Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching

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Quick Takes

Calculators in the Classroom

Using calculators in the classroom, especially in elementary school, has become a divisive issue. While some people think that children should be taught to use calculators from the time they enter school, others fear that learning to use calculators will rob children of the ability to do mental calculations. Much of the contentious atmosphere surrounding this issue arises from seeing calculator use as an either-or situation. Though important, calculators are only one method of computing. Both sides of this debate have some merit; so let's look at some of the points raised.

The National Council of Teachers of Mathematics (NCTM) maintains that each child should learn to solve problems by using a hand-held calculator and mental and written calculations. The NCTM clearly asserts that children need to master all these methods if they are to understand and use mathematics. Why does the NCTM feel so strongly about supporting young children's use of calculators?

Why would children need to use calculators?

In concluding that children of all ages should be proficient with calculators, the NCTM did not intend to rule out other ways of solving problems. Children do need to learn to figure in their heads and to do paper and pencil work, but these methods alone will not meet contemporary needs.

Aversion to using calculators in schools contrasts with their general acceptance in the work place and the daily life of adults. Even a part-time job at the corner fast-food chain requires the use of a calculator in some form. If schools do not teach students to use these devices from an early age, the rising generation will lack necessary work skills. Calculators are one tool almost every employer expects employees to use. Calculators are ubiquitous in the work world and as important for employees as voice mail and word processing.

Word processing is an analogous skill. We do not require that students check all spelling with a dictionary rather than by the computer's spell check program. Instead, we expect students to be able to gauge the reasonableness of a spell check message using their own experiences drawn from reading, writing, and dictionary use. In the same way, young students can learn to compare the calculator's messages to the reasonable answers they have learned to expect from their evolving understanding of arithmetic. The issue is not should students use calculators in the classroom but how calculators should be used.

How could calculator use benefit students?

When students do not have to worry about computation mistakes, they can focus on reasoning and problem solving. Teachers can help students see patterns, check estimates against reality, and solve complex problems, like those encountered in daily life, through the structured use of calculators. Children introduced to the calculator when they are young will find it easy and effective to use. Calculators should be used in the classroom for many reasons:

- Calculators help students at all levels learn mathematically complicated material.
- Even young children can use calculators to focus on the ideas behind computation rather than on the act of calculating.
- Rather than hampering mathematical ability, calculator use can actually improve student achievement in mathematics, according to research.
- Both the SAT and ACT now allow students to use calculators during testing, as do many state-level exams. Students who have not been comfortable with calculators from a young age may be at a disadvantage on these tests. In the recent Third International Mathematics and Science Study (TIMSS) fourth and eight graders who used calculators almost every day performed at higher levels than did those who never used one or only used it once or twice a month.

What does research show about classroom calculator use?

Researchers have studied classroom calculator use for several decades and in many countries. Research in this area began to take off in the late 1970s. In a 1986 study in the Journal for Research in Mathematics Education, Hembree and Dessart analyzed 79 studies of calculator use and found the following:

- Children who use calculators on tests have higher scores in both basic computation skills and problem solving.
- Students who use calculators within a mix of instructional styles do not lose their paper and pencil skills.
- Calculator use in the classroom improves the paper and pencil skills of students regardless of their ability levels.
- Those who use calculators in class have better attitudes toward mathematics than children who do not use them.

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For more information try the TIMSS web page:
http://wwwcsteep.bc.edu/timss

How are calculators used effectively in the classroom?

Too often schools approach calculator use casually and uncritically. While people understand the need for a strategic plan to incorporate computers into the curriculum, often they do not see a similar need for a systematic calculator strategy. All concerned must work together to figure out where the calculator fits into the overall goals of the curriculum and students' needs. Some strategies for effective classroom use follow:

- Have students decide on the reasonableness of calculator answers by estimating before they do the calculation.
- Use questions and discussion to help students think actively about the processes used to arrive at answers.
- Incorporate open-ended problems or projects with several possible solutions (or no solutions) into classroom instruction.
- Mix in problems that are easier to solve by hand or that become unwieldy on the calculator so students will become discriminating in calculator use.
- Teach mathematics as an integrated discipline rather than as disconnected processes.

A frequently overlooked skill is knowing when to use a calculator and when other methods are more efficient. Simple exercises can show students that mental and written computations are often more useful than working with a calculator. For example, in one fourth-grade contest students with paper and pencil were to solve 20 simple subtraction problems working against an adult with a calculator. Since each problem could be solved mentally, the students did better than the adult, who had to key in each number and operation.

Students also need to learn to think about what can cause unreasonable answers on a calculator. Did you put numbers in at the wrong place, fail to put in a decimal, hold a key down long enough for a number to be entered twice?

With guided calculator use even young children can begin to see differences and relationships among arithmetic procedures. The difference between memorizing 5 x 5 = 25 and hitting 5+ on the keypad five times is that the latter activity can lead to discussions about connections between addition and multiplication and make the underlying patterns of multiplication apparent. With teacher guidance young children can become aware of larger numbers or even negative numbers at an earlier age than they have in the past.

In secondary school calculators can help students develop their understanding of algebra and other advanced mathematics. Students will have an easier time learning advanced mathematical procedures if the foundation for complex calculator use is laid in the elementary grades.

Time for exploration is needed for effective calculator use. If students use calculators to figure out the relationship between the circumferences and diameters of many different round objects, they can get beyond problems of correct division and watch the concept of pi emerge. Doing such work adequately, however, requires that the teacher make the time to allow students to work with their own material until the concept is discovered and internalized. Once such time is set aside the calculator will repay with more time available for searching, developing hypotheses, and testing them. Without anxiety over basic mathematical processes, children will be able to concentrate on the applications and meanings of the world of numbers.

IN THE FACULTY LOUNGE

"Hey Chris I heard some good stuff about you last night."

"Well that's unusual Pat. Who from?"

"Justin Franks. Remember him? I think he graduated about three years ago. He was a good kid but could have made higher grades than he did. He was on the track team. About this high. Blonde."

"Oh yeah, Justin was more interested in video games and his garage band than in mathematics as I recall. What is he up to now?"

"He's an assistant manager at Electronic Mart now and he said that because of your class he made assistant manager faster than anyone else who was hired when he was."

"Well gosh I always knew my teaching was powerful but I had no idea it could reach that far! What did he learn from me that helped him become assistant manager?"

"It was the work you did with calculators. Because he learned to use the functions and to key properly he was not stymied when he was introduced to the inventorying cash registers. Then when he had to go to the next step and help make out purchase plans he had a good grasp of how to manipulate the figures on the machine and set up different buying plans. His boss was so impressed that he sent Justin to special training in Little Rock. Then two months later he was made assistant manager. When he finishes at the community college he can get a company scholarship and go to state and get a marketing degree."

"Well, that's great. I always work my students really hard with scientific and graphing calculators. I try to find interesting problems for them. Most of them were based on stuff from business. Maybe that's what stuck with Justin."

"From what he said I think it was mainly just your approach to the calculator. He even quoted you, 'The calculator is a tool to help people with their tasks and their thinking but never a substitute for thinking.' So do you think you could share some of these problems and methods with me? I've never let students use the calculator in my classes; maybe I'll start."

Won't schools have to make sure every student has a calculator and won't that be expensive?

The calculator is cheaper than other technological innovations. A national drive to ensure that each student has his or her own calculator may make more sense, economically and educationally, than a national push for more classroom computers. In most schools computers will continue to be shared resources but calculators could become individual resources used in class and at home. Three types of calculators are generally used in schools:

- **Arithmetic calculators** cost less than $10 and have a numeric keypad with the four basic arithmetic operations, although some may also have percentage and square root keys. A single line of characters displays up to eight digits.
- **Scientific calculators** have a broader range of functions and cost around $20. Some statistical abilities, a more extensive keypad with more than one function for certain keys, and scientific and engineering notation are common.
- **Graphing calculators** have an extensive range of operations, a larger screen, more characters on the line, and the ability to move between displays and use alphabetic characters. They can graph data and symbolic expressions, cost close to $100, and are generally only appropriate in the higher grades.