer mathematics classes result in significant gains in student achievement in mathematical verbal problem solving?

2. Does the use of the hand-held calculator in high school consumer mathematics classes result in improvement of student attitudes toward mathematics?

To accomplish the purpose of the study, pre-tests and post-tests were given to members of an experimental group and a control group in order to measure any changes in scores on achievement in verbal problem solving and on attitude toward mathematics. The data from the tests were analyzed by covariance statistical methods, with the achievement test data also being subjected to an analysis of variance. An opinion poll on calculator use was taken of the members of the experimental group.
CONCLUSIONS

According to the results of the analysis of the achievement test data, there were no significant differences in the gain scores made by the members of the experimental group and those made by the members of the control group. The members of the experimental and control groups both made progress in verbal problem solving, with the members of the control group performing as well on the post-test, without the benefit of calculators, as the members of the experimental group did using calculators. Thus computation, as affected by use of the hand-held calculator, did not appear to be a major factor in verbal problem solving ability of the high school consumer mathematics students involved in this study.

Attitude toward mathematics in general was no better in the experimental classes before or after the study than it was in the control classes, according to the results of the attitude scale that was used in the pre- and post-testing. According to the opinion poll, however, the students in the experimental classes enjoyed their work more and felt more confident of their results when using the calculators than they did in the weeks following the period of the study, when members of all the consumer mathematics classes returned to the traditional paper-and-pencil methods of computation. The students especially appreciated
the speed and the degree of accuracy of the computations obtained through the use of the calculators.

RECOMMENDATIONS

Several limitations existed in this study. Among them were the homogeneity of the students and the particular tests used in the collection of the data. In view of the above limitations, the writer makes the following recommendations based upon the results of this research:

1. Further research, testing the same hypotheses proposed in this study, should be undertaken using consumer mathematics classes made up of students with a more normal distribution of abilities in mathematics.

2. Further research should be conducted, testing the same hypotheses used in this study, employing pre-tests and post-tests constructed specifically for consumer mathematics classes, particularly in the area of achievement tests.

3. Proper operation of calculators should be taught in consumer mathematics classes.

4. Curriculum materials in consumer mathematics should be developed for use with hand-held calculators.

5. Use of calculators in consumer mathematics classes, particularly by underachievers, should be encouraged as a means of developing the individual student's confidence in his mathematical ability.
FURTHER OBSERVATIONS

The investigator and her cooperating teacher both experienced greater ease in teaching the experimental classes from several standpoints. For instance, verbal problems could be dealt with in more depth, for the speed of computation with the calculators enabled the students to complete the assigned problems with time left during the class period for discussion of the various implications of problem situations. This condition led to the use of enrichment material in these classes that was not used in the control classes because of the time element.

Another advantage of the use of calculators that was evident to the two teachers involved in the study was the better discipline situation in the experimental classes. The working atmosphere in these classes seemed to be less tense than that in the control classes; a greater sense of cooperation prevailed among the students in the experimental group. Frustrations with problem solving frequently caused members of the control group to create various situations demanding minor disciplinary actions.

Use of the calculators also seemed to encourage a sense of responsibility in the members of the experimental group. The routine of checking the machines in and out encouraged a settling down into the day's assignment that was not evident in the classes comprising the control group.
The students seemed proud to be entrusted with the calculators and took surprisingly good care of the devices.

Difficulties encountered in the use of calculators in the classroom were largely caused by inaccurate operation of the devices by the students. Careless entering of numbers, inverse entering of the dividend and the divisor in division problems, and the indiscriminate use of answers thus obtained were difficulties that were never entirely overcome by many of the students.

Calculators have a place in the classroom and will probably make an increasingly greater impact on the teaching of mathematics with time. The use of the devices may or may not improve student achievement in and attitude toward mathematics, but the use of calculators is certainly becoming more prevalent. Ways to use calculators effectively in the classroom should be developed, since more and more students now own a hand-held model and many school systems are buying classroom sets of calculators. Mathematics classroom organization will more than likely soon be expanded, particularly at the high school level, to include the use of calculators as a matter of routine.
SELECTED BIBLIOGRAPHY
SELECTED BIBLIOGRAPHY


Denman, Theresa. "Calculators in Class," The Instructor, 83 (February, 1974), 56-57.


Higgins, Jon L. "Mathematics Programs are Changing," The Education Digest, 40 (December, 1974), 56-58.


APPENDIX A

"MATHEMATICS:PROBLEMS" ACHIEVEMENT TEST
These items measure your ability to work mathematics problems.

This section contains 15 problems. Work each item on scratch paper and choose the answer you think is correct. If the correct answer is not given, choose "none of these." Fill in the space on your answer sheet that matches the letter of the answer you choose.

Read Sample Item A below.

Jennie had 3 rings. She gave 1 ring away. How many rings did she have left?

A 2
B 3
C 4
D 5
E none of these

Look at the section of your answer sheet under the word "Problems" and see how the correct answer is marked. Answer space A is filled in for Sample Item A because 3 rings minus 1 ring equals "2" rings.

Do Sample Item B. Fill in the space on your answer sheet that matches the letter of the answer you choose.

Mrs. Herbert had 25 children in her fourth-grade class. If two new boys joined her class, how many students would she have?

F 23
G 25
H 26
J 27
K none of these

You should have marked answer space J for Sample Item B because 25 children plus 2 children equals "27" children.
**MATHEMATICS Problems**

Do Items 1—15 below and mark your answers on the answer sheet. Be careful to keep your place on the answer sheet.

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 1    | How much money will be required to buy 2 cakes of soap at $.18 a cake and 1 dozen eggs at $.65 a dozen? | A $ .83  
B $ .85  
C $ .91  
D $1.01  
E none of these |
| 2    | How much money is needed to buy ¾ pound of butter at $.92 a pound, 4 pounds of sugar at $.24 a pound, and 6 eggs at $.72 a dozen? | F $1.45  
G $1.58  
H $1.88  
J $1.91  
K none of these |
| 3    | In a paper drive, 4 boys brought old papers to school as follows: Fred, 30 pounds; Albert, 40 pounds; Henry, 10 pounds; and Peter, 40 pounds. What was the average number of pounds they brought? | A 25 pounds  
B 30 pounds  
C 35 pounds  
D 40 pounds  
E none of these |
| 4    | A man received 7 per cent interest on a loan of $800 for 1 year. How much interest did he receive? | F $56  
G $560  
H $780  
J $870  
K none of these |
| 5    | The scale of a map is ½ inch = 10 miles. If 2 cities are 3 inches apart on the map, how many miles are they from each other? | A 24  
B 80  
C 120  
D 240  
E none of these |
| 6    | A rectangular athletic field is 100 yards wide and 500 yards long. How many square yards are there in the field? | F 400  
G 600  
H 5,000  
J 50,000  
K none of these |

**GO on to the next page**
7. Our basketball team won 60 percent of their games. If they lost 8 games, how many games did they play altogether?
   - A 10
   - B 12
   - C 16
   - D 20
   - E none of these

8. A swimming pool is 15 feet wide, 50 feet long, and has an average depth of 5 feet. How many cubic feet of water will it hold?
   - F 70
   - G 250
   - H 750
   - J 3,750
   - K none of these

9. Together Mary, Jane, and Ruth received $30. Mary received $6, Jane received $9, and Ruth received $15. What percent of the $30 did Jane receive?
   - A 10%
   - B 20%
   - C 30%
   - D 50%
   - E none of these

10. Some families spend their incomes according to budget plans. If a family used the plan below as a basis, about how much would it spend for clothing?

<table>
<thead>
<tr>
<th>Monthly Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>$525</td>
</tr>
</tbody>
</table>

   - Shelter ............... 26%
   - Food ................. 28%
   - Clothing .......... 7%
   - Operation ......... 10%
   - Savings ............ 9%
   - Other Expenses .... 20%
   - 100%

   - F $35.75
   - G $36.75
   - H $53.20
   - J $75.00
   - K none of these

11. Laura earned $24 and saved $6 of it. What percent did she save?
   - A 1%
   - B 20%
   - C 25%
   - D 400%
   - E none of these

12. A building was insured for $7,500. The insurance cost $.25 per $100. What was the amount of the premium?
   - F $8.75
   - G $13.75
   - H $18.75
   - J $75.00
   - K none of these
What was the average wage per month of factory workers whose monthly wages are listed below?

1 received $750
5 received $670 each
10 received $600 each
14 received $530 each

A $514.00  
B $525.80  
C $584.00  
D $637.00  
E none of these

A merchant paid $3 each for golfing hats that he sold for $4 each. He therefore earned a gross profit of $1 per hat. By what per cent was the cost price increased to provide for this profit?

F 20%  
G 30%  
H 33\(\frac{1}{3}\)%  
J 300%  
K none of these

Antonio's father owns a furniture store. He wished to purchase a dinette set at a list price of $160. A wholesale dealer offered him a discount of 30%. How much will Antonio's father save by taking this discount?

A $4.50  
B $15.00  
C $30.00  
D $45.00  
E none of these
APPENDIX B

ATTITUDE SCALE
ATTITUDE SCALE

Directions: The statements below are about attitudes toward math. Please read each statement carefully. If you agree with the statement, check Column 1 (A); if you are undecided, check Column 2 (U); if you disagree, check Column 3 (D). Respond honestly, please. Do not write your name on the paper.

<table>
<thead>
<tr>
<th>Statement</th>
<th>A</th>
<th>U</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I like math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I hate to do math homework.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I try to avoid math as much as possible.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. My grades in math have been low.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Math puzzles interest me.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I like to try to figure out how to go about working a word problem in math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I try to get out of taking math courses.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I do not mind doing math assignments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I do not see why we have to take so many math courses.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Math classes are boring.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. The logic of math appeals to me.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I accept math assignments as just another task I must do.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. The more math courses I take, the less I like math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. My best grades have been in math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. I enjoy doing math problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Math is an important subject.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I never go beyond the assigned problems in math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. My only goal in working a problem is to get the answer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Math is one of my favorite subjects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. I often work more math problems than are assigned.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

CONSUMER MATHEMATICS
TOPICS, SOURCES, AND TIME SCHEDULES
<table>
<thead>
<tr>
<th>Topic</th>
<th>Major Sources</th>
<th>Time Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking and Credit</td>
<td>Business and Consumer Arithmetic, Olson and McNelly (Textbook) Chapters 8-11</td>
<td>November 11-February 12</td>
</tr>
<tr>
<td></td>
<td>The How and Why of Banking, Mississippi Bankers Association</td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>Business and Consumer Arithmetic, Olson and McNelly (Textbook) Chapters 17-18</td>
<td>February 13-March 12</td>
</tr>
<tr>
<td></td>
<td>Understanding Taxes Internal Revenue Service</td>
<td></td>
</tr>
<tr>
<td>Paychecks and Budgeting</td>
<td>Business and Consumer Arithmetic, Olson and McNelly (Textbook) Chapter 20</td>
<td>March 18-April 2</td>
</tr>
<tr>
<td></td>
<td>Handling Finances: Budgeting, Buying, Saving</td>
<td></td>
</tr>
</tbody>
</table>
VITA

PERSONAL

Name: Mary Ann Neaves Boling
Date of Birth: February 7, 1936
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Parents: John David Neaves and the late Lotta Skelton Neaves
         Goodman, Mississippi
Husband: William B. Boling
         Jackson, Mississippi
Children: William David, James David, Scott Neaves

EDUCATION

High School
   Holmes Agricultural High School
   Goodman, Mississippi, 1953
B. S.
   Mississippi State University
   State College, Mississippi, 1958
   Majors: Mathematics; Education
   Minor: Social Studies
M. Ed.
   Mississippi State University
   State College, Mississippi, 1959
   Major: Guidance Education
   Minor: Mathematics
Ph. D.
   Louisiana State University
   Baton Rouge, Louisiana, 1977
   Major: Education
   Minor: Mathematics

PROFESSIONAL EXPERIENCE

1958-1959
   Mississippi State University
   Graduate Assistant, Mathematics

1959-1974
   Jackson Public Schools
   Jackson, Mississippi
   Provine High School
   Mathematics Teacher
1961
Universities Center
Jackson, Mississippi
Mathematics Teacher,
Summer Session

1974-1975
Louisiana State University
Baton Rouge, Louisiana
Graduate Assistant, Education

1975-1977
Jackson Public Schools
Jackson, Mississippi
Callaway High School
Mathematics Teacher

PROFESSIONAL ORGANIZATIONS
National Council of Teachers of Mathematics
Mississippi Council of Teachers of Mathematics
National Education Association
Mississippi Association of Educators
Jackson Association of Educators
Delta Kappa Gamma, National Honorary Society for Women Educators
Kappa Delta Pi, National Education Honorary Society
Phi Kappa Phi, National Honorary Society

PROFESSIONAL HONORS AND OFFICES
Presider and Workshop Leader, National Council of Teachers of Mathematics, Regional Meetings
Speaker, Mississippi Council of Teachers of Mathematics, State Meetings
Participant, School Evaluation Committees, Mississippi and Louisiana, Southern Association of Schools and Colleges
Member, Curriculum Committee, Mississippi Authority for Educational Television
Past City-wide Chairman, Jackson Public Schools Mathematics Department
Past Local Recipient of STAR Teacher Award, Mississippi Economic Council
Past Historian, Kappa Delta Pi
Listed in 1970 edition, Outstanding Young Women of America

PUBLICATIONS