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Calculators, Attitudes, and Success

by

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Abstract

A study was conducted involving six graphing calculator sections and three traditional sections of a college algebra course. The calculator students showed significant improvements in their overall attitude toward mathematics, their self-concept relative to mathematics, and their enjoyment of mathematics. They rated the calculators and teachers very highly, and they were more successful than the traditional students.

Calculators, Attitudes, and Success

Technology has revolutionized almost all aspects of our information age society, and it has now become a major factor in education at every level. There is nearly universal agreement in the Mathematics/Mathematics Education community that technology will continue to develop as a very prominent feature in the educational landscape. According to the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), calculators with graphing capabilities should be available to all students at all times and a computer should be available in all classrooms for demonstration purposes. The TI-82 (or 83) calculator together with its overhead projection unit is ideally suited to satisfy both of these recommendations. It is an excellent demonstration device for teachers as well as a powerful tool for students to explore mathematical ideas and solve problems.

Background

Southeastern Louisiana University is a rapidly growing, open admissions university with a student population of approximately 15,000 students. Most of the students are from lower to middle socio-economic status families and are of average scholastic ability. Their mean ACT scores are 19.0 (composite) and 17.9 (mathematics). Many of these students have difficulty satisfying the university's graduation requirements of six hours of mathematics at the level of college algebra or higher.

The Department of Mathematics normally teaches about 4,000 students per semester, including approximately 50 sections of college algebra. The combined withdrawal/failure rate in this course is generally about 50 percent, which is a cause of great concern for students, faculty, and administration. This situation has spawned many university and departmental initiatives that have focused on improving the students' success rate in our mathematics courses. This paper reports on one such project.

Graphing Calculator Initiative

As a part of our efforts to address this problem, the Department of Mathematics decided to initiate the use of graphing calculators in the college algebra course. Our goal was to implement this aspect of mathematics education reform with the hope that it would have a positive effect on our students' performance. This decision raised several issues at various levels

within the university that have to be resolved. Administrators were concerned about the impact of the calculators on our students and about the added cost incurred by the students. Some faculty members were reluctant to change their pedagogical approaches; and others voiced epistemological objections, such as the argument that our students would become button pushers rather than problem solvers. After months of discussions, meetings, planning sessions, and letter writing, our plan was finally approved. Six sections of college algebra were designated as graphing calculator sections, and TI-82's were provided to the students.

Design of the Study

In addition to the six calculator sections, three traditional sections of the course taught by the same instructors were included as control groups. The sections varied in size from 25 to 44 with the total number of student participants equaling 328. We attempted to evaluate the impact of the technology on these students from several different perspectives and with multiple instruments.

We administered two attitude measures to the calculator classes and control groups at the beginning and end of the semester. The first was *The Revised Math Attitude Scale* (Dutton, 1962), which rates each student's overall attitude toward mathematics. Complementing this was *The Mathematics Attitude Inventory* (MAI) (Sandman, 1980). The MAI gives six scores per student measuring the following constructs: perception of the mathematics teacher, anxiety toward mathematics, value of mathematics in society, self-concept in mathematics, enjoyment of mathematics, and motivation in mathematics. We also asked the students to fill out questionnaires which I developed specifically for this study (see Appendix). The questions asked the students to give their opinions about various aspects of the course, such as the instructor, the textbook, and the calculators.

Results

The statistical analyses (repeated measures) of the data from the attitude scales revealed that the calculator sections showed significant improvements in (a) their overall attitude toward mathematics, (b) their opinion of the teacher, (c) their self-concept relative to mathematics, and (d) their enjoyment of mathematics (see Table 1). In contrast, the traditional sections showed no changes in their attitudes.

Table 1

Means for Calculator Sections

Measure	**Pre**	**Post**
Dutton	-.04	.26*
MAI		
Teacher	26.0	28.3*
Anxiety	12.4	12.1
Value	22.7	22.6
Self-concept	14.8	16.0*
Enjoyment	17.5	18.4*
Motivation	8.8	8.8

* significant at $p < .05$

We also analyzed the students' responses to the course questionnaire. Below is a summary of student responses to Questions 1 - 5 and some statistics from Question 6.

1. The students listed the calculators, the instructors, and the teaching methods (hands-on, group work) as the most beneficial to their learning.
2. Most found nothing to be least beneficial, but some mentioned logarithms, lack of time, and homework.
3. The students liked the overhead calculator examples, the group work, the problem solving, and the instructors' thorough explanations, patience, and caring.
4. Most students found nothing least beneficial about the teachers' style.
5. Suggestions for improvement included slowing the pace and more calculator workshops.
6. The students were asked to rate several aspects of the course on a scale from 0 (Failing) to 4 (Excellent). The means are as follows:

Teacher - 3.54	Text - 2.61
Calculator - 3.55	Expected grade - 2.55

The grade distributions from the calculator sections are listed below:

Grade:	A	B	C	D	F	W
Percent:	8.6	11.1	20.0	15.6	14.7	30.2

The combined withdrawal and failure rate of 44.9 % represents a small but encouraging improvement over the department's traditional results. The corresponding rate for the control sections was 46.6 %.

Conclusion

In general, research on the incorporation of technology into the mathematics curriculum has shown many positive results. When used in conjunction with other mathematics education reform ideas, technological curricula have enriched students' understanding of mathematical concepts, increased their problem solving abilities, and improved their attitudes toward mathematics. We believe that our efforts in this domain have produced similar results. In particular, we were able to document some positive effects of graphing calculators on our students' attitudes and their success in the course. These results, coupled with other benefits of graphing calculators, led to their adoption in all of our mathematics courses.

In addition to these promising results, there are many other advantages which arise from the use of these calculators. They allow the students to explore and solve more realistic problem situations. The calculators can be used to handle some of the lower level tasks, thus allowing for more time to be devoted to the development of higher order cognitive abilities, such as problem solving and conceptual understanding. They also help students to become more familiar with and proficient in the use of technology, which is a vital skill in today's world.

Many of our faculty have become very excited about this initiative, which now has the full support of both faculty and administration. It is no longer a question as to whether technology, and in particular graphing calculators, should be incorporated into the mathematics curriculum. The question now is how to best capitalize on this power and potential for improving our students' mathematical experiences.

References

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Appendix

Course Questionnaire

Now that you have just about finished the semester, please provide feedback and suggestions about your learning and experiences in this class. You do not have to sign your name as all responses are to be anonymous.

1. What aspects of this class were most beneficial to your learning?

2. What aspects of this class were least beneficial to your learning?

3. What teaching technique or aspect of the teacher's style were the most beneficial to your learning?

4. What teaching technique or aspect of the teacher's style were the least beneficial to your learning?

5. What suggestions do you have for improvement in the following:
   Course content?

   Course activities?

6. Rate the following aspects of the course in terms of its helpfulness to your learning:
   (0 = Failing, 1 = Poor, 2 = Average, 3 = Good, 4 = Excellent)
   Teacher: 0 1 2 3 4
   Textbook: 0 1 2 3 4
   Calculator: 0 1 2 3 4
7. What grade do you expect to make in this class? A B C D F

   Please use the back of this form for any additional comments you may have.