

Mathematics

Are there more multiples of 3 or multiples of 8? How can a diagram be used to represent $7 \times \frac{1}{2}$ as well as $7 \div 2$? What do you know about quadrilaterals? Do numbers that are greater than 36 necessarily have more factors than numbers that are less than 36? If we have 49 sandwiches for our picnic, how many sandwiches can each child have? How many noses are in our class? How many ears are in our class? How many fingers are in our class? What kind of rule will fit the pattern we have observed?

These are just some of the types of questions used to help illustrate worthwhile mathematical tasks, rich discourse, and positive classroom environments for teaching and learning in *Mathematics Teaching Today: Improving Practice, Improving Student Learning* (NCTM 2007). If the task-discourse-environment framework sounds familiar, it is because the idea was previously shared in *Professional Standards for Teaching Mathematics* (NCTM 1991). Although much of the material in that landmark document remains sound and up to date, the NCTM Board of Directors determined that recent developments in the field—including the publication of *Principles and Standards for School Mathematics* (NCTM 2000)—warranted an update.

This update of the groundbreaking NCTM publication Professional Standards for Teaching Mathematics provides more high-quality tools to improve instruction and learning

Mathematics Teaching Today is a resource for teachers, supervisors, teacher educators, families, business leaders, government officials, community members, and others with interest in promoting more and better mathematics for all children. In three chapters of Standards, the book outlines key aspects of high-quality mathematics teaching; a model for observing, supervising, and improving mathematics teaching; and guidelines for teacher education and continued professional growth. Those chapters are followed by an examination of the roles and responsibilities of people in the larger community who

can support teachers, students, administrators, and teacher educators. Finally, reflection questions keyed to each of the sections in the three main chapters provide a tool to promote ongoing conversations and creative approaches for improving mathematics teaching and learning.

The Teaching Cycle

So, what is new in this collection of professional standards? *Mathematics Teaching Today* refers to a three-phase model of teaching practice: knowledge, implementation, and analysis (Reynolds 1992; Shulman 1987). This cyclic model (see the book cover depicted on p. 401) reminds readers that teachers draw on their knowledge of mathematics, students, and student learning as they plan for, enact, and make decisions about their teaching practice.

Teacher knowledge influences how lessons are implemented, and what occurs during class also deepens teachers' knowledge of their students, mathematics, and the effects of various teaching practices. Likewise, effective teaching demands the analysis both of student performance and of one's own teaching performance. When teachers reflect on their practice—by listening to students, ana-

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lyzing student work, and reviewing student responses to class activities—that reflective process enhances teachers’ knowledge bases. And so the cycle continues.

Reflection

Consider the following example of the teaching cycle in action. Suppose that a fourth-grade teacher wants to help her students understand the relationship between factors and multiples. What knowledge will help this teacher prepare her lesson? What tasks will she pose to introduce these concepts? What sort of classroom environment will offer students the freedom to explore the relationship? How will she facilitate discourse to reflect student-initiated conjectures about observed patterns? How will she analyze students’ reasoning? What responses will she formulate to encourage students to think more deeply and communicate more clearly? *Mathematics Teaching Today* provides vignettes that illustrate those aspects of the teaching cycle and that invite teachers to reflect on those issues as they relate to the teachers’ own practice.

Teachers are not the only ones who analyze the teaching and learning of mathematics. Principals, department chairs, curriculum leaders, and mathematics coaches all observe teachers at work in their classrooms for various purposes. Whereas the *Professional Standards for Teaching Mathematics* suggested standards for evaluating teaching, *Mathematics Teaching Today* further emphasizes that observation occurs in the context of a cycle of continuous improvement; the book references models for such improvement. Regardless of the observer’s particular objective, all teacher observation is ultimately aimed at improving teaching and learning. Thus, it is imperative that teachers be an integral part of the analysis of and reflection on their teaching. *Mathematics Teaching Today* describes how such observa-



tions may be conducted and what should be considered in defining the focus of those observations.

Observations should provide information on what the teacher and students are doing. When focusing on the teacher, observers can determine the teacher’s command of knowledge and strategies for teaching mathematics as well as whether the teacher is providing adequate engagement for student learning. When focusing on the students, observers can determine whether the teacher has provided a context and

opportunity for students to be engaged in significant and appropriate activities and whether the students use a variety of representations to demonstrate their mathematical thinking. Below are examples of what observers may look for as evidence that teachers and students are making positive contributions to the processes of teaching and learning mathematics.

Is the teacher—

- choosing “good” problems that invite exploration of an important mathematical concept and that allow students the chance to solidify and extend their knowledge;
- assessing students’ understanding by listening to discussions and by asking students to justify their responses;
- assessing questioning techniques to facilitate students’ learning and reasoning;
- encouraging students to explore multiple solutions;
- challenging students to think more deeply about the problems they are solving and to make connections with other ideas within mathematics;
- using multiple representations to foster a variety of mathematical perspectives;

Observation of mathematical teaching practices occurs in the context of a cycle of continuous improvement

- creating a variety of opportunities, such as group work and class discussions, for students to communicate mathematically; and
- modeling appropriate mathematical language and strategies with a disposition for solving challenging mathematical problems?

Are students—

- engaging actively in the learning process;
- using existing mathematical knowledge to make sense of assigned tasks;
- making connections among mathematical concepts;
- reasoning and making conjectures about problems;
- communicating their mathematical thinking verbally and in writing;
- listening and reacting to others' thinking and solutions to problems;
- using a variety of representations, such as pictures, tables, graphs, and words, for their mathematical thinking;
- using mathematical and technological tools, such as physical materials, calculators, and computers, along with textbooks and other instructional materials; and
- building new mathematical knowledge through problem solving and understanding?

Teacher Education and Professional Growth

The chapter in *Mathematics Teaching Today* that addresses teachers' education and continued professional growth reflects developments in the field that have occurred since the first edition. Of particular note is that recommendations for the content preparation of teachers at all grade levels are consistent with the current requirements set forth by the National Council for Accreditation of Teacher Education (NCATE 2006), the largest teacher education accreditation body. *Mathematics Teaching Today* also reflects recommendations from the Conference Board of the Mathematical Sciences (CBMS 2001), organized using the same grade-band structure that appears in *Principles and Standards* (NCTM 2000). As a result, this chapter now includes recommendations for the preparation

of prekindergarten teachers. Expectations for them are the same as those for teachers of kindergarten through grade 5. Recommendations include demonstrated proficiency in number and operations, understanding of mathematical relationships and functions, ability to use spatial visualization and geometric reasoning, understanding of data analysis and probability concepts, and knowledge of measurement concepts and tools. Although these content expectations may seem high for teachers who work with three- and four-year-olds, such a

level of mathematical knowledge is consistent with the high expectations of the National Board for Professional Teaching Standards (NBPTS 2001) for accomplished early childhood teachers.

Reflective Questions

Another new feature of the book is the collection "Questions for the Reflective Practitioner," designed to inspire thoughtful reflection and discussion by individuals or within groups of preservice teachers, practicing teachers, school teacher leaders, department chairs, principals, district-level administrators, teacher educators, professional developers, parents, community members, and others with an interest in and commitment to improving the teaching and learning of school mathematics. Although questions may be aimed at particular readers, everyone is invited to consider the issues they address from his or her own professional or personal perspective. Here are some of the reflection questions:

1. Reflect on your daily classroom routine. To what activities do you devote the most time? To what activities do you devote the least time? What messages might your classroom routines send to students about what is valued in your classroom? What messages might those routines send about the nature of mathematics?
2. What role does technology play in your classroom? How do students decide when technology would be an appropriate tool to use? What technology tools would you like your students to use more regularly? Which technology tools would you like to learn more about?
3. What are the benefits and limitations of using student work samples to assess the effectiveness

of specific lessons or units? What other information would be useful for documenting the quality of student learning?

4. How can you encourage and support collaborative planning and decision making to enhance teachers' professional growth and, ultimately, children's learning?
5. What role does problem solving play in basic content courses for teacher candidates or teachers? How are teacher candidates or teachers prepared to teach heuristics and explore multiple solution methods with their own students?

The dialogue resulting from discussions about the teaching and learning of mathematics, the supervision of teachers, and the education or continued growth of teachers ought to stimulate further investigation of issues or pursuit of strategies for improvement.

Positive Constants

What has stayed the same in this collection of professional standards? Many of the issues identified in *Professional Standards for Teaching Mathematics* are as relevant today as they were in the early 1990s. For example, inherent in the original title was a message that mathematics teachers are professionals. Teaching is a complex endeavor, and expert teachers should work collaboratively with other teachers and administrators to address issues of professional and school improvement.

The goal of more and better mathematics for all students cannot be reached by relying on teacher demonstrations, practice worksheets, inadequate class time, or six classes a day per teacher. Mathematics teachers need appropriate resources to challenge, motivate, and engage all students. Calculators, computers, and manipulatives are as integral to learning and doing mathematics as chemicals are to a chemistry laboratory. If mathematics teachers are to meet the needs of the increasingly diverse student populations in their classrooms, they need time to plan, study, reflect, develop curriculum, and confer with colleagues.

Likewise, the book delineates the roles and responsibilities of government policymakers, business and industry leaders, schools and school systems, colleges and universities, professional organizations, families, and communities. Each group has an opportunity to help improve mathematics education by supporting teachers and schools and by providing needed resources, including money, equipment, personnel, and time.

Finally, as in the original document, the begin-

ning of each chapter spells out assumptions about teaching and learning, which are as valid today as when they first appeared:

- All students can learn to think mathematically.
- *What* students learn is fundamentally connected with *how* it is learned.
- Teaching is a complex practice that cannot be reduced to a formula or to isolated components.
- Because teaching is complex, the continuous improvement of teaching is complex.
- The education of mathematics teachers is an ongoing process. Being a teacher implies a dynamic and continuous process of growth that spans a career.

Just as its predecessor did, *Mathematics Teaching Today* raises issues, asks questions, provides a vision, and challenges readers to do their part to build on existing strengths, identify areas for growth, and make and enact plans for improvement. We are confident that those questions and issues will spark a renewed, collaborative conversation leading to better mathematical experiences and understanding for all children.

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