

# Technology and Tools in the Common Core State Standards for Mathematics

By Jason Zimba

Technology and tools are mentioned often in the Common Core State Standards for Mathematics (CCSSM). Most prominently, Standard for Mathematical Practice MP.5 sets an expectation that students will “Use appropriate tools strategically.” The word *tools* in this standard isn’t simply synonymous with calculators—or with computers; the standard also includes strategic use of physical tools such as protractors, as well as strategic use of conceptual tools such as the number line, the coordinate plane, other diagrams, or even formulas.

The word *strategically* is important in MP.5. If the student isn’t being strategic, then the student isn’t meeting the standard. Using pencil and paper to find the mean of a hundred data values is a poor strategy. So is using a calculator to evaluate a messy algebraic expression without checking first to see if the expression simplifies (see also MP.7). To instill and assess such strategic habits of mind, textbooks, teachers, and tests should sometimes create circumstances for poor use of tools, misuse of tools, and/or mistakenly **not** using tools. Routine use of tools happens of course, but it’s not really an instance of MP.5.

Some individual content standards call explicitly for the use of technology (e.g., to draw geometric shapes with specified conditions; see 7.G.2). Technology is also specifically mentioned in the overview of each conceptual category in High School (see, e.g., Number and Quantity on p. 58 of the CCSSM and Modeling on pp. 72-73). In general, technology in the Standards is prominent in high school, less prominent in middle school, and least prominent in elementary school. This trend is consistent with the Standards’ strong focus on arithmetic in Grades K–5. It is also consistent with the Standards’ coherent treatment of arithmetic: arithmetic as portrayed in the Standards is a foundation skill that requires fluency as well as a thinking subject with great conceptual richness; a rehearsal for algebra. Thus in Grades K–5, working with numbers by hand is essential to the design of the Standards.

In the middle grades, arithmetic becomes settled business—a tool in the toolkit—and new frontiers begin to open up, such as proportional relationships, functions, statistics, algebra, and major work in geometry. All of these become substantial domains of study in high school, again with an increasing technology trend from Grade 6 up through high school.

As a practical matter, both assessment consortia have had to determine the role of calculation aids on assessments. An assessment policy that aligns to the focus, coherence, and technology trends in CCSSM will necessarily treat the different grade bands differently. In Grades K–5, working with numbers by hand is essential to the design of the Standards, and calculation aids are not appropriate for summative assessments in these grades, except as deemed appropriate for accommodations by each consortium. But calculation aids should become available beginning in Grade 6, by which time arithmetic is no longer the focus and new frontiers for technology are opening up. Indeed, to capture the technology trend in the Standards, calculation aids and technology in Grades 6–HS should generally increase from grade to grade in terms of prevalence and power. However, the appropriate tools for summative assessments do vary by standard (e.g., a calculator would not be appropriate for 6.NS.2 or 7.NS.1), so it is best to have variable control over the kinds of technology presented along with each given task. By high school, students could have access to a broad toolkit (whether handheld or online), with capabilities such as a scientific calculator, a coordinate plane graphing utility, and a statistical analysis suite. Students taking the assessment could use the toolkit at their discretion; tasks are written with this in mind. In some cases, such as where computation or mental work is key, the toolkit is unavailable; conversely, where even greater capability would be appropriate, e.g., as in polynomial division, it could be appropriate to provide additional tools along with the task (computer algebra functionality in this example).

These examples and counterexamples show the importance of keeping the mathematics at the center of every decision. As William McCallum wrote in 2001,<sup>1</sup>

In order to consider sensibly the uses of technology, we must, paradoxically, start out by forgetting about it. In the same way that we might plan a trip by first choosing a destination on a map, and then considering the details of getting there, we should start out by considering first our mathematical goals, and then consider the ways we and our students can get there.

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<sup>1</sup> <http://math.arizona.edu/~wmc/Research/NCTMCASArticle.pdf>