The Right Equation for Math TEACHING

The Common Core State Standards for Mathematical Practice require a new method of teaching. Know what to look for in your classrooms.

BY DEBORAH SCHIFTER AND BURT GRANOFSKY

Full implementation of the Common Core State Standards for mathematics is still a few years away for many states. But district and school leaders are faced with many decisions now—from curriculum adoption to teacher professional development—that will influence the long-term effectiveness of this bold initiative. What will the Common Core State Standards actually look like when implemented in real classrooms with real students?

School leaders have a significant task in front of them, as they are key agents in ensuring that the Common Core fulfills its promise of transforming mathematics teaching and learning across the country. To lead an effective adoption of the standards, they need to know why a Common Core approach is different from what existed before, what mathematics instruction should look like, and how to support teachers throughout the implementation phase.

Why the Common Core Is Different

A fundamental critique of American education is that it is "a mile wide and an inch deep." The authors of the Common Core responded to this criticism by creating a set of standards that approach mathematics instruction in quite a different way than most of the sets of state standards that it replaces.

First, the authors emphasize that the Common Core is both focused and mathematically coherent. It is focused because there are fewer Common Core State Standards than existing state standards. It is coherent because it supports large conceptual issues at the heart of K-12 mathematics, and considers how those concepts develop from grade to grade.

Precisely because of this coherence, the content standards of the Common Core cannot be read as discrete items. Content addressed in different standards is connected and sometimes overlaps. It would be a mistake to think that even a veteran teacher could fully cover all of the mathematical ideas in any one standard in a single lesson.

Second, the Common Core promotes eight Standards of Mathematical Practice that identify mathematical "habits of mind" educators should seek to develop in their students at all levels. These practices—such as constructing viable arguments, critiquing the reasoning of others,

and communicating with precision—often take years to develop, but are essential for success in mathematics.

Common Core State Standards are different from many state standards in that they require teachers to give each practice explicit, focused attention to inculcate students in these mathematical ways of thinking. Once a class begins to enact the practices, however, they become a seamless part of mathematical discussions.

Principals need to know that it is the interplay of the Standards of Mathematical Practice and the content standards that make the Common Core such a robust set of guidelines. The Common Core embraces the idea that teaching can be nonlinear, with various types of classroom experiences all supporting the same instructional standard.

When principals observe a lesson, they should expect to see students working through partially formed (or even incorrect) ideas about mathematics. They also should expect to see teachers who are pushing their students to think like mathematicians—to justify their ideas, communicate with peers, and construct arguments, even if those arguments lead to some interesting tangents. These are all necessary steps for students to take as they develop enduring understandings about mathematics.

What Common Core Math Instruction Looks Like

Diving directly into mathematics itself can illustrate exactly what instruction that aligns with the Common Core State Standards can look like, and can help principals understand what to look for when conducting walkthroughs. Let's examine the idea of "properties of operations," which appears in grade 2. The individual standards detail what students need to know and be able to do. The cluster heading, in bold, puts the group of standards (or cluster) in a larger context. (Three of the five standards within the cluster are excerpted below; emphasis added.)

Use place value understanding and *properties of operations* to add and subtract.

2.NBT.5. Fluently add and subtract within 100, using strategies based on place value, *properties of operations*, and/or the relationship between addition and subtraction.

2.NBT.7. Add and subtract within 1,000, using concrete models or drawings and strategies based on place value, *properties of operations*, and/or the relationship between addition and subtraction; relate the strategy to a written method.

2.NBT.9. Explain why addition and subtraction strategies work, using place value and the *properties of operations*.

Some educators may interpret the understanding of "properties of operations" to mean that students must memorize definitions for the properties. This interpretation misses the point of the Common Core. Rather, teachers need to provide experiences that allow students to make sense of how these properties interact with the calculation strategies they use every day.

Consider the expression 46-18=? and what it can show us about how to teach properties of operations. Some students might incorrectly subtract the smaller digit from the larger in each column, regardless of the order of the digits, and say the difference is 32. Students tend to persist with this error even after they have been corrected or have had opportunities to see that it is wrong.

An elementary teacher in Massachusetts, Ms. Stern, was faced with this very error of subtraction, and took an approach that was quintessentially aligned with the Common Core: She addressed the misconceptions behind the error.

First, Ms. Stern asked her students to think about the effect of changing the order of numbers in an addition expression. After some investigation, students were quite sure that changing the order of addends does not

The Impact of Next Generation Science Standards

The United States is facing a crisis in science and math achievement. In 1994, 31 percent of all science and engineering master's degrees and 41 percent of all science and engineering doctoral degrees were conferred to foreign students, according to the U.S. Department of Education. That percentage has since declined slightly: According to the National Science Foundation, 25 percent of graduate students in science and engineering were in the United States on temporary visas in 2006. Further, results from the 2009 Programme for International Student Assessment reveal that the United States ranked 14th in reading, 17th in science, and 25th in math out of 34 countries.

In response, President Barack Obama announced the "Educate to Innovate" campaign to encourage teachers in science, technology, engineering, and math—the STEM fields—to use more interactive teaching methods to increase student engagement and eventually produce more homegrown graduates in these fields.

The Next Generation Science Standards (NGSS), which have just undergone their first public review, are slated for final release in late 2012 or early 2013. The standards are based on *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, the first idea of which is

to provide "a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields."

Twenty-six states are involved in the development of the NGSS and will consider adopting them once they are completed. Many other states have also expressed an interest in the standards, so it seems quite likely that the NGSS will form the basis for what a majority of students in the United States study in science.

In addition to life science, earth and space science, and physical science, the NGSS include technology, engineering, and the application of science as a fourth content area. Specifically, the NGSS have a strong focus on scientific and engineering practices, which are combined with core disciplinary ideas to form performance expectations. These performance expectations describe the outcomes that would be assessed after instruction.

Also outlined in the NGSS is that students will be expected to understand important ideas about engineering design such as knowing that "a solution needs to be tested, and then modified on the basis of the test results, in order to improve it." They also will be expected to understand links among engineering, technology, science, and society.

Although the standards do not prescribe how students should learn these ideas, educators will need to think carefully about how to address them in the K-12 curriculum.

In the inaugural issue of *The STEM Classroom*, published by the National Science Teachers Association, STEM education was defined as "a way to combine many related disciplines—currently viewed by students and society as independent subjects with little overlap—into a single, integrated program that emphasizes the interdependences among the four disciplines and their applications to everyday life." This definition, and its implementation in schools, is the linchpin of an effective response to the NGSS.

To learn more about the NGSS, administrators could begin by downloading and reading *A Framework for K-12 Science Education*, which is available online as a free PDF from the National Academies Press. Elementary school administrators may want to encourage their staffs to join professional organizations devoted to science education as a means to increase their exposure to professional development opportunities.

If the NGSS are adopted by all 50 states, the science required in elementary schools will undoubtedly increase. The second draft of the NGSS will be available for public comment in late fall 2012, and all administrators should read the draft carefully and consider commenting. The public review process is an important part of the creation of the NGSS.

Teaching specific skills and concepts in science, technology, engineering and mathematics independent of the opportunities to learn how they are connected to one another and to other disciplines does a disservice both to the learner and to the knowledge at stake.

The National Science Teachers Association and many other professional organizations are marshalling their resources around this integrated whole to help teachers and administrators. The end result will be a more robust educational environment for all students. P

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affect the sum: 6+3 was the same as 3+6, for example. Then Ms. Stern asked about changing the order of the numbers in a subtraction equation. Since order did not matter in addition, did they think that 17-9 was the same as 9-17? Students responded with a range of ideas, but all concluded that order does matter when subtracting.

Ms. Stern's approach hinged on a number of important elements: her knowledge of the math content and of why students sometimes struggle with subtraction, and a plan for helping students work through it. She was able to take a commonly held misconception about subtraction and lead her students on a journey where they began to recognize addition and subtraction as distinct operations that behave differently.

So, what came of the lesson?

After two class sessions spent on the order of the numbers in subtraction, Ms. Stern returned to the original equation. When asked to solve 46-18, students were able to successfully work through the problem. Through this activity, Ms. Stern engaged her students in several of the Standards of Mathematical Practices. Her students analyzed mathematical structure concerning addition and subtraction, and after they articulated what they noticed, they created arguments to justify their conclusions and explain their thinking to others. In the context of teaching a skill (double-digit subtraction), the teacher promoted understanding of the properties of operations, and helped her students think like mathematicians.

Ms. Stern's instruction illustrates how approaching the Common Core as constellations of items—specific standards, cluster headings, grade-level critical areas, and mathematical practices—can allow teachers to act on their understanding of how students learn, how they make connections, and how they can develop mathematical power.

The Principal's Role

School leaders can take two concrete steps to support teachers and mathematics support specialists as they think about how to implement the Common Core State Standards thoughtfully and faithfully.

Pick a good curriculum. Choosing a mathematics curriculum that supports Common Core ways of teaching and learning about mathematics is an essential first step. There are many strong, Common Core-aligned curricula available for elementary, middle, and high school adoptions. However, there also are some curricula that pay lip service to the Common Core without actually embracing its central tenets. Where curriculum decisions are made by committee, school leaders should make every effort to inform the decision-makers about what the Common Core is, what it is not, and what curricula best support this new way of thinking about mathematics education.

Teachers need time and space to teach. If the authors of a curriculum have made sure their lessons cover the standards, then teachers will be able to put their energy into other important issues—such as preparing lessons, analyzing their students' work, and collaborating with colleagues. It is the job of the curriculum, not the teacher, to ensure that every content standard has been met within a certain grade.

Invest in teacher professional development. If Common Core instruction is to transform classrooms, then school leaders must prioritize teacher professional development in two main areas. First, teachers will need to understand both the mathematical content and the conceptual challenges students deal with when they encounter that content. Using the example from earlier, teachers not only need to know that 46-18=32 is incorrect, but also be able to delve into the reasons why a student would make this mistake.

Second, teachers will require support with the Standards for Mathematical Practices—both in thinking about how to teach with them, and in learning how to identify evidence of these practices in student work.

Teachers must know that implementing the Common Core requires their effort. They cannot deliver the standards directly into students' minds; there is extensive mathematical thought, practice, and peer collaboration that needs to happen.

As for principals, they too should study the ideas and approach of the Common Core. The Common Core State Standards are intended to be a new direction for mathematics education in the United States. Principals have the power to support the new standards' implementation, helping the standards live up to their promise of improving student learning.

In particular, principals should become familiar with the Standards of Mathematical Practices and learn what it means to enact these practices in K-12 classrooms. They also must remember that learning is messy, and that there are few paved roads from learning to understanding. P

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Principal ONLINE

Access the following Web resources by visiting *Principal* magazine online: **www.naesp.org/NovDec12**

This website describes a variety of resources, including **three sets of professional development materials**: "Lenses on Learning" for school principals, "Developing Mathematical Ideas" for teachers, and "Cultivating a Math Coaching Practice" for coaches.

NCSM offers tools and professional development materials for helping students attain the Common Core State Standards, including the **Standards for Mathematical Practice**.