CHAPTER SEVEN
Conclusions

Inside the Classroom observations and interviews provided a great deal of information about the nature and quality of K–12 mathematics and science education in the United States. The findings of this study are summarized below, followed by a discussion of the implications of these findings for improving the quality of mathematics and science education.

Summary

This study included observations of a nationally-representative sample of 364 mathematics and science lessons in grades K–12. In addition, extensive interviews with teachers following the observations provided insight into the influences on those lessons—why particular topics and skills were taught, and why the particular instructional strategies were employed.

Trained observers described each lesson in detail, rated various components of the lesson, judged the likely impact of the lesson on students along a number of dimensions, and provided an overall assessment of the quality of instruction. Based on *Inside the Classroom* observations, mathematics and science lessons in the United States are relatively strong in a number of areas: a majority of lessons incorporate content that is both significant and worthwhile; have teachers who seem confident in their ability to teach mathematics and science; and who provide accurate content information. At the other end of the spectrum, fewer than 1 in 5 mathematics and science lessons are strong in intellectual rigor; include teacher questioning that is likely to enhance student conceptual understanding; and provide sense-making appropriate for the needs of the students and the purposes of the lesson. Overall, 59 percent of mathematics/science lessons nationally are judged to be low in quality, 27 percent medium in quality, and only 15 percent high in quality.

Lessons that are judged to be high quality generally share a number of key elements. Not only do they have important mathematics/science learning goals, but they also provide opportunities for students to grapple with that content in meaningful ways. There does not appear to be a single right way to engage students with the mathematics/science content; giving students experience with phenomena, making real-world connections, playing games that focus on important learning goals, and using contrived contexts to motivate the learners are all used effectively. Some high quality lessons are "traditional" in nature, incorporating the use of lectures and worksheets; other high quality lessons are "reform-oriented," involving students in more open-ended inquiries. In all cases, lessons that are judged to be high quality start where the students are, and provide opportunities for students to deepen their understanding.

The "culture" of the mathematics/science classroom appears to be a key factor as well. Lessons that are judged to be of high quality have learning environments that are simultaneously

respectful and challenging of students. Teachers in these classes make sure that students are intellectually engaged with the mathematics/science content, and monitor student understanding as the lesson progresses. Finally, teachers of lessons that are judged to be of high quality help students to make sense of the mathematics/science concepts being addressed, rather than assuming that students will forge that understanding on their own.

In contrast, lessons judged to be low in quality are characterized by learning environments that are lacking in respect and/or rigor; questioning that emphasizes getting the right answer and moving on, without also focusing on student understanding; and "just starting" with no particular motivation and "just ending" without summarizing or other sense-making.

There also appears to be a pattern of differential quality of instruction across types of communities, in classes with varying proportions of minority students, and in classes of varying ability levels. Lessons in rural schools tend to be lower in quality on key indicators such as the extent of intellectual rigor and sense-making than are lessons in suburban and urban schools (those in large and mid-size cities). Similarly, lessons in classes with high percentages of minority students tend to be lower in quality than those in other classes. Finally, lessons in classes comprised of students considered "low ability" and those with students considered "middle" in ability tend to be lower in quality on key indicators than those in heterogeneous and high ability classes.

Based on interviews with teachers participating in the *Inside the Classroom* study, it appears that while most teachers are given a great deal of guidance on what to teach, they have considerable latitude on how to teach. External factors, such as state and district curriculum standards, assessments, and textbook/curriculum programs are identified by teachers as the most important influences on their selection of content for lessons. In contrast, teachers report designing their instruction using resources and strategies grounded in their background knowledge, experiences, and beliefs—about mathematics and science, about effective pedagogy, and about the students they teach.

Implications

Based on the observations conducted for the *Inside the Classroom* study, the nation is very far from the ideal of providing high quality mathematics and science education for all students. The study findings, both the lesson snapshots and teacher reports on what influenced their lesson designs, have implications for the preparation and continuing education of the mathematics/science teaching force, and for the support provided to teachers.

Teachers need a vision of effective instruction to guide the design and implementation of their lessons. Findings from this study suggest that rather than advocating one type of pedagogy over another, the vision of high quality instruction should emphasize the need for important and developmentally-appropriate mathematics/science learning goals; instructional activities that engage students with the mathematics/science content; a learning environment that is simultaneously supportive of, and challenging to, students; and, vitally, attention to appropriate

questioning and helping students make sense of the mathematics/science concepts they are studying.

A number of interventions would likely be helpful to teachers in understanding this overall vision, and in improving instructional practice in their particular contexts. First, teachers need opportunities to analyze a variety of lessons in relation to these key elements of high quality instruction, particularly teacher questioning and sense-making focused on conceptual understanding. For example, starting with group discussions of videos of other teachers' practice, and moving toward examining their own practice, lesson study conducted with skilled, knowledgeable facilitators would provide teachers with helpful learning opportunities in this area.

Second, the support materials accompanying textbooks and other student instructional materials need to provide more targeted assistance for teachers—clearly identifying the key learning goals for each suggested activity; sharing the research on student thinking in each content area; suggesting questions/tasks that teachers can use to monitor student understanding; and outlining the key points to be emphasized in helping students make sense of the mathematics/science concepts.

Third, workshops and other teacher professional development activities need to themselves reflect the elements of high quality instruction with clear, explicit learning goals; a supportive but challenging learning environment; means to ensure that teachers are developing understanding. Without question, teachers need to have sufficient knowledge of the mathematics/science content they are responsible for teaching. However, teacher content knowledge is clearly not sufficient preparation for high quality instruction. Based on the *Inside the Classroom* observations, teachers also need expertise in helping students develop an understanding of that content, including knowing how students typically think about particular concepts; how to determine what a particular student or group of students is thinking about those ideas; and how the available instructional materials (and possibly other examples, investigations, and explanations) can be used to help students deepen their understanding.

Fourth, the apparent inequities in quality of instruction need to be further explored, and if confirmed, steps need to be taken to resolve them. It is essential that all students receive high quality instruction, regardless of the location of their schools or the demographic composition of their classes.

Finally, administrators and policymakers need to ensure that teachers are getting a coherent set of messages. Tests that assess the most important knowledge and skills will have a positive influence on instruction, as will providing opportunities and incentives for teachers to deepen their understanding of the mathematics/science content they are expected to teach, and how to teach it. Only if pre-service preparation, curriculum, student assessment, professional development, and teacher evaluation policies at the state, district, and school levels are aligned with one another, and in support of the same vision of high quality instruction, can we expect to achieve the goal of excellence and equity for all students.