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AUTHOR Cech, Joseph Philip
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ABSTRACT

An experiment was designed to test whether or not the use of desk calculators improved the attitudes and computational skills of low achieving, ninth-grade general mathematics students. Analysis of the data did not support the hypothesis that the use of calculators would improve students' attitudes toward mathematics. The hypothesis that the use of calculators would improve students' computational skills was also not supported. The hypothesis that low achievers in mathematics can compute better with calculators than without them was accepted. (FL)

THE EFFECT THE USE OF DESK CALCULATORS HAS ON ATTITUDE AND ACHIEVEMENT IN NINTH-GRADE GENERAL MATHEMATICS CLASSES

BY

JOSEPH PHILIP CECH

Submitted in partial fulfillment of the requirements
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Director of Thesis

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Experimental studies necessarily involve a number of persons besides the investigator. Maine Township High School, location of the experiment, had several individuals actively assisting in this study. The investigator wishes to thank the administration for permitting this experiment to be conducted, and is especially grateful to Miss Ruth Anderson, department chairman who made valuable suggestions and arranged the classes; to Mr. Jerry Nelson, teacher who composed the lesson plans and provided valuable guidance to the experiment; and to Mr. Paul Nelson and Mr. John Hynek who taught the classes in the experiment.

The writer is deeply appreciative of the sincere encouragement given by Dean Philip Peak which was a deciding factor in the completion of this effort.

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J.P.C.

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THE EFFECT THE USE OF DESK CALCULATORS HAS ON ATTITUDE AND ACHIEVEMENT IN NINTH-GRADE GENERAL MATHEMATICS CLASSES

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JOSEPH PHILIP CECH

THE EFFECT THE USE OF DESK CALCULATORS HAS ON ATTITUDE AND ACHIEVEMENT WITH LOW-ACHIEVING NINTH GRADERS

There appear to be two important reasons for the use of the calculators with low achieving students. One is the motivation they provide, and the other is the improved achievement possible. This study addressed itself to these two reasons. In particular, it was experimental in design and tested the following three hypotheses:

1. The use of the calculators in the instructional program with ninth-grade, low achieving mathematics students improves their attitude toward the study of mathematics.

2. The use of calculators in the instructional program with ninth-grade, low achieving mathematics students improves their computational skills.

3. Ninth-grade, low achieving mathematics students can compute better with calculators than without calculators.

SOURCE OF DATA

This study was conducted at the Maine Township (East) High School in Park Ridge, Illinois. The school is in a suburban area with students from the middle and upper middle economic brackets and is highly regarded in the State as having excellent facilities and an outstanding staff and curriculum. The school used calculators in about half of the General Mathematics classes during the 1968-69 school year. For the 1969-70 school year the General Mathematics students (about 100 of them) were scheduled into five classes of about

20 each in a random manner. This scheduling of mathematics classes was done by a computer before other classes were scheduled.

The students are placed into General Mathematics on the basis of their I.Q. scores and standardized achievement test scores. These students have I.Q. scores of about 75 to 95 and have scored two years or more below grade level on achievement tests.

Mr. Paul Nelson and Mr. John Hynek were the two teachers teaching the four classes used in the experiment. Each had one control group and one experimental group. The choice of which was the experimental group and which was the control group was done by a flip of a coin. Both Mr. Paul Nelson and Mr. John Hynek were experienced teachers. Miss Ruth Anderson, department chairman, arranged many details including the selection of teachers. The administration interested in evaluating their calculator oriented program and has been very cooperative.

EXPERIMENTAL DESIGN AND PROCEDURE

Each of the two teachers in the experiment had one control group and one experimental group, so the teacher variable was held constant. Lesson plans were developed during the summer prior to the fall semester by Mr. Jerry Nelson, a highly regarded teacher who previously taught a class using the calculators. These lesson plans were used by both teachers for both groups, thus the instruction was the same for both groups. The only difference was that the experimental group which used calculators received four days of additional instruction time dealing with the operation of the calculator. Both groups had seven weeks of instruction (45 minutes a day) dealing with addition, subtraction, multiplication, and division of whole numbers. The treatment which the experimental group received was use of the calculators to verify paper and pencil computation. The students were told to check their work by using the calculators while the control group was told merely to check their work.

The teachers encouraged the students in the experimental group to check each problem as soon as they completed it. This was done in order to reduce the time lapse between response and reinforcement. However, they did not force the students to do so, for fear of adversely affecting the students' attitudes. The teachers indicated that the students did follow this suggestion willingly.

The lesson plans utilized worksheet materials, which were written by several teachers in the district several years ago; and they utilized the text, Trouble Shooting Mathematics Skills, written by Bernstein and Wells. The lesson plans also included specific instructions on the administration of the pre-test and post-test to insure that all students received the same instructions and were given the same time to complete the tests.

Every Monday morning before school started the investigator met with the two teachers in the experiment to discuss the lesson plans for that week. So the teachers were completely familiar with the plans for the week.

Both groups were given pre-tests and post-test which measured attitude toward mathematics and computational skills with whole numbers. The attitude test which was used as the pre-test and post-test was the

PY 011, Pro-Math Composite Test developed by SMSG for their longitudinal study. The pre-test and post-test used to measure computational skills with whole numbers was the Stanford Diagnostic Arithmetic Test, [illegible], Parts A, B, and C. This test has two forms W and X. Form W was used as the pre-test and post-test with both groups to deal with the hypothesis that the use of calculators in the instructional program increases computational skills. In addition, Form X was used as a post-test with the experimental group to deal with the hypothesis that these students can compute better with calculators than without calculators.

The attitude pre-test was used to verify the comparability of both groups. The attitude post-test was used to determine the attitude of both groups after the seven week experimental period. The t-test for the difference between the mean score of both groups was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

The computation pre-test and post-test were used to determine the change in computational skill for each student in both groups. The change or difference in the scores for each student was determined as was the mean and variance for these differences for the experimental group and the control group. The t-test for the differences between these mean differences was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

To deal with the hypothesis that these students can compute better with calculators than without them, the comparable parts of Form X of the Stanford Diagnostic Arithmetic Test were administered to the experimental group the day after Form W was completed. Whereas the students were not allowed to use the calculators for Form W, the students were told they could use the calculators to get results for the test items when taking Form X. The mean and variance were computed for the distribution of the Form X scores. The t-test for the difference between the means of the Form W and Form X distributions was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

FINDINGS AND CONCLUSIONS

Analysis of the attitude test scores does not support the hypothesis that the use of the calculators in the instructional program with ninth-grade, low achieving mathematics students improves their attitude toward mathematics.

Analysis of the test scores on the computational skills does not support the hypothesis that the use of the calculator in the instructional program with ninth-grade, low achieving mathematics students improves their computational skills.

Analysis of the scores on the two forms of the post-test on computational skills does support the hypothesis that ninth-grade, low achieving mathematics students can compute better with calculators than without them.

GENERAL COMMENTS

Low achieving, ninth-grade students are subjected to a host of social, academic, and physiological pressures. These shape their attitudes toward the study of mathematics and are monumental when compared to the salutary effects the use of the calculator may have to improve their attitudes. However, given enough time to act on attitudes, the calculator may be worthwhile. But its use over a year's time or so cannot be expected to produce great changes in attitudes.

The calculator was used as a tool in the intructional program of most of the studies reviewed by this investigator and was so used in this experiment. It was not used so that the natural consequences could be insights into the understanding of mathematical principles. And the use of the calculator as a means to improve computational skills through reinforcement will fail when so used for a short time, say less than a year. What effects its use may have when used over a number of years is unknown. However, schools cannot expect the use of calculators to be significantly better that conventional means to improve computational skills when used only in the General Mathematics class in the ninth grade. It is the investigator's view that the use of calculators as tools in the instructional program to improve computational skills is strategically unsound; for its impact, if it has any, is too light for the time it has to operate.

Though the calculator may be of no value in improving computational skills, this does not preclude its desirability when other objectives are being sought. An objective such as the ability to solve meaningful problems possibly can be achieved in some cases only with the help of some calculating device such as a calculator or computer. For the tediousness of computation may make some problems beyond the capabilities of the student.

Perhaps the one objective which the calculator may be useful in achieving is the one which suggests that students should understand the mathematics with which they are dealing. The calculator might be used to illustrate more effectively some mathematical principles. In such circumstances the calculator is a teaching device such as models and graphic representations of mathematical ideas. However, its effectiveness in achieving this objective has not been tested, nor are there easily available instructional materials or software designed to achieve this objective through the use of calculators.

CHAPTER I

INTRODUCTION

There is probably more dissatisfaction with the instruction in the ninth-grade General Mathematics classes than in any other segment of mathematics instruction. Teaching General Mathematics classes is commonly regarded as an occupational hazard by most teachers. Local teachers' organizations such as the Kankakee Federation of Teachers (Kankakee, Illinois) have included in their demands to their school boards the provision that below average ability classes be smaller than the regular classes.[1]

Statement of the Problem

This study is an attempt to determine the effectiveness of the calculator in meeting two commonly espoused objectives in ninth-grade mathematics for low achievers, namely, (a) improved computational skills, and (2) improved attitude toward mathematics.

Justification of the Study

Lack of noticeable success with practices and procedures used in General Mathematics classes has caused general dissatisfaction among teachers. This dissatisfaction has been reflected in the efforts of not only local school districts but also larger groups such as

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[1]Illinois Federation of Teachers, Illinois Union Teacher, No. 20, The Federation, Springfield, Illinois, 1969.

the National Council of Teachers of Mathematics (NCTM). In an effort to provide some assistance in this area of instruction, the National Council has authorized the writing of materials designed specifically for General Mathematics classes.[2]

This concern of the effectiveness of General Mathematics instruction is also reflected in the massive efforts of the United States Office of Education in implementing the Elementary and Secondary Education Act (ESEA). Many Title III, ESEA proposals which have been funded deal with low achieving students. Projects such as the Program for Mathematically Underdeveloped Pupils, under the direction of Jack Foley of West Palm Beach, Florida, have focused on this kind of student.[3] From this particular project have come units of instruction which included three designed to be used with desk calculators.

The Title I, ESEA program, which provides federal funds for compensitory efforts directed toward the underprivileged students, has enabled schools to purchase the somewhat expensive calculators. Of the twenty-nine case histories written by local educators and described in a research publication, twenty-three indicated that the calculators were purchased with the help of federal funds.[4]

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[2]National Council of Teachers of Mathematics, Experiences In Mathematical Discovery, The Council, Washington, D.C., 1966.

[3]Foley, Jack, director, A Program for Mathematically Underdeveloped Pupils, Title III, ESEA Project 1588, West Palm Beach, Florida.

[4]Mathematics and Science Research, Case History Series, School Math Lab, Olivetti Underwood Corporation, One Park Ave., New York.

Ruth Irene Hoffman, professor of mathematics at the University of Denver, has been very active in working with programs designed for the low achiever. She feels that one of the common elements of projects for low achievers in mathematics is the use of mathematics laboratories, with all their ramifications including calculators, remote terminals for computers, and flow charting for problem analysis.[5]

In as much as a great deal of effort is being directed toward improving instruction for the low achiever in ninth-grade mathematics classes, and a great deal of money is channeled into this same effort; it is imperative to determine the effectiveness of any approach which may be proposed. In particular this study is an attempt to determine the effectiveness of the calculator in meeting some objectives in ninth-grade mathematics for low achievers.

Any attempt to evaluate a particular practice must be done in terms of the objectives such a practice is intended to achieve. The objectives that schools define for the use of calculators vary a great deal as a review of such statements will bear out.

The London Times reported on a conference at which school people participating in an experiment involving calculating machines said that less able children seem to be more interested in the mathematics lessons when these machines are used, and such incentives are of value in the schools.[6] Three years later this same London Times

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[5]Hoffman, R. I., "The Slow Learner - Changing His View of Mathematics," The Bulletin 52:87, April, 1968.

[6]"More than a Novelty; Calculators for All," London Times Educational Supplement 2488:140, January 25, 1963.

reported on another conference at which Mr. E. Kerr said the use of these calculators would free students from the drudgery of complicated computation and allow them to concentrate on the mathematical principles. Also, these calculators would permit teachers to present real life situations which often require lengthy computation.[7]

Sells reports that the use of hand-operated adding machines in seventh-grade classes can result in a great deal of pupil interest, and in general, permits the pupil to explore broader areas of arithmetic than were open to him with paper and pencil.[8]

The Wynne (Arkansas) Mathematics Laboratory Project utilizes calculators. McDermott reported that as the course progressed, it became apparent that students knew how to work math problems, but were not capable of arriving at the right answers. This is where the calculators proved their value. After two weeks of learning how to add, subtract, multiple, and divide on the calculators, the students had the pleasure of being able, at last, to arrive at correct answers. Success was a tonic.[9]

McNally feels that the advantage of using the calculators include the self-challenge of computing totals and then using the calculators to verify results.[10]

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[7]"Taking the Drudgery Out of Mathematics," London Times Educational Supplement 2672:293, August 5, 1966.

[8]Sells, B. L., "Machines Come to Math Class," Elementary School Journal 60:14-17, October, 1959.

[9]Lewis, B., "Underachievers Measure Up," American Education 5:27-8, February, 1969.

[10]McNally, J. E., "Two Motivators For the Mentally Retarded: Adding Machines, Typewriters," Instructor 77:42, June, 1968.

Shoemaker has been very active directing programs which use the calculator. He feels that the need to prepare low achievers for employment and the need for interesting and highly motivating activities makes the calculator especially effective.[11]

In the previously mentioned publication, Case History Series, School Math Lab, twenty-nine schools each reported the objectives they hoped to reach by using the calculator.[12] The objectives each school stated can be described by one or more of the following:

1. More effective use of class time
2. Greater motivation
3. Vocational needs
4. Allows for more individual attention
5. Improves basic skills
6. Provides opportunity to experience success
7. Improves attitude
8. Develops understandings of basic concepts
9. Develops reasoning ability
10. Provides more problem-solving experiences

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[11] Shoemaker, T. E., Involving Low-Achievers In Mathematics, p. 1.

[12] Mathematics and Science Research, . . ., op. cit.

Statement of Objectives

There appear to be two important reasons for the use of the calculators with low achieving students. One is the motivation they provide, and the other is the improved achievement possible. This study will address itself to these two reasons. In particular, this is an experimental study which will test the following three hypotheses:

1. The use of the calculators in the instructional program with ninth-grade, low achieving mathematics students improves their attitude toward the study of mathematics.

2. The use of calculators in the instructional program with ninth-grade, low achieving mathematics students improves their computational skills.

3. Ninth-grade, low achieving mathematics students can compute better with calculators than without calculators.

Definition of Terms

In this study the term calculator will refer to any electric printing calculator which can perform the four basic operations of addition, subtraction, multiplication, and division with whole numbers. The Monroe-Matic Mach 1.07 Printing Calculator was used in this experiment.

The term, low achieving mathematics student, will refer to students in the lowest track at Maine Township High School (East). These students are placed in this track because of their low I.Q. scores and low achievement in mathematics. Specifically, these students'

I.Q. scores are between 75 and 95, and they score two years or more below grade level on arithmetic achievement tests.

The term, attitude toward the study of mathematics, will refer to the test score on the PY 011, Pro-Math Composite Test developed by SMSG for the longitudinal study they conducted and described by them as a scale designed to measure general attitude toward mathematics.[13]

The term, computational skills, will refer to test scores on the Stanford Diagnostic Arithmetic Test, Test 2 Parts A, B, and C, which deals with addition, subtraction, multiplication and division with whole numbers.[14]

[13] Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G., editors, NLSMA Reports, No. 5, Description and Statistical Properties of Y-Population Scales, p. 183.

[14] Beatty, L. S., Madden Richard, Gardner, E. F., Stanford Diagnostic Arithmetic Test, Level II, p. 4-5, Harcourt, Brace and World, Inc., New York, 1966.

CHAPTER II

REVIEW OF RELATED RESEARCH

In Studying the effect the calculator has on arithmetic achievement in grades six through eight, Durrance found that calculators did not enable students to achieve significantly more in arithmetic.[15] His study involved average students and not exclusively low achievers. At the time he reported his study, he felt that his results did not preclude the possibility of significant gains in achievement with low achievers and suggested that further research is needed to determine whether the calculator would be effective in remedial programs of arithmetic.

In an attempt to provide a preliminary study of the potential value of calculating machines for mathematics instruction, Betts used a group of thirteen high achieving sixth-grade students.[16] No control group was used, and the instruction with calculators lasted about five weeks. Betts concluded that the sixth grade does not provide enough problem drill to justify extensive use of calculators and further investigation is needed at a higher level.

There are a number of factors which affect achievement in computational skills in mathematics. These computational skills involve conditioned responses such as recalling number facts and

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[15] Durrance, V. R., The Effect of the Rotary Calculator on Arithmetic Achievement in Grades Six, Seven, and Eight, p. 56, doctor's thesis, George Peabody College, Nashville, 1964.

[16] Betts, E. A., "Preliminary Investigation of the Value of a Calculating Machine for Arithmetic Instruction," Education 58:229-235, December, 1937.

performing a sequence of acts necessary in a particular algorithm. Holland and Skinner maintain that such responses require reinforcement, if indeed they are to be shaped and maintained; and reinforcement is most effective when provided quickly after a response.[17] In computation, reinforcement is provided when a result a student gets is verified to be correct or incorrect. In classrooms in which students may verify paper and pencil computational results with the calculator, the reinforcement is provided much sooner than when the student must get verification from the teacher. For the teacher will verify results either after the list of problems is completed by the student, or when the student takes the trouble to ask the teacher for verification. Thus devices such as calculators which can provide quick verification of results can shape responses and improve computational skills.

Results of a pilot study conducted at the University of California in 1955 indicated that attitudes do affect achievement in arithmetic. The study used interviews with seventeen students for the source of the data. According to the results of this study. "The data indicated that parents determine the initial attitudes of their children and affect their achievement in arithmetic and mathematics."[18] Three factors seem to affect both attitude and performance in several subjects including mathematics, and they are parental expectation of children's

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[17]Holland, J. G. and Skinner, B. F., The Analysis of Behavior, McGraw-Hill, New York, 337 pp.

[18]Poffenberger and Norton, "Factors Determining Attitudes Toward Arithmetic and Mathematics." The Arithmetic Teacher 2:113-116, April, 1956.

achievement, parental encouragement regarding these subjects, and parent's own attitude toward this area of curriculum.

In an ex post facto type of study a relationship between attitude and achievement was indicated when Stephens found that there is a significant difference in attitude toward mathematics between accelerated students and regular students and between accelerated and remedial students. But no such difference was found between the regular and remedial students.[19]

In an experiment involving fourth-grade students, Lyda and Morse found that associated with teaching of arithmetic and change in attitude toward the study of arithmetic are significant gains in arithmetic computation and reasoning.[20]

Concerning the role attitude plays in facilitating learning Ragen says, "The child's attitudes affect what he learns, what he remembers, and what he does."[21] After reviewing many studies dealing with remedial programs Wilson concluded, "A change in attitude is often a necessary first step in a remedial program for arithmetic at high school and college levels."[22]

Using individualized instruction for remedial arithmetic for

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[19] Stephens, L., "Comparison of Attitudes and Achievement Among Junior High School Mathematics Classes," The Arithmetic Teacher 9:351-356, November, 1960.

[20] Lyda, W. J. and Morse, E. C., "Attitudes, Teaching Methods, and Arithmetic Achievement," The Arithmetic Teacher 9:136-138, March, 1963.

[21] Ragan, W. B., Modern Elementary Curriculum, The Dryden Press, New York, 1953, 496 pp.

[22] Wilson, G. M., "Toward Perfect Scores In Arithmetic Fundamentals," The Arithmetic Teacher 1:13-16, December, 1954.

ninth-grade students Bernstein found that many pupils expressed a greater liking for mathematics after they participated in the program.[23]

The length of instruction in mathematics is another factor which affects achievement. Jarvis found that sixth-grade students who studied arithmetic for 55-60 minutes a day for three years achieved significantly more on arithmetic fundamentals than did a comparable group who studied for 35-40 minutes a day for the same time period.[24]

Many teachers using the calculators feel that the actual experiences which the students gain contribute to an improvement in attitude and achievement. However, when cuisennaire materials were used with primary grade children for from one to two years in the state of New York, Passey found that they achieved significantly less than those using conventional methods.[25] He did find, however, that interesting patterns of achievement were indicated by consistently descending means, no matter what the program of instruction in arithmetic, on the various descending levels of mental maturity, reading ability, and socioeconomic status.

In an experiment designed to determine the relative effectiveness of a calculator, an abacounter and teacher made aids in increasing test scores of 270 fifth-grade students in arithmetic fundamentals and arithmetic reasoning, Redell and DeVault found that

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[23]Bernstein, A. L., A Study of Remedial Arithmetic Conducted With Ninth-Grade Students, Unpublished Doctoral Dissertation, Wayne University, 1955.

[24]Jarvis, T. J., "Time Allotment Relationships To Pupil Achievement In Arithmetic," The Arithmetic Teacher 9:248-250, May, 1963.

[25]Passey, R. A., "The Effect of Cuisennaire Materials on Reasoning and Computation," The Arithmetic Teacher 10:439-440, November, 1963.

calculators and abacounters produced significantly greater gains than did teacher-made aids.[26] And the specific aid used in these classrooms did make a difference in the achievement of the pupil.

Since the calculators seem to interest students because of their novelty, increased achievement may be due solely to chis novelty effect. Longstaff indicated that teacher enthusiasm for the use of calculators was due, among other things, to their potential as a toy to provide classroom diversions.[27] However, Popham found that there was no significant differences in the learning of geometry between two groups one of which had used teaching machines for an extended period of time and one which had been using these machines for a short period of time.[28] Thus the novelty effect does not necessarily produce greater achievement.

Small found that the low achievers need to be relieved of their anxiety toward mathematics, and in general are impeded by psychological factors to a large degree.[29] Several recommendations were made, one of which advocated remedial programs based on the individual levels of abstractive ability of the low achievers.

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[26]Redell, W. D. and DeVault, M. V., "In-Service Research In Arithmetic Teaching Aids." The Arithmetic Teacher 6:243-246, May, 1960.

[27]Longstaff, F. R., and others, "Desk Calculators In the Mathematics Classroom," Canadian Council for Research in Education, ERIC, ED 029 498, June, 1968.

[28]Popham, W. J., "The Influence of Novelty Effect Upon Teaching Machine Learning," San Francisco State College, ERIC, ED 003 605, August, 1962.

[29]Small, E. E., and others, "The Problems of Under Achievement and Low Achievement In Mathematics Education," Florida University, ERIC, ED 101 535, November, 1966.

Thus the time lapse between response and reinforcement affects mathematics achievement as does a host of psychological and socio-economic factors including attitude toward the study of mathematics with all its contributing factors such as individualized instruction, novelty effect of the materials used, etc. Although no conclusive evidence supports the view that calculators improve achievement or attitude when used with heterogeneous groups or with above average groups, several investigators such as Durrance and Betts have commented on the possibility of significant gains with low achievers.

CHAPTER III

METHODOLOGY

This chapter will describe the statistical design of the experiment including background information on the school, teachers, and students.

The School, Teachers, and Pupils

This study was conducted at the Maine Township (East) High School in Park Ridge, Illinois. The school is in a suburban area with students from the upper middle and middle economic brackets and is highly regarded in the State as having excellent facilities and an outstanding staff and curriculum. The school used calculators in about half of the General Mathematics classes during the 1968-69 school year. For the 1969-70 school year the General Mathematics students (about 100 of them) were scheduled into five classes of about 20 each in a random manner. This scheduling of mathematics classes was done by a computer and before other classes were scheduled.

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Both Mr. Paul Nelson and Mr. John Hynek are experienced teachers. Miss Ruth Anderson, department chairman, arranged many details including the selection of teachers. The administration is interested in evaluating their calculator oriented program and has been very cooperative.

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The lesson plans utilized worksheet materials, which were written by several teachers in the district several years ago; and they utilized the text, Trouble Shooting Mathematics Skills, written by Bernstein and Wells.[30] The lesson plans also included specific instructions on the administration of the pre-test and post-test to insure that all students received the same instructions and were given the same time to complete the tests.

Every Monday morning before school started the investigator met with the two teachers in the experiment to discuss the lesson plans for that week. So the teachers were completely familiar with the plan for the week.

Both groups were given pre-tests and post-tests which measure attitude toward mathematics and computational skills with whole numbers. The attitude test which was used as the pre-test and post-test was the PY 011, Pro-Math Composite Test developed by SMSG for their longitudinal study.[31] The pre-test and post-test used to measure computational skills with whole numbers was the Stanford Diagnostic Arithmetic Test, Test 2, Parts A, B, and C.[32] This test has two forms, W and X. Form W was used as the pre-test and post-test with both groups to deal with the hypothesis that the use of calculators in the instructional program increases computational skills. In addition, Form X was used as a post-test with the experimental groups to deal with the hypothesis

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[30]Bernstein, A. L., and Wells, D. W., Trouble Shooting Mathematics Skills, Holt, Rinehart, and Winston, Inc., New York, 1963.

[31]Wilson, Cahen, and Begle, op. cit., p. 183.

[32]Beatty, Madden, and Gardner, op. cit., pp. 4-5.

that the student can compute better with calculators than without calculators.

The attitude pre-test was used to verify the comparability of both groups. The attitude post-test was used to determine the change and the t-test for the difference between the means was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

The computation pre-test and post-test were used to determine the change in computational skill for each student in both groups. The change or difference in the score for each student was determined as was the mean and variance for these differences for the experimental group and the control group. The t-test for the differences between these mean differences was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

To deal with the hypothesis that these students can compute better with calculators than without them, the comparable parts of Form X of the Stanford Diagnostic Arithmetic Test were administered to the experimental group the day after Form W was completed. Whereas the students were not allowed to use the calculators for Form W, the students were told they could use the calculators to get results for the test items when taking Form X. The mean and variance were computed for the distribution of the Form X scores. The t-test for the difference between the means of the Form W and Form X distributions was used, with 5% level of confidence as the criterion for rejecting the null hypothesis.

Summary

Ninth-grade low achievers were randomly placed into four classes. These four classes were randomly partitioned into a control group of two classes and an experimental of two classes. The treatment given the experimental group was the use of calculators to verify paper and pencil computation. The instruction in both groups was the same in all other aspects. The lesson plans were the same, the two teachers taught both control and experimental groups, the instructional time was the same, and all the students attended the same school. The dependent variables were attitude toward mathematics and computational skills with whole numbers using calculators and without calculators. The t-test for the difference between the means was used to determine significant changes at the 5% level of confidence.

CHAPTER IV

FINDINGS

The information concerning attitude was obtained by administering the PY 011, Pro-Math Composite Test developed by SMSG for their longitudinal study.[33] It was used as the pre-test before the treatment began which was shortly after the fall semester of 1969. It was again used as the post-test, some eight weeks later after the unit of instruction was completed. This test was given to both the control and the experimental group.

The students involved in the study were selected by the school to take the General Mathematics course. Since this somewhat homogeneous set of students was randomly placed into a control group of 40 and an experimental group of 41, the investigator was confident that the two groups were comparable. However, to lend added weight to the contention that the two groups were comparable, the pre-test scores on the attitude test were analyzed. Table 1 shows the pre-test scores on the attitude test of the control group and the experimental group. The mean for each group is 31.18 and 31.76, respectively. The variance for each group is 33.50 and 23.50, respectively. The test of significant difference between the two means used assumes the two groups to be independent. The t score for the difference between the two means is .49. Therefore, the contention that these two groups' means are not comparable cannot be rejected.

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[33]Wilson, Cahen, and Begle, op. cit., p. 183.

TABLE 1. PRE-TEST SCORES ON ATTITUDE TEST

Control Group	Experimental Group	Control Group	Experimental Group
25	37	27	29
26	35	38	25
28	29	29	26
31	44	34	27
24	31	35	28
27	24	34	32
25	28	38	31
23	31	26	34
37	30	20	34
32	35	33	27
35	32	29	39
40	40	37	38
35	29	28	32
40	41		29
26	28		
25	39		
26	37		
32	27		
39	32		
22	34		
32	33		
37	26		
29	27		
44	36		
28	33		
38	27		
33	26		

Mean of Control Group	31.18
Variance of Control Group	33.50
Mean of Experimental Group	31.76
Variance of Exp. Group	23.50
t Score	.49
Significance Level	31%

Table 2 shows the post-test scores on the attitude test for the control group and the experimental group. The means are 32.83 and 32.07, respectively. The variances are 30.10 and 53.62, respectively. The test of significant difference between the two means used assumes the two groups to be independent. The t score for the difference between the two means is .53. Therefore, the first hypothesis that the use of calculators in the instructional program with ninth-grade, low achieving mathematics students improves their attitude toward the study of mathematics cannot be supported.

TABLE 2. POST-TEST SCORES ON ATTITUDE TEST

Control Group	Experimental Group	Control Group	Experimental Group
29	31	32	33
31	29	36	23
28	24	30	28
34	40	37	13
30	26	36	32
28	25	37	29
23	15	39	39
19	34	23	42
37	24	30	38
42	36	36	29
37	36	34	42
35	37	41	42
38	26	29	39
27	35		35
38	26		
25	39		
27	38		
31	34		
36	34		
36	35		
34	34		
41	19		
31	33		
42	48		
26	32		
37	34		
31	27		

Mean of Control Group	32.85
Variance of Control Group	30.10
Mean of Experimental Group	32.07
Variance of Exp. Group	53.62
t Score	.53
Significance Level	30%

The differences between the pre-test and post-test scores on the computation test of the control group and the experimental group are given in Table 3. The test used in both instances was the Stanford Diagnostic Arithmetic Test, Form W, Test 2, Parts A, B, and C.[34] The means are 8.50 and 7.90, respectively. The variances are 55.10 and 28.72, respectively. The t-test used assumes the two groups are independent. The t score on the difference between the two means is .42, which is at the 34% significance level. Since this does not meet the 5% significance level originally established, the second hypothesis, that the use of calculators in the instructional program with ninth-grade, low achieving students improves their computational skill, cannot be supported.

[34] Beatty, Madden, and Gardner. op. cit., pp. 4-5.

TABLE 3. DIFFERENCES BETWEEN PRE-TEST AND POST-TEST SCORES ON COMPUTATION TEST

Control Group	Experimental Group	Control Group	Experimental Group
-2	15	17	11
-12	-1	13	3
3	10	2	6
-3	7	3	4
2	4	8	3
12	15	21	-2
3	12	19	7
21	8	20	6
7	6	19	0
17	11	4	6
2	6	6	1
9	13	8	13
-1	7	17	2
11	8		8
-2	5		
8	1		
3	7		
13	5		
13	11		
14	10		
9	9		
5	2		
9	16		
10	17		
16	13		
8	21		
8	18		

Mean of Control Group	8.50
Variance of Control Group	55.10
Mean of Experimental Group	7.90
Variance of Exp. Group	28.72
t Score	.42
Significance Level	34%

To test the third hypothesis, Form X of the same computation test was given only to the experimental group after they had completed Form W of the post-test. In taking the Form X test the students were permitted to use the calculators to obtain answers. The scores on the Form W test and the scores on the Form X test are given in Table 4. The means of the post-test scores are 48.56 on the Form X test and 40.80 on the Form W test. The variances are 44.30 for the Form X test and 68.60 for the Form W test. The t-test used assumes the two distributions are dependent. The t score for the difference between these two means is 5.92, which is significant at the 1% level of confidence. Therefore, the hypothesis, that ninth-grade, low achieving mathematics students can compute better with calculators than without calculators, is accepted.

TABLE 4. POST-TEST SCORES ON COMPUTATION TEST BY EXPERIMENTAL GROUP

Student	Form W	Form X	Student	Form W	Form X
1	43	52	28	48	53
2	25	48	29	34	40
3	37	48	30	20	37
4	49	52	31	49	54
5	37	53	32	41	47
6	40	55	33	27	38
7	36	48	34	48	54
8	39	49	35	55	56
9	43	52	36	45	50
10	49	39	37	47	56
11	49	55	38	32	56
12	49	55	39	32	43
13	43	48	40	22	48
14	38	53	41	45	55
15	35	52			
16	30	38			
17	42	53			
18	51	50			
19	47	56			
20	53	32			
21	40	49			
22	35	37			
23	50	53			
24	42	35			
25	40	44			
26	40	44			
27	46	54			

Mean (Form W)	40.80
Variance (Form W)	68.60
Mean (Form X)	48.56
Variance (Form X)	44.30
t Score	5.92
Significance Level Below	1%

Summary

Ninth-grade, low achieving mathematics students were randomly placed into a control group of 40 and an experimental group of 41. The experimental treatment was the use of calculators in the instruction. The unit of work was the addition, subtraction, multiplication, and division of whole numbers. The instructional time was the same for both groups as was the influence of the teacher, the unit of instruction, and the school environment. Both groups were given pre-tests and post-tests to measure attitude toward mathematics. The treatment produced no significant difference in this attitude.

Both groups were given a pre-test and post-test to measure computational skills with whole numbers (Form W). The treatment produced no significant difference in learning computational skills.

After the treatment was completed and the computational post-test, Form W, was completed, the experimental group was given another comparable form of the test, Form X. On this second post-test, however, students were permitted to use the calculators when taking the test. The test scores on Form X were significantly higher at the 1% level of confidence than the test scores on Form W. Therefore, the use and availability of calculators produces higher computational test scores.

CHAPTER IV

SUMMARY

There is a strong movement to improve the instruction of mathematics for the ninth-grade, low achiever. A great deal of this effort is directed toward the implementation of the mathematics laboratory approach to teaching which uses a variety of visual aids and models including calculators. Teachers are enthusiastic about the use of calculators with these students; and even though all research conducted in the past indicates that the use of the calculator does not achieve certain objectives better than conventional instruction, efforts to use calculators have not been abated.

To this date, research concerning the use of calculators has not focused on the low achieving ninth-grader. Therefore, it seems appropriate that the use of calculators with these students be subjected to careful study. A complete study would require evaluating the use of calculators in relation to all the various objectives which proponents claim can be achieved. This study is an attempt to evaluate the use of the calculator with low achieving, ninth-grade mathematics students in relation to three objectives or purposes. The first is that the use of calculators improves their attitude toward mathematics. The second is that it improves their paper and pencil computational skills. The third is that it enables them to use calculators effectively to obtain computational results when called upon to do so.

Ninth-grade, low achievers were randomly placed into a control group of 40 and an experimental group of 41. Two teachers taught a unit on computation with whole numbers to one class of each group.

The same lesson plans were used for each group by both teachers. The experimental group had the use of calculators. The treatment consisted of having the students check their paper and pencil computation with the calculators. The experimental group was allowed just enough extra time to learn how to operate the calculators. The unit of instruction on whole numbers took seven weeks at 45 minutes a day.

The PY 011, Pro-Math Composite Test, developed by SMSG for their longitudinal study, was the attitude test used to measure the attitudes of the students toward mathematics.[35] After the treatment, the difference in the mean scores of both groups was analyzed for significance.

The Stanford Diagnostic Arithmetic Test, Test 2, Parts A, B, and C was used to measure the computational skills of the students in both groups.[36] One form of the test (Form W) was used as a pre-test and a post-test. The gains or differences between the pre-test and post-test scores were analyzed for significance.

After the unit of instruction and the post-testing were completed, the experimental group was given another form of the test (Form X). Whereas the experimental group was not allowed to use the calculators when taking the Form W post-test, it was allowed to use them when taking the Form X test. The differences between the two post-tests were analyzed for significance.

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[35]Wilson, Cahen, and Begle, op. cit., p. 183.

[36]Beatty, Madden, and Gardner, op. cit., pp. 4-5.

Conclusions

Analysis of the attitude test scores does not support the hypothesis that the use of the calculators in the instructional program with ninth-grade, low achieving mathematics students improves their attitude toward mathematics.

Analysis of the test scores on the computational skills does not support the hypothesis that the use of the calculator in the instructional program with ninth-grade, low achieving mathematics students improves their computational skills.

Analysis of the two forms of the post-test on computational skills does support the hypothesis that ninth-grade, low achieving mathematics students can compute better with calculators than without them.

Low achieving, ninth-grade students are subjected to a host of social, academic, and physiological pressures. These shape their attitudes toward the study of mathematics and are monumental when compared to the salutary effects the use of the calculator may have to improve their attitudes. However, given enough time to act on attitudes, the calculator may be worthwhile. But its use over a year's time or so cannot be expected to produce great changes in attitudes.

The calculator was used as a tool in the instructional program of most of the studies reviewed in this paper and was so used in this experiment. It was not used so that the natural consequences could be insights into the understanding of mathematical principles. And the use of the calculator as a means to improve computational skills through reinforcement will fail when so used for a short time, say less than a year. What the effects its use may have when used over a number of years is unknown. However, schools cannot expect the use of calculators to be significantly better than conventional means to improve computational skills when used only in the General Mathematics class in the ninth grade. It is the investigator's view that the use of calculators as tools in the instructional program to improve computational skills is strategically unsound; for its impact, if it has any, is too light for the time it has to operate.

Recommendations

The dissatisfaction with the ninth-grade, low achieving mathematics classes is acute and most likely will not disappear in the very near future. The experience which this investigator gained in working with this problem suggests the following recommendations:

1. The most fruitful efforts probably will involve socially oriented solutions. Thus innovations which deal with such low achievers in a socially oriented way should be encouraged. Here is where administrators can look for more immediate help.

2. Calculators should be available to all students in order to provide computational assistance when the problem warrants their use. They may be located in a mathematics laboratory or in each classroom as the local situation dictates.

3. Programs should be developed which use the calculator in the instructional process. The calculator should be used to develop insights which it cannot when used merely as a tool.

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Vita

Joseph P. Cech was born in Whiting, Indiana, on September 29, 1923, where he attended both elementary and secondary school. He received a B.S. in Business from Indiana University in 1947. After spending the next few years in the business world, he again entered Indiana University where he received a M.S. in Education in 1957. He taught at Niles Township High School in Skokie, Illinois for the next seven years during which time he attended a series of National Science Foundation Summer Institutes at Northwestern University in Evanston, Illinois. From these he received a M.A. in Mathematics from Northwestern University. During the past five years he has been Mathematics Supervisor for the State of Illinois.

As Mathematics Supervisor he has provided elementary and secondary school districts with consultative assistance for their mathematics programs. He has organized mathematics workshops in modern mathematics for elementary and junior high school teachers and principals. As part of his responsibilities as Mathematics Supervisor, he has evaluated schools for state recognition purposes and has participated in several North Central Association evaluations of high schools.

Over the past five years he has composed many state publications as well as contributed articles to the Illinois Journal of Education and The Illinois Administrators Communicator. He has reviewed manuscripts of text materials in mathematics for several publishers, and evaluated institute proposals for the National Science Foundation.

He is a member of the National Council of Teachers of Mathematics, a member of the executive board of the Illinois Council of Teachers of Mathematics, a member of the Chicago Men's Mathematics Club, and a representative to the Metropolitan Mathematics Federation of Chicago.