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We should model, teach, encourage, and value estimation and mental math as pillars in our students' development of number sense.

KNOWING ABOUT *ABOUT* IS IMPORTANT—FOR ALL

Estimation is critical to building number sense, mental math skill, and computational fluency. NCTM's *Principles and Standards for School Mathematics* asserts that the development of computational fluency requires students to make a "connection between conceptual understanding and computational proficiency" (NCTM 2000, p. 35). An understanding of computation is grounded in mathematical foundations and grows out of a grasp of place value, operations, and number relationships. Unfortunately, teachers often administer written tests that focus only on procedures and precise calculations. Although the ability to do well on such tests is, of course, an important aspect of computational fluency, teachers should stress the importance of estimation and the use of mental math in developing fluency and helping students use mathematics proficiently every day.

Let's start with estimation. Do you think of estimation as a useful tool that you want to help your students develop? An estimate does not give a precise solution, but it can serve as a useful starting point for planning. A book review in the magazine *Science* describes the practice of deriving an approximate result when data are insufficient to make a more precise calculation. "That ability allows one to determine whether or not an answer is reasonable by a quick calculation" (Mertens 2008, p. 1160). Many times, we ask ourselves—and we should urge our students to ask themselves, as well—"What do I expect the answer to be?" A reasonable estimate before starting a calculation can be of value—*great* value—both in its own right and as a check of a calculation.

Now let's consider number sense. In the early years of working with number, students gradually build a set of benchmark numbers. As a student's counting ability grows, those benchmarks come to include multiples of 10 or 100. Students use benchmarks in a variety of ways—for example, to recognize that 39 is one less than 4 tens, or that 62 is just two more than six tens. This use of benchmarks becomes critical in grasping the sizes of fractions and decimals, helping students understand that 12/13 is close to 1, 34/70 is just under 1/2, and 28/9 is just over 3. Such comparisons reflect an ability to think flexibly about the sizes of numbers.

Furthermore, when students work with benchmarks that allow them to consider differences in orders of magnitude, they strengthen and enrich their number sense, particularly in operations. Consider suggesting the following idea to your students for a rich classroom discussion—"When you add numbers of tens, the sum is a number of tens: 3 tens + 4 tens = 7 tens; 8 tens + 9 tens = 17 tens. However, when you multiply tens, the product is a number of hundreds: 2 tens × 3 tens = 6 hundreds; 8 tens × 9 tens = 72 hundreds." This look at operations and their impact on the order of magnitude enhances students' mathematical reasoning and supports their computational proficiency. As students expand their skills with estimation and mental math, they lay a foundation for understanding another critical component of arithmetic and algebra—the laws of exponents.

Teaching for computational proficiency and conceptual understanding is a complex, yet crucial task. We should model, teach, encourage, and value estimation and mental math as pillars in our students' development of number sense. Practice with estimation actively builds mathematical proficiency as students reason and solve problems. Drawing on skills in estimating and mental math aids students in developing flexibility with procedures and taking advantage of all their knowledge of numbers (National Research Council 2001). Thus, activities that foster estimation skills must be regularly integrated into mathematics experiences and lessons. Ω

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Reference

Mertens, Stephan. "On the Back of an Envelope." Review of *Solving the World's Problems on the Back of a Cocktail Napkin*, by Lawrence Weinstein and John A. Adam. Science 321 (August 29, 2008): 1160.

National Research Council. *Adding It Up: Helping Children Learn Mathematics*. Edited by Jeremy Kilpatrick, Jane Swafford, and Bradford Findell. Washington, D.C.: National Academy Press, 2001.