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

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There appear to be two important reasons for the use of calculators with low-achieving students. One is to provide motivation, and the other is to improve achievement. The study discussed here addressed itself to the effect of the calculator in these two areas. In particular, this experimental study tested the following three hypotheses:

1. The use of 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 the General Mathematics classes during the 1968-69 school year. For the 1969-70 school year the General Mathematics students (about a hundred 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 were placed in General Mathematics on the basis of their IQ scores and standardized achievement-test scores. These students had IQ scores of about 75 to 95 and had scored two years or more below grade level on achievement tests.

EXPERIMENTAL DESIGN AND PROCEDURE

Two experienced teachers taught the four classes used in the experiment. Each teacher had one control group and one experimental group; so the teacher variable was held relatively constant. The choice of which class was the experimental group and which was the control group was made by a flip of a coin. Lesson plans were developed during the summer prior to the fall semester by a teacher who had previously taught a class using the calculators. These lesson plans were used by both teachers for both groups in order to control the instructional activities, assignments, and time for both groups. One variable in instruction was that each experimental group, which used calculators, received four days of additional instruction time dealing with the operation of the calculator. Both the experimental and the control groups had seven weeks of instruction (45 minutes a day) dealing with addition, subtraction, multiplication, and division of whole numbers. The experimental groups differed from the control groups in that they used the calculators to verify paper and pencil computation; the students in an experimental group were told to check their work by using the calculators, while those in a control group were told merely to check their work.

The teachers encouraged students in the experimental groups to check each problem as soon as they completed it but did not force them to do so. This was done in order to reduce the time lapse between response and reinforcement. The teachers indicated that the students did follow this suggestion willingly.

The lesson plans utilized worksheet materials, which were written by teachers in the district several years ago, and the textbook *Trouble Shooting Mathematics Skills* (Bernstein and Wells 1963). The lesson plans also included specific instructions on the administration of the pre-test and the post-test to ensure 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. This was done to ensure that both teachers followed the experimental design.

All groups were given pre-tests and post-tests that measured attitude toward mathematics and computational skills with whole numbers. The attitude test that was used as the pre-test and post-test was the PY 011 Pro-Math Composite Test, developed by the SMSG for its longitudinal study (Wilson, Cahen, and Begle 1968, p.183). 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 (Beatty, Madden, and Gardner 1966, pp.4-5). This test has two forms, W and X. Form W was used as the pre-test and post-test with both the experimental and the control 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 that these students can compute better with calculators than without calculators.

The attitude pre-test was used to verify the comparability of both kinds of groups. The attitude post-test was used to determine the attitude of both after the seven-week experimental period. The t test for the difference between the mean scores of both was used, with the five percent 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 kinds of 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 the five percent 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 groups the day after Form W was completed. Whereas the students were not allowed to use the calculators for form W, they 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 the Form-X distributions was used, with the five percent level of confidence as the criterion for rejecting the null hypothesis.

FINDINGS AND CONCLUSIONS

Analysis of the attitude-pre-test scores, as shown in Table 1, does not support the view that the experimental and control goups were different. Analysis of the attitude-post-test scores, as shown in Table 2, 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.

TABLE 1
PRETEST SCORES ON ATTITUDE TEST

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

TABLE 2
POSTTEST SCORES ON ATTITUDE TEST

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

Analysis of the test scores on the two forms of the computational-skills test, as shown in Table 3, does not support the hypothesis that the use of calculators 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, as shown in Table 4, 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 for a short time may have in improving their attitudes. In this study a seven-week experience did not have a significant effect. However, given enough time, the use of the calculator may improve attitudes toward mathematics.

TABLE 3
Differences between Pretest and Posttest Scores on Computation Test

Control Group	Experimental Group
−2	15
−12	−1
3	10
−3	7
2	4
12	15
3	12
21	8
7	6
17	11
2	6
9	13
−1	7
11	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
17	11
13	3
2	6
3	4
8	3
21	−2
19	7
20	6
19	0
4	6
6	1
8	13
17	2
	8

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

TABLE 4
Posttest Scores on Computation Test by Experimental Group

Student	Form W	Form X
1	43	52
2	25	48
3	37	48
4	49	52
5	37	53
6	40	55
7	36	48
8	39	49
9	43	52
10	49	39
11	49	55
12	49	55
13	43	48
14	38	53
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
28	48	53
29	34	40
30	20	37
31	49	54
32	41	47
33	27	38
34	48	54
35	55	56
36	45	50
37	47	56
38	32	56
39	32	43
40	22	48
41	45	55

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%.

The calculator was used as an aid for computation in the instructional program of most of the studies reviewed by this investigator and was so used in this experiment. It was not used to build insights into the understanding of mathematical principles. This experiment, as well as those experiments found in the literature, indicates that the use of the calculator as a means to improve computational skills through reinforcement is not effective when so used for 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 have results significantly better than the results of conventional means to improve computational skills when calculators are used only in the General Mathematics class in the ninth grade. It is the investigator's opinion that the use of calculators 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*, in some cases, can be achieved only with the help of a calculating device such as a calculator or computer; for the complexity of computation may make some problems beyond the capabilities of the student.

Perhaps the one objective that the calculator *may* be useful in achieving is the objective that students should understand mathematics. The calculator *might* be used effectively to illustrate some mathematical principles. In such circumstances the calculator is a teaching device, just as models and graphic representations of mathematical ideas are. 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.

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