Calculators for Students with Special Needs

Despite the recommendation of the National Council of Teachers of Mathematics (2000) that calculators be used for all grade levels and for all students, the use of calculators in elementary mathematics continues to be controversial. Many teachers, administrators, and parents fear that students will not develop computational proficiency while learning with calculators.

Research, including NAEP scores, shows this outcome not to be so (Dessart, DeRidder, and Ellington 1999). Nonetheless, many teachers (and school systems) are comfortable with their decision not to allow calculators in the elementary grades, because most students are capable of achieving at least some level of proficiency in performing computation with pencil and paper. But what about students with special needs who, no matter how much they practice, continue to struggle with basic computation long after most other students have achieved proficiency?

The vignette that follows describes a student, Mark, who is being deprived of a rich and useful mathematics education as envisioned by NCTM (2000) simply because he struggles with basic computation. Allowing Mark to use a calculator would make all the difference in his mathematical development and future success in mathematics.

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We developed a framework to help middle school teachers present a clear rationale for their decisions about whether and when to let their students use calculators (Thompson and Sproule 2000). Ms. Christie's story motivated us to adapt the framework for elementary school teachers, particularly for teachers with students whose computational difficulties serve as a barrier to experiencing a broader array of mathematics activities.

Christie shared her frustrations about the lack of a rich mathematics education for her son Mark:

> Mark is an intelligent sixth grader who has a learning disability in mathematics. Despite making good grades in other subjects, he struggles with basic computation and scores poorly in mathematics. At school, where he is not allowed to use a calculator, he struggles with mathematics tasks and problem solving because he finds it difficult to makes progress with the computation required in the tasks. The result is that Mark is given mostly routine exercises to practice his computational skills with whole numbers and is frustrated by the situation. At home, where Mark is allowed to use a calculator, he excels at mathematical puzzles, games, and finding patterns and relationships.

When Christie discussed the situation with Mark's mathematics and special education teachers, they explained that calculators are not appropriate in elementary school and that only once basic computational skills are mastered are students allowed to move on to other mathematics topics. She is concerned because Mark is starting to hate school mathematics and is not being prepared to study algebra and other middle and high school mathematics topics.

Figure 1

Flow chart adapted from Thompson and Sproule (2000)

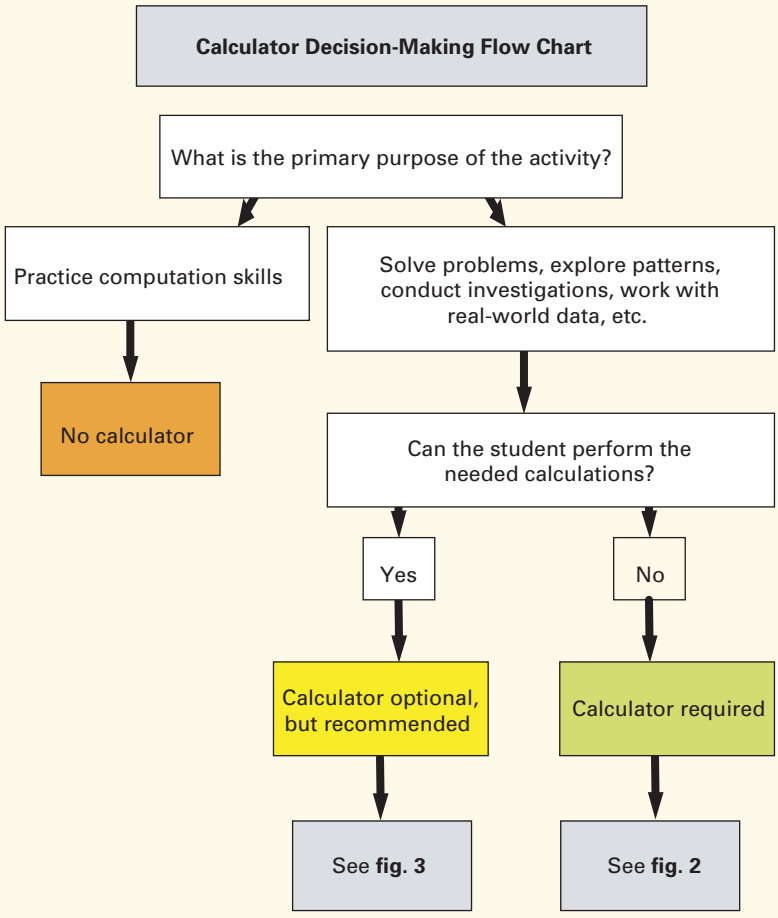

Figure 2

Activity requiring a calculator; adapted from Wheatley and Hersberger (1986)

The Range Game

First pick a start number, a range, and an operation. Store the start number and operation in the calculator. Students then take turns entering a number and pressing [=] to try to get a result in the target range.

Example: Pick a start number of 17, a range of 800 to 830, and multiplication as the operation. Press [17] [x] [=] to store 17 as a factor. Press a number and then [=]. If you try 25, the result is 425. That answer is about half the target, so your next try may be 50. The result is 850. Continue estimating until your answer is within the target range.

Mathematical Difficulties

Mathematics teachers need to be aware of the numerous learning problems that can affect mathematical proficiency, including attention deficits, memory problems, visual-spatial difficulties, auditory processing difficulties, motor disabilities, and information-processing deficits (Westwood 2000). For example, students with attention deficits may have difficulty maintaining attention to steps in algorithms or problem solving. Students with memory problems are often unable to remember mathematics facts, forget steps in an algorithm, or have difficulty solving multistep word problems. Students with motor difficulties may encounter difficulties keying in numbers and operations. Thus, students with special needs may require additional training and assistance in

learning to use a calculator.

In general, even with the calculator, students with disabilities face difficulties in learning many mathematical ideas. In a rich mathematics problem, however, the calculator shifts the focus of attention from computation, which the calculator can do, to thinking, which the calculator cannot do, and may help students with disabilities attain levels of understanding that are equal to those of their fellow students. In these situations, a calculator serves as a tool rather than a crutch because it requires the students to think through and solve the mathematics problems. Even with a calculator, students need to learn to make sense of the answers attained with the calculator, which procedures and operations are required in a problem, and how to generalize results to other situations.

Deciding When to Use Calculators

Although the framework presented by Thompson and Sproule (2000) was originally directed at middle school mathematics teachers, it can be used at any grade level. In particular the ideas it presents can be helpful to mathematics and special education teachers in the elementary grades as they decide whether to allow students who have computational difficulties to use the calculator as an accommodation so that these students can participate in a greater variety of mathematics activities.

The framework is designed to help teachers focus less on computations and more on (a) the goals of a particular mathematics activity and (b) the needs and abilities of the students. The framework is based on how a teacher answers the following two questions when using a mathematics task in the classroom:

- Is the primary purpose of the task to perform or practice calculations, or is it to engage students in mathematical processes, such as solving problems, finding patterns, or performing investigations?
- Can a student perform, within reason, the necessary calculations to participate in the mathematics task?

When deciding whether to allow the use of a calculator as an accommodation, a teacher should consider his or her goals and the purpose of a particular mathematics activity. If developing computational skills is neither the primary focus of the activity nor the primary goal of the teacher in using the activity, then a calculator is a reasonable accommodation. The flowchart in **figure 1** is a framework to help teachers decide whether to let students use calculators.

In situations in which the student can perform the needed computations, we nonetheless recommend the use of the calculator so that he or she can focus on thinking mathematically, solving problems, looking for patterns, and so forth, rather than get stuck on the computational aspects of the task.

Example Uses of Calculators

Figures 2 and **3** show two examples of how a teacher might use the calculator decision-making flowchart. **Figure 2** illustrates a task in which the calculator is required. The calculator is optional but recommended for the task in **figure 3.**

The "range game" (adapted from Wheatley and Hersberger [1986]) provides an opportunity for students to develop and practice estimation. Although many students could conceivably evaluate their estimate using pencil and paper, doing so would make the game cumbersome and of very lit-

Figure 3

Activity in which a calculator is optional but recommended; adapted from Coburn (1987)

Patterns in Operations

Calculate the answer for each of the first three rows. Write down the answer for each of the next two rows without calculation.

1)	101 x 22 = _____	2)	9 x 9 + 7 = _____
	222 = _____		98 x 9 + 6 = _____
	2222 = _____		987 x 9 + 5 = _____
	22222 = _____		9876 x 9 + 4 = _____
	222222 = _____		98765 x 9 + 3 = _____

tle value. The use of the calculator is required to ensure that students engage in estimation and are able to evaluate their answer without getting stuck on computation. Students can be required to estimate using large or small start numbers, depending on their proficiency with the four operations.

"Patterns in operations" (adapted from Coburn [1987]) is a useful task serving different purposes. The task can be completed using either pencil-and-paper methods or the calculator. This task may be a meaningful way in which advanced students can practice their pencil-and paper computation while investigating patterns within their answers. In this instance, using the calculator may be optional. Without a calculator, however, students with computational difficulties would spend so much time just trying to complete the operations that they would be deprived of the higher-level reasoning involved in the pattern investigation. Additional activities involving the use of the calculator can be found in *Teaching Children Mathematics* and other NCTM publications.

Importance of a Balanced Curriculum

The decision-making chart assumes a balanced curriculum for all students consisting of a wide variety of mathematical experiences. That is, teachers should include tasks that require practicing computation as a primary goal and tasks that focus on the development of mathematical reasoning and problem solving. A curriculum dominated by one or the other approach would be imbalanced and not to the students' advantage.

Sadly, students with special needs are frequently not given sufficient opportunity to solve problems, explore patterns, and conduct investigations. Special education and mathematics teachers should continue to provide additional practice and remediation to help students with special needs develop computational proficiency. All students, however, regardless of special need, should have opportunities to explore patterns, solve problems, apply mathematics to real-life situations, estimate and approximate, interpret graphs and tables, and so forth, without having their inability to perform calculations serve as a barrier to these opportunities.

Learning real-life applications of mathematics is particularly important for students with special needs because they will likely need more practice than other students. Calculators allow students to work with real-world data instead of the "contrived numbers" that textbooks often use to make the calculations easier or the answer "prettier." In general, little is gained if a student masters computational skills but does not learn how to apply this knowledge in realistic and authentic situations (Grant 1998).

Using the Framework

Although not investigated on a large scale, the teachers who have used our framework have all reconsidered the role that the calculator can play in their classrooms. Most have decided that if students with special needs or other students with computational difficulties need a calculator, then they will allow the entire class to use the calculator. They are comfortable with this approach because computational proficiency is not the primary goal of the activity and because students otherwise have sufficient opportunity to practice computational skills throughout the year. To date, none of the teachers have experienced a decline in students' computational ability, and all have found that using the calculator increased the participation of all students in a wider variety of mathematical activities. These outcomes are consistent with research findings over the past twenty years showing that if calculators are used in the elementary grades to solve problems, conduct investigations, and explore patterns, then students' computational proficiency is not harmed and is, in some instances, improved (Dessart, DeRidder, and Ellington 1999).

Final Comments

The Individuals with Disabilities Education Act (1997) requires that all students have access to a general education curriculum to the greatest extent possible. In this environment, teachers can view the calculator as a tool that can facilitate equity and inclusion and allow all students to access the full range of rich mathematics. In addition to helping students gain access to mathematical experiences that would otherwise be inaccessible to them, using a calculator can help many students with special needs increase their self-confidence, reduce their anxiety, and increase their motivation to solve mathematics problems.

A teacher should not let preconceived notions of calculator use—whether for or against—arbitrarily influence his or her decision about whether to use calculators in the classroom. Instead, a teacher should develop thoughtful rationales when deciding whether to let a student use a calculator by focusing on his or her goals as

a teacher and the students' needs and abilities. The teacher makes the ultimate decision about whether calculator use by students is allowed in his or her classroom. We hope this framework persuades teachers who otherwise think calculators are inappropriate in the elementary grades to rethink the possible role that calculators can serve for all students, but in particular, as a classroom accommodation for students with special needs.

References

Coburn, Terrence. *How to Teach Mathematics Using a Calculator*. Reston, Va.: National Council of Teachers of Mathematics, 1987.

Dessart, Donald, Charlene M. DeRidder, and Aimee J. Ellington. "The Research Backs Calculators." *Mathematics Education Dialogues* (May/June 1999): 6.

Grant, S. G. *Reforming Reading, Writing, and Mathematics*. Mahwah, N.J.: Lawrence Erlbaum Associates, 1998.

Individuals with Disabilities Education Act Amendments. Public Law 105-17. 1997.

National Council of Teachers of Mathematics (NCTM). *Principles and Standards for School Mathematics*. Reston, Va.: NCTM, 2000.

Thompson, Anthony, and Stephen Sproule. "Deciding When to Use Calculators." *Mathematics Teaching in the Middle School* 6 (October 2000): 126–29.

Westwood, P. *Numeracy and Learning Difficulties: Approaches to Teaching and Assessment.* Victoria: Acer Press, 2000.

Wheatley, Grayson H., and James R. Hersberger. "A Calculator Estimation Activity." In *Estimation and Mental Computation,* 1986 Yearbook of the National Council of Teachers of Mathematics (NCTM), edited by Harold L. Schoen and Marilyn J. Zweng, pp. 182–85. Reston, Va.: NCTM, 1986. ▲