Calculators in *Investigations*

> "Technology pervades the world outside school. There is no question that students will be expected to use calculators in other settings; this technology is now part of our culture. More important, when calculators are used effectively in the classroom, they can enhance students' understanding and use of numbers and operations. Teachers can capitalize on the appropriate use of this technology to expand students' mathematical understanding, not to replace it." (NCTM, 2005.)

During elementary school, students should become comfortable using a basic calculator as a tool that is common in their homes and communities. Increasingly, sophisticated calculators are being developed and used in settings ranging from high school mathematics courses to science, business, and construction. Students need to learn how to use the calculator effectively as a tool, just as they need to learn to read a clock, interpret a map, measure with a ruler, or use coins. Learning to use such a tool is not a simple task. It depends on a solid understanding of the four operations and the number system.

Students should use calculators for sensible purposes, not as a replacement for mental calculations or for pencil and paper calculations they are learning to do. Just as with other tools, students must learn both *how* to use calculators correctly and *when* they are appropriate to use. Students might use a calculator as an aid if they have many calculations to carry out outside of math class, or to solve problems for which they can think out a solution but don't yet have the experience to carry out the computation. For example:

> In one primary classroom, students became interested in the number of days in the year. Although these students were not yet able to add a string of 12 double-digit numbers, they could articulate a sound strategy–adding the number of days in each month–and use a calculator to carry it out.
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> A teacher in one upper grade class used a class book order to have a discussion focused on estimation. In this class of 25 students, most children ordered at least one book, and some bought several, resulting in a long list of different prices. After sharing strategies for estimating the total cost as a class, several students wanted to know the actual cost of the order. Each of these students used a calculator to add the numbers. They checked their totals with each other to see if they got the same answer, compared that total to the estimates generated by the class, and presented their findings to the class the following day.

Teachers should look for opportunities like these, where the numbers and calculations are beyond the students' skills in written or mental computation, and the focus of the activity is not on developing computational fluency. Students should develop the habit of estimating what a reasonable answer should be to any problem before they calculate. This skill is essential to multi-digit calculation, whether done mentally, on paper, or with a calculator.

Investigating with the calculator can also give students an opportunity to notice mathematical patterns and to ask questions about mathematical symbols. For example, in a second-grade class, students were dividing many numbers by 2, which led to a discussion of the meaning of 0.5. In a fourth-grade class, some students became intrigued with the square root sign. The teacher challenged them to systematically keep track of the results of applying the square root symbol to whole numbers, starting with 1, and to come up with an idea about its meaning. These examples show how calculators can "enable students to explore new areas of mathematics and to tackle many challenging mathematical problems that are impractical to attempt without the aid of such tools." (NCTM, 1999, p. 7)

As they are developing computational fluency, students rely on their own representations and reasoning. Because *Investigations* wants students to see how calculators can be used as math tools, it also includes one or more activities at each grade that explicitly requires a calculator, beginning in Grade 2.

> In Grade 2, calculators are used in an activity called *Beat the Calculator*. (See Unit 3, Session 1.3.) A pair of students turns over a card with a number string (e.g. 7+4+3+4+5) on it. One player adds the numbers mentally (perhaps adding 7+3 and 4+4, and then combining 10+8+5) while the other uses a calculator to add the numbers in order. In addition to mastering the mechanics of using a calculator, students learn, to their surprise, that the child working mentally is almost always faster and more accurate than the child with the calculator.
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> In Grade 3, the calculator is used to explore the relationship between fractions and decimals, with a focus on halves and fourths. (See Unit 7, Sessions 3.1-3.3.) The context of money is used to explore the connections among ideas and notation such as a 1/4 of a dollar, a quarter, $0.25 and 25¢. Students solve problems involving money with pencil and paper, then on the calculator. They discuss fraction notation (1/2), decimal notation (0.50), and the relationship/equivalence between the two.
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> In grade 4, calculators are used to introduce the activity *Broken Calculator*, a variation of the Ten-Minute Math activity *Today's Number*. (See Unit 2, Session 1.1.) Done periodically throughout the year, this activity challenges students to make a number appear on their calculator display without using particular keys. The "broken" keys can be numbers, operations, or both. For example, "make 1,000 without using 1 or 0" or "654 using only addition and subtraction, and without using the digits 6, 5, or 4." Once they learn the activity, students write their expressions first, and use a calculator to check their solutions, if they wish.
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> In Grade 5, students use calculators as they begin to interpret fractions as a way to notate division problems (i.e. 1/4 is one way to express one divided by four). (See Unit 6, Sessions 1.7-1.10.) Students find the decimal equivalents of many fractions and percents, including fractions that result in repeating and non-repeating decimals. They can determine some equivalents through reasoning (1/4 is 25% or 0.25, 1/8 is 12 1/2% or 0.125); for others, they use a calculator (1/3 is 0.3333...).

Whenever such activities are included, the curriculum supports the teacher in asking questions that help students learn good practices with the calculator: How are you keeping track of what you have added and what you still need to add? … Is that the answer you expected? Does it make sense? … Is your result reasonable given your initial estimate? … How can you double-check the calculator result?

Investigations sees the calculator as an efficient tool for many purposes in life, and aims to help students learn to use it sensibly, knowing that using it well depends on the user's correct analysis and organization of the problem, comparing its results with reasonable estimates, understanding when they are appropriate to use and for double-checking.

References

The National Council of Teachers of Mathematics. (May, 2005). *Computation, Calculators, and Common Sense: A Position of the National Council of Teachers of Mathematics.*

The National Council of Teachers of Mathematics. (1999). *NCTM News Bulletin*.

Note: Much of the above essay is based on “Part 5: Technology in *Investigations*” in *Implementing* Investigations *at Grade X.*

