

# Preface: Math Tools: A Cure for the Common Core

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**A**lmost a decade ago, we embarked on a journey guided by a simple question: *What would a tools-based approach to mathematics instruction look like?* What we wanted to develop was a new kind of resource—a practical, easy-to-use collection of “math tools” that would respond directly to the different instructional challenges teachers of mathematics face. This journey culminated in *Math Tools, Grades 3–12: 64 Ways to Differentiate Instruction and Increase Student Engagement* (Silver, Brunsting, & Walsh, 2008).

Let’s fast forward a few years. In light of new experiences, new perspectives (welcome, Ed Thomas), and new challenges facing mathematics educators, we felt the time was right for an enhanced and updated edition of *Math Tools*. Of course, not all the challenges teachers of mathematics confront are new—the tools in this enhanced edition of *Math Tools* remain excellent techniques for helping teachers increase student engagement, differentiate instruction, and design comprehensive lessons and units. We’ve also taken care to highlight these tools as effective options for formatively assessing student progress and integrating technology and multimedia into the classroom. But, as the subtitle to this preface reminds us, the emergence of the Common Core State Standards for Mathematics (National Governors Association Center for Best Practices [NGA], Council of Chief State School Officers [CCSSO], 2010b) is the most significant challenge facing teachers of mathematics. Thus, the emergence of the Common Core documents—and their expectations—have guided much of our work in developing this new and revised version of *Math Tools*.

The Common Core State Standards for Mathematics are new, but not radical. They bring together Standards for Mathematical Content (specific for kindergarten through high school) and Standards for Mathematical Practice, which “describe varieties of expertise that mathematics educators at all levels should seek to develop in their students” (NGA Center, CCSSO, 2010b, p. 6). These standards are built from decades of collaboration and progress in developing a more rigorous mathematics curriculum. The goal of the Common Core is to “describe a coherent, focused curriculum that has realistically high expectations and supports an equitable mathematics education for all students” (2010) is supported by the National Council of Teachers of Mathematics (NCTM), the National Council of Supervisors of Mathematics (NCSM), the Association of State Supervisors of Mathematics (ASSM), and the Association of Mathematics Teacher Educators (AMTE).

The longstanding positions and principles of these organizations are reflected in the central elements of the Common Core State Standards for Mathematics, including the notion that “all students need to develop mathematical practices such as solving problems, making connections, understanding multiple representations of mathematical ideas, communicating their thought processes, and justifying their reasoning” (NCTM, 2010).

And, as John Kendall (2011) notes in *Understanding Common Core State Standards*, “[T]he standards’ emphasis on conceptual understanding is evident not just in its Standards for Mathematical Content but also in its Standards for Mathematical Practice, which show indebtedness to NCTM’s (2000) *Principles and Standards for School Mathematics* and to the strands of mathematical proficiency identified in the National Research Council’s influential text *Adding It Up* (Kilpatrick, Swafford, & Findell, 2001)” (p. 23).

In the second edition of *Math Tools*, we do not attempt to provide a primer on the Common Core State Standards for Mathematics. This work is done much better by other resources, such as NCTM’s *Making It Happen: A Guide to Interpreting and Implementing Common Core State Standards for Mathematics* (2012). And, if you’re looking for a general overview of the Common Core, we recommend the aforementioned *Understanding Common Core State Standards* (Kendall, 2011). But, if you’re looking for a set of ready-to-use instructional tools that build the type of mathematical thinking and reasoning highlighted in the Standards for Mathematical Practice, then this new edition of *Math Tools* is your book.

Over the subsequent pages, you’ll notice that we have put our focus on the Standards for Mathematical Practice. We’ve done so because they tell us how “developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years” (NGA Center, CCSSO, 2010b, p. 8). In other words, “These standards establish critical practices that are valued throughout the grade levels” (Kendall, 2011, p. 24). The practices serve as the “thinking glue” that holds the entire mathematics curriculum together, from kindergarten through high school.

Here are the eight Standards for Mathematical Practice (NGA Center, CCSSO, 2010b):

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

For students to consistently demonstrate these practices, teachers must routinely provide activities and lessons that support the development of requisite knowledge (e.g., vocabulary) and appropriate habits (e.g., justification of work).

We developed a new edition of *Math Tools* to help teachers in elementary, middle, and high school mathematics classrooms identify and select the best instructional tools to address the Standards for Mathematical Practice. The tools in this book support the development of students' reasoning and skills, and provide formative assessment opportunities that allow teacher and student to assess and refine students' thinking and learning. That's why we believe this enhanced edition of *Math Tools* can be the "cure" for the Common Core, helping to alleviate teachers' anxiety over implementing these standards by breaking down the Standards for Mathematical Practice and providing practical, effective, and easy-to-use instructional tools that address them.

Each math tool includes a "Building Common Core Thinking" section, which identifies the Standards for Mathematical Practice the tool supports by number, key word, and key phrase extracted from the practice description (see Figure B on pp. xiv–xv for a sampling of these key phrases). In addition, some math tools also include a Common Core "ELA Note." This note highlights any key College and Career Readiness Anchor Standards for Reading, Writing, Speaking and Listening, or Language (NGA Center, CCSSO, 2010a) that the tool can support. For example, the Building Common Core Thinking section for the Explaining Solutions tool (p. 159) is shown in Figure A below:

**Figure A** Building Common Core Thinking Section from Explaining Solutions Tool

**Building Common Core Thinking**

Explaining Solutions builds students' reflecting, reasoning, and sense-making habits as they explain and communicate the problem-solving process behind a solution. Explaining Solutions supports the following Standards for Mathematical Practice (MP):

- **(MP 1) Sense:** explaining correspondences between equations, descriptions, tables, and graphs or diagrams
- **(MP 2) Reason:** *learning to create coherent representations*
- **(MP 3) Argument:** supporting and justifying conclusions
- **(MP 4) Model:** interpreting mathematical work in the light of a context
- **(MP 6) Precision:** formulating careful explanations

**ELA Note:** Explaining Solutions can also help support the Common Core Anchor Standards for Writing and Language related to informative/explanatory writing (W.CCR.2), on-task writing (W.CCR.4), conventions of standard written English (L.CCR.1, L.CCR.2), and use of vocabulary (L.CCR.6).

It is our sincere hope that teachers of mathematics will use this new edition of *Math Tools* as a rich and practical resource for developing "mathematically proficient students," thus preparing students for success in college and careers of the 21st century and "curing" the anxiety building in many schools surrounding the Common Core State Standards for Mathematics.

**Figure B** Standards for Mathematical Practice—Key Words and Phrases

Standard for Mathematical Practice (MP)	Key Word	Key Phrases
<p><i>Mathematically proficient students . . .</i></p> <p>1. Make sense of problems and persevere in solving them</p>	<p>Sense (MP 1)</p>	<ul style="list-style-type: none"> <li>• Explain to themselves the meaning of a problem</li> <li>• Look for entry points to a problem</li> <li>• Make conjectures</li> <li>• Plan a solution pathway</li> <li>• Consider analogous problems</li> <li>• Monitor and evaluate their progress</li> <li>• Transform expressions, change viewing windows, etc.</li> <li>• Explain correspondences between equations, verbal descriptions . . .</li> <li>• Use concrete objects or pictures to help conceptualize</li> <li>• Check answers to problems using a different method</li> <li>• Ask themselves, “Does this make sense?”</li> <li>• Understand others’ approaches to solving complex problems</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>2. Reason abstractly and quantitatively</p>	<p>Reason (MP 2)</p>	<ul style="list-style-type: none"> <li>• Make sense of quantities and their relationships</li> <li>• Decontextualize problems</li> <li>• Represent problems symbolically, and manipulate those symbols as needed</li> <li>• Contextualize problems</li> <li>• Pause to look deeper into symbols</li> <li>• Create a coherent representation of a problem</li> <li>• Make meaning of quantities, not just compute them</li> <li>• Flexibly use different properties of operations and objects</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>3. Construct viable arguments and critique the reasoning of others</p>	<p>Argument (MP 3)</p>	<ul style="list-style-type: none"> <li>• Understand and use assumptions, definitions, and previously learned information</li> <li>• Make conjectures and build a logical progression of statements to explore the truth of their conjectures</li> <li>• Analyze situations by breaking into cases</li> <li>• Recognize and use counterexamples</li> <li>• Justify and communicate their conclusions and respond to the arguments of others</li> <li>• Reason inductively</li> <li>• Compare plausible arguments, distinguish correct logic, and explain incorrectness</li> <li>• Construct arguments using concrete referents: objects, drawings, diagrams, actions</li> <li>• Determine domains to which an argument applies</li> <li>• Listen to and read arguments of others, decide if they make sense</li> <li>• Ask useful questions to clarify and improve arguments</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>4. Model with mathematics</p>	<p>Model (MP 4)</p>	<ul style="list-style-type: none"> <li>• Apply the mathematics they already know to solve real, everyday problems</li> <li>• Write an equation or inequality to describe a situation</li> <li>• Apply reasoning to analyze a problem</li> <li>• Solve or design a problem (e.g., use a function to describe how one quantity depends on another)</li> <li>• Make valid approximations and assumptions to simplify a situation</li> <li>• Identify need for revisions</li> <li>• Identify important quantities, map relationships using a variety of techniques/draw conclusions</li> <li>• Interpret and reflect on results</li> </ul>

Standard for Mathematical Practice (MP)	Key Word	Key Phrases
<p><i>Mathematically proficient students . . .</i></p> <p>5. Use appropriate tools strategically</p>	<p>Tools (MP 5)</p>	<ul style="list-style-type: none"> <li>• Develop proficiency using a variety of tools: pencil and paper; calculator and software; ruler, compass, and protractor</li> <li>• Make use of available and appropriate tools, recognizing their value and limitations</li> <li>• Use tools to explore and deepen understanding by visualizing the problem in different ways and/or comparing possible solutions with the data</li> <li>• Use technology to explore problems that they could not study using pencil and paper alone—for example, calculators to compute problems with much data or very large numbers; graphing calculators to preview concepts traditionally reserved for later math classes; computers to analyze complex problems that could not otherwise be studied; or the Internet to research or explore mathematical content</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>6. Attend to precision</p>	<p>Precision (MP 6)</p>	<ul style="list-style-type: none"> <li>• Communicate precisely both verbally and in writing</li> <li>• Use complete sentences for both written and verbal answers</li> <li>• Use clear, accurate definitions</li> <li>• State meaning of mathematical symbols</li> <li>• Label details accurately (e.g., units, axes, tables and graphs)</li> <li>• Calculate accurately and efficiently, expressing answers with appropriate precision and units</li> <li>• Give carefully formulated explanations to others</li> <li>• Examine solutions or claims in light of definitions and constraints</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>7. Look for and make use of structure</p>	<p>Structure (MP 7)</p>	<ul style="list-style-type: none"> <li>• Look closely to discern a pattern or structure</li> <li>• See parts in relationship to the whole</li> <li>• Consider alternative perspectives for a given problem or situation</li> <li>• Break complicated problems into smaller, simpler parts</li> <li>• Recognize significance or underlying structure of a problem</li> </ul>
<p><i>Mathematically proficient students . . .</i></p> <p>8. Look for and express regularity in repeated reasoning</p>	<p>Repetition (MP 8)</p>	<ul style="list-style-type: none"> <li>• Notice patterns in calculations or solutions to problems</li> <li>• Generalize methods and shortcuts</li> <li>• Maintain oversight of the process</li> <li>• Attend to the details</li> <li>• Continually check for reasonableness</li> </ul>