Who is a mathematician? Are we facilitating the development and support for individuals to explore and engage in the wonder, joy, and beauty of mathematics? The National Council of Teachers of Mathematics (NCTM) advocates for high-quality mathematics teaching and learning for each and every student. This aligns with the American Mathematical Society’s mission of encouraging and promoting the transmission of mathematical understanding and skills, and fostering an awareness and appreciation of mathematics and its connections to other disciplines and everyday life. These are important directions for our mathematics community. If we are to expand opportunities for all students in mathematics we must be committed to actions that support all students in doing mathematics across PK–12, post-secondary, and beyond. We must work to develop individuals so that they see themselves as confident, capable, lifelong learners of mathematics and statistics. This is vital to our future as a democratic society and for our place in the world community. I want to focus on actions we must commit to if we are to prepare students to successfully engage and lead in their world.

In 2018 NCTM released Catalyzing Change in High School Mathematics: Initiating Critical Conversations with the purpose of challenging stakeholders in PK–12 education to engage in essential conversations to examine current beliefs, policies, and practices that have had significant negative consequences both for students and the mathematical community as a whole. These conversations then should lead to plans to provide opportunities for all students to engage in mathematics in significant depth to prepare them to not only meet the needs of society but to be leaders in our world. It was apparent that it would be important to also have these critical conversations across early childhood, elementary and middle grades so that as students transition to high school they are fully prepared. To that end in 2020 NCTM released Catalyzing Change in Early Childhood and Elementary Mathematics and Catalyzing Change in Middle School Mathematics. Across all three publications there are four proposed recommendations that span the grade levels so that all learners have a “successful life-long journey with mathematics” [2, p. 9].

1. **Broaden the Purposes of Learning Mathematics.** Each and every individual should develop deep mathematical understanding as confident and capable learners; understand and critique the world through mathematics; and experience the wonder, joy, and beauty of mathematics.

2. **Create Equitable Structures in Mathematics.** PK–12 mathematics should dismantle inequitable structures, including ability grouping and tracking students into qualitatively different learning experiences and dead-end course pathways, and challenge spaces of marginality and privilege.

3. **Implement Equitable Mathematics Instruction.** Mathematics instruction should be consistent with research-informed and equitable teaching practices that foster students’ positive mathematical identities and strong sense of agency.

4. **Develop Deep Mathematical Understanding.** Early childhood settings and elementary schools should build a strong foundation of deep mathematical understanding within middle school and at least the first two years of high school offering a common shared pathway with all students having a continuous four-year mathematics
pathway. These should be grounded in the use of mathematical practices and process to coherently develop deep mathematical understanding ensuring the highest quality mathematics education for each and every student [1–3].

As you read and reflect on these recommendations, you may wonder what tracking is and if there is room for appropriate acceleration in mathematics? Catalyzing Change in High School Mathematics [1] distinguishes between tracking and acceleration. “Tracking is the practice of placing students into qualitatively different course pathways or qualitatively different mathematical learning experiences” [3, p. 29]. Tracking often reinforces the notion that some are capable of doing mathematics and others are not and becomes a system for labeling students in terms of perceived mathematical ability or potential. This often results in those labeled having lower ability or potential being placed in mathematics classes that do not prepare them for continued study of mathematics, thus limiting their opportunities. Each and every student has the ability to learn significant mathematics when provided appropriate learning opportunities with an emphasis on reasoning, sense-making, and problem solving. Opportunities to expand understanding and explore mathematics should be open to a wide range of students, and if there are structural barriers that inhibit access to students these should be addressed and removed.

But what of acceleration? In 2016, NCTM’s position statement Providing Opportunities for Students with Exceptional Promise, stated that “Students with exceptional mathematical promise must be engaged in enriching learning opportunities during and outside the school day to allow them to pursue their interests, develop their talent, and maintain their passion for mathematics.” Acceleration can enable students with exceptional mathematical promise and interest to move ahead in the curriculum. It can support students who show skills, insights, or interests to be challenged to go deeper into mathematics, but we need to be cautious that acceleration practices do not set up mathematics learning as a race with winners and losers. Rather than perpetuating a system based on moving as quickly as possible through a set of courses, we should work to develop a system that allows every student the opportunity to think deeply about mathematics and values sense-making and application. We want to grow the varied fields of mathematics, which I am fairly certain are not at capacity! We want and need more mathematicians. To do this, we need to ensure that multiple opportunities are available to all students and that critical concepts are not skipped or addressed in a rushed manner. We do not want students to believe that mathematics is about memorizing a process and that they should move faster at all costs, as this could lead them to dislike mathematics and all that the system represents. I believe that working together to support a system that values understanding over speed, values an experience where most if not all leave seeing the importance of mathematics, and cultivates within each student a belief that they can do, understand, and apply mathematics, will help to sustain the field of mathematics and a society that values the work that mathematicians do.

It is essential that a deep understanding is developed across mathematical concepts. For some, calculus may be a goal in high school. According to a joint Calculus position statement of NCTM and MAA “A high school calculus course should not be the singular end goal of the PK–12 mathematics curriculum at the expense of providing a broad spectrum of mathematical preparation.” Thus, it is imperative that students have additional opportunities through pathways that include areas such as statistics, mathematical modeling, or data science which are important for students to understand and critique their world. These critical conversations and collaborations called for in Catalyzing Change are needed across PK–16 to ensure that all students are prepared for their future.

What does this mean for postsecondary mathematics education? Catalyzing Change in High School [1, p. 92–93] identifies five beginning actions for postsecondary educators.

- Ensuring strong articulation and seamless pathways between the high school and the postsecondary mathematics curricula;
- Collaborating with school- and district-based mathematics educators;
- Working with in-service and preservice teachers to support research-informed and equitable instructional practices focused on essential concepts across content domains of number, algebra and functions, statistics and probability, and geometry and measurement (See Catalyzing Change in High School for specifics related to these concepts);
- Collaborating with school and district educators to develop additional mathematics pathways and populating courses with essential concepts across content domains of number, algebra and functions, statistics and probability, and geometry and measurement;
- Collaborating with school and district educators to challenge and dismantle system structures that impede students’ access to and success in mathematics.
Consider Maryam Mirzakhani’s journey into mathematics. You know her as the first female and first Iranian to win the Fields Medal, mathematics’ highest award. Initially she did not see herself as a mathematician. She loved stories, reading novels, writing, and doodling her thoughts. In middle school her math teacher told her that she was not particularly talented in mathematics. The following year, she had a teacher who encouraged her and introduced her to geometry, which she saw as different from any mathematics she had known before. It changed the direction of her journey into mathematics. One teacher’s encouragement made her aware of the beauty of mathematics and opened opportunities for her to engage in rich mathematics, and our world has been forever changed.

If Maryam had not been supported in seeing mathematics with many purposes, think what would have been lost to her and to us. Every student who comes through our door is capable of doing mathematics, of learning and expanding their understanding of their world through mathematics. Are we providing learning spaces to unearth the mathematician in each student and foster in all this love of mathematics that we have? I challenge us to have these needed conversations among and across our organizations, in our mathematics and education departments, with PK–16 educators, and all stakeholders. Where will you start?

References