Progress and Challenge

In 1989, the National Council of Teachers of Mathematics (NCTM) launched the standards-based education movement in North America with the release of *Curriculum and Evaluation Standards for School Mathematics*, an unprecedented initiative to promote systemic improvement in mathematics education. Now, twenty-five years later, the widespread adoption of college- and career-readiness standards, including adoption in the United States of the Common Core State Standards for Mathematics (CCSSM) by forty-five of the fifty states, provides an opportunity to reenergize and focus our commitment to significant improvement in mathematics education. To realize the potential of these new standards, we must examine the progress that has already been made, the challenges that remain, and the actions needed to truly ensure mathematical success for all students.

Looking back at mathematics education and student achievement in mathematics, we find much to celebrate. Owing in large measure to the leadership of NCTM, the gradual implementation of a growing body of research on teaching and learning mathematics, and the dedicated efforts of nearly two million teachers of mathematics in North America, student achievement is at historic highs:

- The percentage of fourth graders scoring "proficient" or above on the National Assessment of Educational Progress (NAEP) rose from 13 percent in 1990 to 42 percent in 2013. (National Center for Education Statistics [NCES] 2013)
- The percentage of eighth graders scoring "proficient" or above on the NAEP rose from 15 percent in 1990 to 36 percent in 2013. (NCES 2013)
- Average scores for fourth and eighth graders on these NAEP assessments rose 29 and 22 points, respectively, between 1990 and 2013. (NCES 2013)
- Between 1990 and 2013, the mean SAT-Math score increased from 501 to 514, and the mean ACT-Math score increased from 19.9 to 20.9. (College Board 2013a; ACT 2013)
- The number of students taking Advanced Placement Calculus examinations increased from 77,634 in 1982 to 387,297 in 2013, of whom about 50 percent scored 4 or 5. (College Board 2013b)
- The number of students taking the Advanced Placement Statistics examination increased from 7,667 in 1997 to 169,508 in 2013, of whom over 33 percent scored 4 or 5. (College Board 2013b)

These are impressive accomplishments. However, while we celebrate these record high NAEP scores and increases in SAT and ACT achievement—despite a significantly larger and more diverse range of test-takers—other recent data make it clear that we are far from where we need to be and that much still remains to be accomplished:

- Average mathematics NAEP scores for 17-year-olds have been essentially flat since 1973. (NCES 2009)
- The difference in average NAEP mathematics scores between white and black and white and Hispanic 9- and 13-year-olds has narrowed somewhat between 1973 and 2012 but remains between 17 and 28 points. (NCES 2013)
- Only about 44 percent of U.S. high school graduates in 2013 were considered ready for college work in mathematics, as measured by ACT and SAT scores. (ACT 2013; College Board 2013c)
- Among cohorts of 15-year-olds from the 34 countries participating in the 2012 Programme for International Student Assessment (PISA), which measures students' capacity to formulate, employ, and interpret mathematics in a variety of real-world contexts, the Canadian cohort ranked 13th in mathematics, placing it quite high among non–East Asian countries, whereas the U.S. cohort ranked 26th. (Organisation for Economic Co-operation and Development [OECD] 2013a)
- Although many countries' mean scores on the PISA assessments increased from 2003 to 2012, the United States' and Canada's mean scores declined. (OECD 2013a)
- U.S. students performed relatively well on PISA items that required only lower-level skills—reading and simple handling of data directly from tables and diagrams, handling easily manageable formulas—but they struggled with tasks involving creating, using, and interpreting models of real-world situations and using mathematical reasoning. (OECD 2013b)
- On the PISA tests, only 8.8 percent of students in the United States reached the top two mathematics levels, compared with 12.6 percent of the students across all 34 participating countries, including 16.4 percent of students in Canada and more than 30 percent of students in Hong Kong–China, Korea, Singapore, and Chinese Taipei. (OECD, 2013a)
- Only 16 percent of U.S. high school seniors are proficient in mathematics and interested in a STEM career. (U.S. Department of Education 2014).

These more disturbing data point to the persistent challenges and the work that we still need to do to make mathematics achievement a reality for all students:

- Eliminate persistent racial, ethnic, and income achievement gaps so that all students have opportunities and supports to achieve high levels of mathematics learning

- Increase the level of mathematics learning of all students, so that they are college and career ready when they graduate from high school
- Increase the number of high school graduates, especially those from traditionally underrepresented groups, who are interested in, and prepared for, STEM careers

In short, we must move from "pockets of excellence" to "systemic excellence" by providing mathematics education that supports the learning of all students at the highest possible level.

To achieve this goal, we must change a range of troubling and unproductive realities that exist in too many classrooms, schools, and districts. *Principles to Actions* discusses and documents these realities:

- Too much focus is on learning procedures without any connection to meaning, understanding, or the applications that require these procedures.
- Too many students are limited by the lower expectations and narrower curricula of remedial tracks from which few ever emerge.
- Too many teachers have limited access to the instructional materials, tools, and technology that they need.
- Too much weight is placed on results from assessments—particularly large-scale, high-stakes assessments—that emphasize skills and fact recall and fail to give sufficient attention to problem solving and reasoning.
- Too many teachers of mathematics remain professionally isolated, without the benefits of collaborative structures and coaching, and with inadequate opportunities for professional development related to mathematics teaching and learning.

As a result, too few students—especially those from traditionally underrepresented groups—are attaining high levels of mathematics learning.

Thus, this is no time to rest on laurels. Even a casual review of entry-level workplace expectations and the daily responsibilities of household management and citizenship suggest that such core mathematical ideas as proportion, rate of change, equality, dimension, random sample, and correlation must be understood by nearly all adults—a target far from the current reality.

What is different and promising today, however, is the hope that the implementation of CCSSM, and the new generation of aligned and rigorous assessments, will help to address the continuing challenges and expand the progress already made. The need for coherent standards that promote college and career readiness has been endorsed across all states and provinces, whether or not they have adopted CCSSM. As NCTM (2013) has publicly declared,

> The widespread adoption of the Common Core State Standards for Mathematics presents an unprecedented opportunity for systemic improvement in mathematics education in the United States. The Common Core State Standards offer a foundation for the development of more rigorous, focused, and coherent mathematics curricula, instruction, and assessments that promote conceptual understanding and reasoning as well as skill fluency. This foundation will help to ensure that all students are ready for college and the workplace when they graduate from high school and that they are prepared to take their place as productive, full participants in society.

CCSSM provides guidance and direction, and helps focus and clarify common outcomes. It motivates the development of new instructional resources and assessments. But CCSSM does not tell teachers, coaches, administrators, parents, or policymakers what to do at the classroom, school, or district level or how to begin making essential changes to implement these standards. Moreover, it does not describe or prescribe the essential conditions required to ensure mathematical success for all students. Thus, the primary purpose of *Principles to Actions* is to fill this gap between the development and adoption of CCSSM and other standards and the enactment of practices, policies, programs, and actions required for their widespread and successful implementation. Its overarching message is that effective teaching is the nonnegotiable core that ensures that all students learn mathematics at high levels and that such teaching requires a range of actions at the state or provincial, district, school, and classroom levels.

In *Principles to Actions*, NCTM sets forth a set of strongly recommended, research-informed actions for all teachers, coaches, and specialists in mathematics; all school and district administrators; and all educational leaders and policymakers. These recommendations are based on the Council's core principles. In *Principles and Standards for School Mathematics*, NCTM (2000) first defined a set of Principles that "describe features of high-quality mathematics education" (p. 11). The list on the following page presents updated Principles that constitute the foundation of *Principles to Actions*.

The revisions to this updated set of Principles reflect more than a decade of experience and new research evidence about excellent mathematics programs, as well as significant obstacles and unproductive beliefs that continue to compromise progress. In succeeding sections, these six Principles are defined, examined for unproductive and productive beliefs, linked to effective practices, and illuminated with examples. The final section proposes specific actions for productive practices and policies that are essential for widespread implementation of pre-K–12 mathematics programs with the power to ensure mathematical success for all students at last.

Guiding Principles for School Mathematics
Teaching and Learning. An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically.
Access and Equity. An excellent mathematics program requires that all students have access to a high-quality mathematics curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential.
Curriculum. An excellent mathematics program includes a curriculum that develops important mathematics along coherent learning progressions and develops connections among areas of mathematical study and between mathematics and the real world.
Tools and Technology. An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking.
Assessment. An excellent mathematics program ensures that assessment is an integral part of instruction, provides evidence of proficiency with important mathematics content and practices, includes a variety of strategies and data sources, and informs feedback to students, instructional decisions, and program improvement.
Professionalism. In an excellent mathematics program, educators hold themselves and their colleagues accountable for the mathematical success of every student and for their personal and collective professional growth toward effective teaching and learning of mathematics.