Using Calculators for Students in Grades 6-8
By: Center for Implementing Technology in Education (CITEd)

Should students use calculators when learning about algebra or number and operations? (See http://www.nctm.org/standards/content.aspx?id=16909 for definitions of each topic.) How should teachers integrate calculators to teach these topics? Following are examples of how some researchers think calculators can be incorporated into algebra lessons to help students in grades 6-8. These studies used a design that shows strong evidence that calculators lead to better student achievement. Nevertheless, readers should judge for themselves if any of these fit with their teaching styles and specific classroom needs.

Since we found quite a few articles that cover these grades, we broke our discussion into several pieces. Below, we offer some information about curriculum studies (i.e., studies that evaluate whether a calculator-infused curriculum was more effective than some comparison condition) and we share a study that reminds us that calculators are not always beneficial. We have also included information about descriptive articles and an online resource.

**Curriculum studies**
Graham & Thomas (2000) developed a curriculum, presented over three weeks, that used a TI-80 or TI-82 graphics calculator to help teach students about algebraic variables (e.g., what is the X variable in the equation, 8X=24?). The curriculum goes beyond solving equations, and encourages students who are just learning about algebra to think about variables at a conceptual level. Among other things, the graphics calculator provides the means for students to construct equations, substitute different values for a variable, make subsequent predictions about outcomes, and receive immediate feedback. One hundred and eighty-nine students (ages 13 and 14) of mixed ability were assigned to either use this curriculum or use more typical introductory algebra lessons in classrooms. It turned out that students in the treatment group did significantly better from pre- to post-test than students in the control group.

Bardini, Pierce, & Stacey (2004) did another study that considered the effects of using TI-83 calculators to teach algebra. They asked students to follow a textbook
chapter on linear functions from *Graphing Algebra: Explorations with a Function Grapher*, which alternates between teaching calculator skills and algebra. The study—which followed the students over a 25-session period using a pre-post design—tested students' graphing skills and their knowledge of symbolic algebra. The sample included 17 high-achieving Australian eighth graders, but only 15 completed both score sets. Interview data was obtained from the teacher and six of the students; 20 of the 25 sessions were observed by the researchers. The study results suggest that the curriculum increased student learning of algebra; there may have also been additional benefits to using this curriculum, such as enhanced motivation.

Judson & Sawada (2000) compared student performance on a statistics test for eighth grade students who were either participating in science classes in which mathematics was integrated using technology, or in regular science classes. The authors used descriptive methods to compare letter grades on the test between students in the two types of science classes, and found that students in the science class which integrated math with technology received more As and Bs, and fewer Ds and Fs, than students in the regular science class.

Kwon (2002) asked whether calculator-based ranger (CBR) activities improve student graphing ability and understanding. CBR provides real-time graphing capability, which may help students to better visualize physical problems and check their intuitions. The study compared the mathematics achievement of students (grades seven and eight) who used CBR against those who did not (eleventh-graders with no experience with CBR or graphing calculators). The findings suggested that use of CBR activities enhanced students' graphing abilities.

Owens (1995) compared multi-line, multi-operation calculators (a type of graphing calculator) to last-entry-or-result calculators (a scientific calculator) to see if the former would improve algebra and pre-algebra students' understanding of basic order of operation problems. Four eighth-grade classes participated, two of which were pre-algebra (lower ability) and two regular algebra (higher ability) classes. Sixty-one students were used in the analysis. Overall, there was a significant difference on algebra performance, favoring the group that used the graphing calculators. These results suggest that it may be better to use these (compared to
scientific calculators) when helping students understand certain concepts, such as order of operations.

Merriweather & Tharp (1999) investigated the effect of using the TI-82 graphing calculator with eighth-grade general education math students, focusing primarily on their changes in attitude towards mathematics and calculators, as well as any change in their algebraic problem-solving strategies. The study included 56 students from three regular education eighth-grade classes in a suburban Virginia middle school; these students were assigned to two groups. One group used the TI-82 during instruction, while a control group did not use a calculator. At the end of the study, students in both groups took a standardized attitude survey and their responses were compared. All students were also asked to solve one algebra word problem when the post-survey was administered. The majority of students who did not use a calculator tended to use more formal rule-based approaches when solving the problem. The majority of students who used the calculator wrote expressions that were similar to how they might appear in the calculator display. Although most students in the control group thought it would be fun to use calculators, over half of the students in the calculator group reported being confused by the calculators, and became more focused on pressing the right buttons than on the problem they were trying to solve.

Further reading
In addition to the above studies, CITEd found three descriptive articles that offer some ideas about using calculators to teach algebra in grades 6-8. Wilson & Brown (1998) discuss how a graphing calculator can be used in conjunction with applets to explore the derivation of the central limit theorem and bell curve convergence. They do so by sharing an activity in which students graph walking speeds, and how this is measured using motion detectors. Edwards (2000) presents a way middle school students can use the table-building features of "second-generation graphing calculators" to create a variety of Pythagorean triples (e.g., "two of the integers differ by 2"). Widmer & colleagues (1998) suggest that a graphing calculator can be used in conjunction with other technologies, such as spreadsheet and graphs, to teach algebraic and geometric concepts.

CITEd also found some articles that offer ideas for using calculators to teach other concepts, such as geometry and numbers and operations. Eisen (1999) describes
how to use a graphing calculator (TI-83) to demonstrate number factors (e.g., the factors of 16 are 1, 2, 4, 8, & 16; any primary number has 2 factors). Factorial sets follow rules of magnitudes (i.e., some numbers have more factors than others); students can graph factor sets and plot (scatter plots on a quadrant) to see what types occur in various scenarios. Hand (2000) describes how he introduced students to base-8 and binary systems, among others, by first giving examples through "Mickey Mouse" and "Mr. Ed" math and then using a scientific calculator to perform these operations. Johnson (2000) describes how she uses a Mission: Impossible scenario to help her middle school students explore the concepts of intercepts, slope, and rates of change with Calculator-Based Ranger (CBR) and a graphing calculator. Another article describes a math club activity with programmable calculators and spreadsheets to teach kids about limits in number theory (Beigie, 2000). The students were given a limit problem and told to program their calculator to determine the height of stacks of blocks after first 10 sequences. They generated a corresponding graph, and were asked to observe the pattern and identify the structure in which the pattern occurred.

Full references for all these studies are listed below.

**Online resources**
Concrete lesson plans that might help you apply the ideas presented here to teaching strategies are available online. Bates & colleagues (1998) developed a resource guide that was put together by 14 classroom teachers to integrate graphing calculators into the math curriculum for grades 7-12, as well as to help make graphing calculators easier to use in the classroom. Fourteen lessons plans and two activity packets are presented that cover a variety of mathematics concepts and topics. Each lesson plan offers the approximate time needed for the lesson, a content area and process strand, covered goals for the lesson, and the necessary materials and equipment to implement the lesson.

**References**


