Teaching and Learning the Common Core State Standards for Mathematical Practice

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Released in 2010 by the Common Core State Standards Initiative (CCSSI), the Common Core State Standards for Mathematics have been adopted by the majority of states in the USA and are expected to be fully implemented by the end of 2014. With this in mind, teacher education programs must provide training in the new standards immediately, especially in those states that have already adopted the standards. Otherwise, new mathematics teachers may enter the profession with little to no exposure or understanding of the standards that they will be expected to teach. The Common Core State Standards consist of two major components: (1) Standards for Mathematical Content and (2) Standards for Mathematical Practice. This paper will focus on the Standards for Mathematical Practice, which are devoted to the nurturing of problem solving skills, critical thinking abilities, and mathematical habits of mind. This paper also presents ideas for future research endeavours generated by a group of mathematics educators attending the March 2014 BSRLM conference.

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Common Core State Standards for Mathematical Practice

With the initial implementation of the Common Core State Standards in Mathematics (CCSSM) currently under way across much of the United States, it is imperative that teachers not only understand the new Common Core content expectations but also know how to incorporate the Common Core Standards for Mathematical Practice.

The Standards for Mathematical Practice apply to all year levels, so the discussion can readily include the entire class regardless of the preservice or inservice teacher's chosen year level. Once the Standards for Mathematical Practice are understood, the content standards can be introduced. These vary across grade levels, but certain domains (such as geometry) are continually revisited and developed further. Conducting an overview of all of the standards provides teachers at all levels a chance to understand the pacing and growth expected of students throughout their school enrollment. The purpose of this paper is to summarise each of the Standards for Mathematical Practice and to report future research ideas that emerged from a discussion among mathematics educators at the March 2014 BSRLM conference.

Standards for Mathematical Practice

The Standards for Mathematical Practice are essentially the best practices of successful mathematicians (CCSSI, 2012). Mathematics learners at all year levels should strive for these traits and capabilities in order to be successful themselves.

When introducing these standards to preservice and inservice teachers, it is beneficial to have a class discussion about each one, with emphasis on how to ensure that learners are meeting each standard. For preservice teachers with minimal teaching experience, this process can be especially enlightening since the standards may be different from their own educational experiences as learners of mathematics. The following is a brief discussion about the Standards for Mathematical Practice, outlining considerations around each standard. Ideas included in this discussion were examined and explored by session attendees during the March 2014 BSRLM conference.

"CCSS.Math.Practice.MP1 – Make sense of problems and persevere in solving them" (CCSSI, 2012, para. 2). For MP1, students learn that problem solving can be an independent or group endeavor. It involves making a plan for how to solve a problem, correctly implementing the plan, and verifying the reasonableness of a solution. Perseverance is a learned trait, and students must be trained to keep trying different methods of solving a problem until they are successful. Teachers must take care not to give answers or hints too readily, or else students will learn that giving up on a problem is acceptable.

"CCSS.Math.Practice.MP2 – Reason abstractly and quantitatively" (CCSSI, 2012, para. 3). For MP2, students must learn to make sense of the numbers and quantities in a problem and recognize relationships between them. They must also understand and be able to use the properties of equations, use symbols to represent mathematical concepts (decontextualise), and connect symbols to what they represent (contextualise). These abilities are crucial for successful problem solving and real-world applicability, and should be continually stressed throughout a student's education.

"CCSS.Math.Practice.MP3 – Construct viable arguments and critique the reasoning of others" (CCSSI, 2012, para. 4). MP3 requires students to use prior knowledge to construct arguments. They must communicate and justify their conclusions to others. As other students do the same, all must consider the viewpoints of others and compare the effectiveness of different arguments. This helps students to identify unique methods and perhaps find a more elegant approach to solving a given problem.

"CCSS.Math.Practice.MP4 – Model with mathematics" (CCSSI, 2012, para. 5). With MP4, students must model the real-world using mathematics. This encourages the application of mathematics to everyday life situations, which helps make mathematics more relevant and interesting to students.

"CCSS.Math.Practice.MP5 – Use appropriate tools strategically" (CCSSI, 2012, para. 6). MP5 expects students to consider and use a variety of tools when solving mathematical problems. As mentioned previously, this includes the use of technology, such as graphing calculators, computer algebra systems, and dynamic geometry software, to explore and deepen understanding of mathematical concepts. In addition, students should also use their estimation skills to determine the reasonableness of answers.

"CCSS.Math.Practice.MP6 – Attend to precision" (CCSSI, 2012, para. 7). For MP6, students should learn to communicate precisely about mathematics. This primarily involves the use of appropriate vocabulary. In addition, students should also learn to use the equal sign properly, specify units of measure with appropriate labels, and express numerical answers with precision.

"CCSS.Math.Practice.MP7 – Look for and make use of structure" (CCSSI, 2012, para. 8). With MP7, students are encouraged to find and analyze patterns and structures. This requires students to "step back" from a problem in order to gain an overview of it, a look at the "big picture". This also helps students to shift perspective and consider different points of view. With experience, students will learn to decompose complex problems into simpler components, helping to make tougher problems more manageable.

"CCSS.Math.Practice.MP8 – Look for and express regularity in repeated reasoning" (CCSSI, 2012, para. 9). Finally, MP8 calls on students to notice if calculations are repeated. If so, students should ask themselves: what general methods should be used to solve the problem? What kinds of shortcuts could be used to hasten the calculation? By analyzing problems for common methods and shortcuts, students strengthen their mathematical skill fluency.

Research Opportunities

It is hoped that the infusion of the Standards for Mathematical Practice into mathematics teaching/learning opportunities will encourage learners to appreciate mathematics, to find connections among mathematics and other school subjects, to apply mathematics to life outside of school, and to seek the beauty and enjoyment of mathematics. Educational researchers would be well served to design and implement studies that focus on the Standards for Mathematical Practice. During the March 2014 BSRLM conference, participants brainstormed potential areas of focus for future research endeavours pertaining to the Standards for Mathematical Practice. Stemming from this discussion, possible questions for future research studies include:

1. How are the Standards for Mathematical Practice infused into teaching/learning environments?
2. How do teachers of various year levels conceptualise and apply the Standards for Mathematical Practice? How do teachers help learners to conceptualise and apply the Standards?
3. How does knowledge of the Standards for Mathematical Practice affect the way learners approach problem solving?
4. Are there Standards for Mathematical Practice that teachers and learners perceive as more salient than others?
5. How might the Standards for Mathematical Practice be incorporated into subject areas other than mathematics?

As the Standards for Mathematical Practice are relatively recent in terms of implementation, mathematics teacher educators and educational researchers have rich opportunity to add to the professional literature in the next few years. It will be interesting to read and reflect upon future studies and how they affect the mathematics education landscape.

References

Common Core State Standards Initiative. (2012). *Standards for Mathematical Practice.* Retrieved from http://www.corestandards.org/Math/Practice. Accessed March 1, 2014.