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The Common Core State Standards' Mathematical Practices: What do They Mean for the Adventist Mathematics Classroom?

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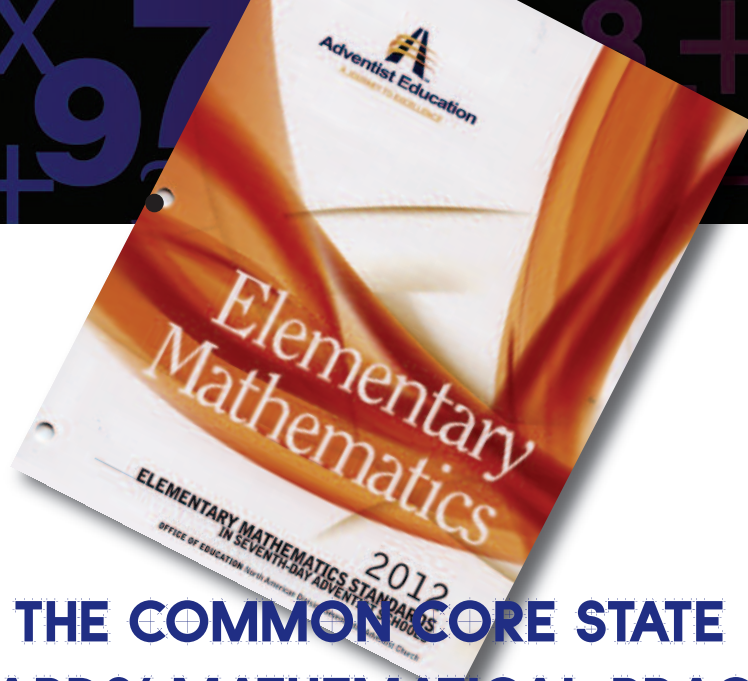
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THE COMMON CORE STATE STANDARDS' MATHEMATICAL PRACTICES:

WHAT DO THEY MEAN FOR THE

ADVENTIST

Mathematics Classroom?

A nationwide state-sponsored curriculum for mathematics and language arts will soon be implemented in public schools across the United States. This will also include a new system for assessing students' mastery of the curriculum. The main focus of this article is what mathematics teachers will need to do to adapt their instruction because of the coming changes. Resources are available to help teachers to prepare for the implementation of the new standards known as the Common Core State Standards (CCSS).

An examination of the new *Elementary Mathematics Standards in North American Division (NAD) Seventh-day Adventist Schools* (2012) reveals that the mathematics curriculum for grades K-8 has been aligned with the Common Core State

Standards of Mathematics (CCSS-M). On the first page of the recently released elementary standards, the mathematical practices that are part of the Common Core are listed. *The NAD Mathematics Curriculum Guide* (2003) for the secondary level, based on the 2000 National Council of Teachers of Mathematics (NCTM) content and process standards, is undergoing a similar update. Since the elementary NAD standards include all of the Common Core without neglecting the integration of faith, which is included in the essential questions and big ideas, the secondary NAD standards should also align well with the CCSS while maintaining a faith-based focus.

What makes the Common Core standards different from previous standards? Will it be worth the effort to incorporate them into the NAD standards? What benefits are anticipated in the area

BY MARIAN PRINCE



of student learning and comprehension?

But first, an overview of the history of the CCSS. With the decline in world ranking of U.S. students' scores on the National Assessment of Education Progress (NAEP), the Trends in Mathematics and Science Study (TIMSS), and other international measures of student academic achievement,¹ educators and politicians have been looking for a way to coordinate the standards across the states without implementing a national curriculum (which is frequently done in other countries), since curriculum is locally determined in the U.S. In 2010, the Council of Chief State and School Officials (CCSSO) and the National Governors Association (NGA) released the Common Core State Standards in Mathematics (CCSS-M) and English Language Arts, which most of the states are adopting.² The standards (<http://www.corestandards.org/>) are designed to ensure that students will develop the skills necessary for college and careers in a global economy.³

After the NCTM developed curriculum and evaluation standards in 1989 regarding the mathematical content that should be taught, it became evident that teachers needed guidance regarding how to train students to become mathematically proficient. So in 2000, the NCTM published Process Standards.⁴ A year later, the National Research Council recommended that teachers develop five strands of Mathematical Proficiency in their students.⁵

For a number of years, these guidelines did not have a large-scale impact on the way mathematics was taught in U.S. classrooms.⁶ But, given the broad base of participation and collaboration by so many states, the authors of the CCSS-M resolved that with the full implementation of the Common Core State Standards, the way mathematics is taught and learned would change. When the CCSS were released in 2010, they contained eight Mathematical Practices that are to be applied at *each* grade level. These Mathematical Practices are designed to complement the content standards.

The CCSS Mathematical Practices

Figure 1 shows the relationship among the practices.

The CCSS Mathematical Practices can be briefly summarized as follows:

1. *Make sense of problems and persevere in solving them.* Students are able to state what the problem asks them to do. They can identify solution strategies that fit within the conditions and limiting factors of the problem. They continually check their solutions, adapt their approach if necessary, and are will-

ing to think “outside the box.”

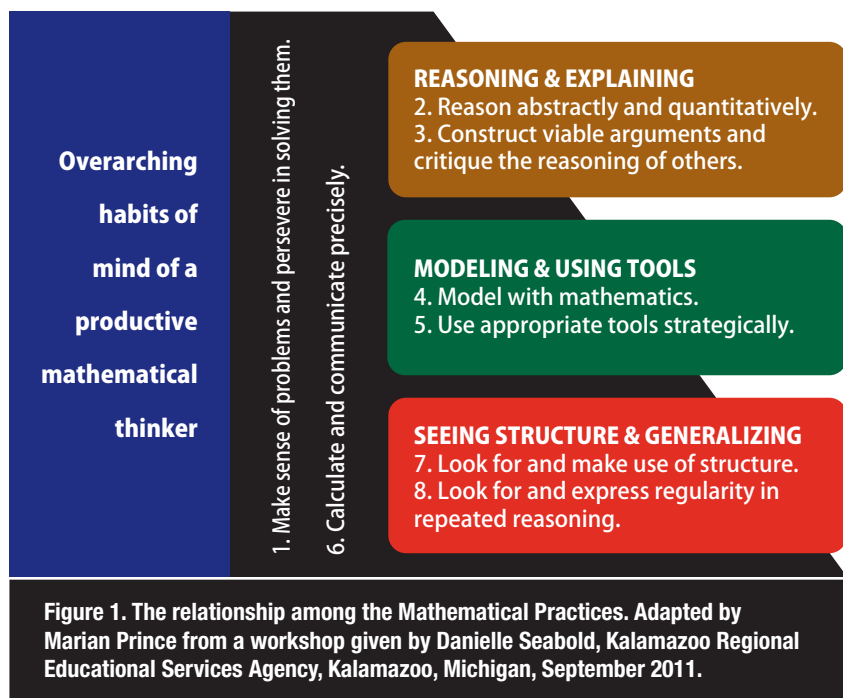
2. *Reason abstractly and quantitatively.* Students are able to understand what the numbers in the problem represent and how the numbers affect the problem. By transforming the problem into symbols and using the properties of mathematics, they are able to find the solution and to understand the meaning of their answer in practical terms.

3. *Construct viable arguments and critique the reasoning of others.* Students are able to craft logical arguments, and after listening to the arguments of others, are able to respectfully ask questions to identify strengths and weaknesses. They are capable of clearly communicating their own arguments and suggesting improvement(s) in the logic of other students' arguments.

4. *Model with mathematics.* Students are able to apply mathematics to everyday life and the workplace. Using a variety of tools (diagrams, tables, graphs, flowcharts, and formulas), students are able to decide if their model makes sense and to interpret the results of their solutions based on the situation.

5. *Use appropriate tools strategically.* When solving a mathematical problem, students are able to make sound decisions about when to use technology, manipulatives, and other hand-held tools and be able to identify resources that inform the problem-solving process. They are also capable of recognizing the limitations of certain tools.

6. *Calculate and communicate precisely.* In their attempt to communicate precisely to others, students will use clear defi-



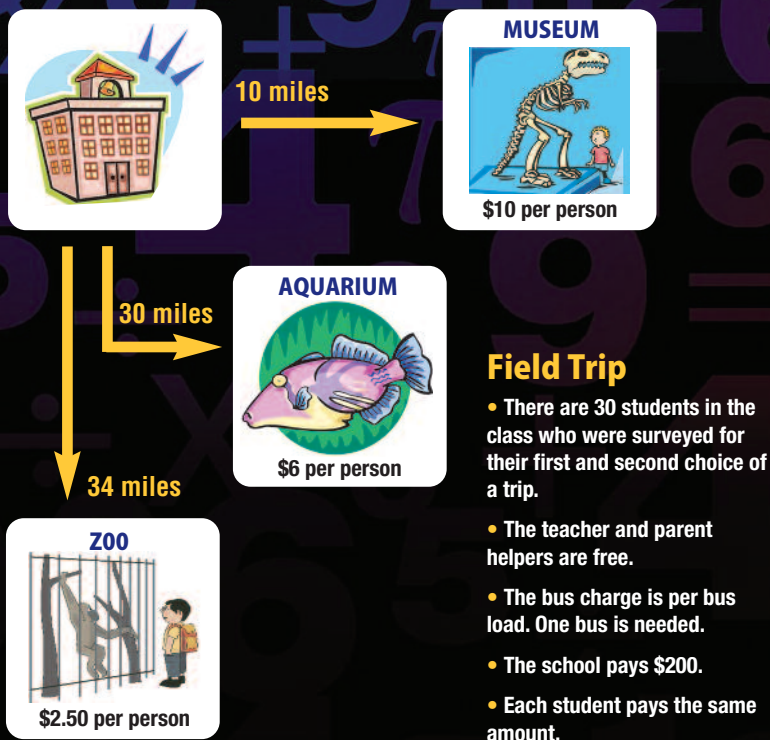


Figure 2. Diagram of a Sample 6th-Grade Performance Task from the Smarter Balanced Assessment Consortium. Sample items adapted by Marian Prince.

nitions and appropriate units, explain any symbols used, and label graphs and diagrams with the necessary information. They will calculate accurately and express numerical answers with an appropriate degree of precision.

7. *Look for and make use of structure.* Students are able to identify, generalize, and extend patterns appropriately. Examples: Recognizing that 3 plus 7 is the same as 7 plus 3; and that the new fact, 7×8 , is the same as $7 \times 5 + 7 \times 3$ that are more familiar; students will be able to conclude that $9 = 2 + 7$ and $14 = 2 \times 7$ in the expression $x^2 + 9x + 14$.

8. *Look for and express regularity in repeated reasoning.* Students are able to notice repeated calculations or patterns and to find shortcuts to use while solving problems. They are able to judge whether the results are reasonable and accurate.⁷

Why Are These Mathematical Practices Important?

Adventist teachers in the North American Division need to be knowledgeable about the Common Core Standards, since the church's mathematics curriculum corresponds to these standards. Students transferring from your school will need to be prepared for the CCSS mathematical practices in their new classrooms. Likewise, you will need to know how the CCSS-M have shaped the mathematical background of students entering your classroom.

Moreover, learning more about the CCSS mathematical practices and incorporating them into your instructional repertoire should improve your teaching of mathematics—whether or not you have a strong math background or a degree in mathematics

or mathematics education.

As of the writing of this article, for the 2014-2015 school year, all but five of the 50 states have agreed to implement a new system of assessment. This is an unprecedented state-level cooperation on academic standards. Two consortia, Smarter Balanced Assessment Consortium (SBAC) and the Partnership for Assessment of Readiness for College and Careers (PARCC), have received Race to the Top funds to develop an assessment system to measure the full breadth of the CCSS in order to provide instructionally relevant information, fair accountability measures, and valid data to inform policy decisions. Through the use of Computer Adaptive Testing, electronic grading of constructed response items, and performance tasks (some through computer simulation), the assessment system incorporates three main approaches: summative, interim/benchmark, and formative in a secure online-testing environment.⁸ This testing system, if implemented as designed, should serve as a driving force to bring about

change in the way mathematics is taught in the American classrooms.

Review the sample 6th-grade task in Figure 2 that the SBAC released for feedback and review. This item is designed to measure whether students can apply mathematics to make a decision based on understanding of proportional reasoning, including application of unit rates.⁹

The students are to calculate how much each student will pay for each trip and write a letter to the teacher recommending which field trip to take based on students' first- and second-place votes, costs, and distance. Because this problem requires using Mathematical Practices 1, 2, 3, 4, 6, 7 and 8, students who have not developed the habit of applying the Mathematical Practices will likely not do well on this item. When this assessment system is put into place, teachers at all grade levels will have to use instructional practices that encourage their students to internalize and use these mathematical practices as they learn the required content.

What Do the Mathematical Practices Look Like in a Classroom?

There are videos of exemplary lessons that show students participating in lessons that require them to use one or more Mathematical Practices. One of the Public Video Lessons featured on <http://www.insidemathematics.org> is a 5th- and 6th-grade lesson on multiple representations of numeric patterning called "The Button Task." (See Figure 3.) After predicting the number of but-



tons needed to make Pattern 11, students discuss in their groups the responses given by Learners A and B. To aid students in discussing the principles involved, the teacher asks them to share questions they would like to ask Learners A and B.

When the teacher asked each group to share what they had heard at their table, some students asked, “Where did Learner B get the 4?” while other students said that they understood Learner A’s strategy better than Learner B’s. The teacher then distributed manipulatives for students to use in investigating each solution.¹⁰

The students critiqued the two solutions to the mathematical problem while looking for patterns, persevering in solving a problem, reasoning abstractly and quantitatively, using structure, and modeling with mathematics. Thus, “The Button Task” helped facilitate the development of mathematical practices in these students. Many other activities are given to demonstrate the other CCSS mathematical practices, but because of space limitations, only one example can be included here.

The SBAC has made a goal to provide an online repository by the 2014-2015 school year where teachers can find resources for implementing formative assessment as well as model CCSS lesson plans and student work. This goal is well on the way to being realized. The Inside Mathematics Website (<http://www.insidemathematics.org/>) has a number of videos showing teachers planning, teaching, and reflecting on model lessons that involve students in using the various mathematical practices.

Also included are samples of student work that demonstrate the effectiveness of the lessons, as well as model CCSS lessons (<http://www.gomaisa.org/>) that are in the process of being created by the Michigan Association of Intermediate School Administrators (MAISA). A Website where teachers can find all these Common Core resources was created by Danielle Seabold, mathematics consultant at the Kalamazoo Regional Educational Service Agency (KRESA), which you can explore here: <http://bit.ly/MI-CCSS-M>. Kent County (Michigan) Intermediate School District has built an online system (Curriculum Crafter) that allows paid subscribers to keep up with the changes in the standards. There is limited free access to this tool at <http://www.curriculumcrafter.org/>. Each Regional Educational Service Agency in Michigan and the other participating states have accumulated resources to help schools align their instruction with the Common Core Content and Practice Standards.

What Do Mathematics Teachers Need to Be Doing?

Math teachers need to be including the instructional practices that research has shown to enhance student achievement. Marzano and his colleagues supplied the research results for Identifying Similarities and Differences; Summarizing and Note Taking; Reinforcing Effort and Providing Recognition; Homework and Practice; Nonlinguistic Representations; Cooperative Learning; Setting Objectives and Providing Feedback; Generating

THE BUTTON TASK

Pattern 1

Pattern 2

Pattern 3

Assignment:
Create Pattern 11

Learner A
added 1 for the button in the middle
 $(11 \times 3) + 1 = 34$ buttons

Learner B
made an illustration

$$4+3+3+3+3+3+3+3+3+3+3$$

$$2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \quad 10 \quad 11$$

and added
 $4+3+3+3+3+3+3+3+3+3+3 = 34$ buttons

Figure 3. The Button Task. Summarized from Grades 5-6 Numeric Patterning Video Lesson: <http://www.insidemathematics.org.>

and Testing Hypotheses; and Cues, Questions, and Advance Organizers.¹¹ Teachers will find it helpful to review these practices periodically, since they are foundational classroom strategies in developing the CCSS Mathematical Practices.

During each marking period, teachers can also incorporate several activities into their lessons that engage students in mathematical discussions, during which they use some or all of the CCSS Mathematical Practices and thereby deepen the students’ understanding of the mathematics embedded in various tasks. A number of resources online provide assistance. On the Inside Mathematics site, the Problem of the Month link is particularly valuable. Grouped by mathematical strand, each task is presented at multiple levels so that teachers of any grade can select the age- and skill-appropriate version of the task for their students. Look at the Math Tasks tab in the KRESA Live Binder (<http://bit.ly/MI-CCSS-M>), and follow the links to lessons from the National Council of Supervisors of Mathematics (NCSM) under the tab, Great Tasks: NCSM, and the Mathematics Assessment Project (MAP) under the tab, Grades 6-12 MAP tasks. Check out each tab, where you will find an assortment of resources to help you start implementing the Common Core. The common-core standards are found in the tab, CCSS-M Info and CCSS-M Unpacked. You can download the CCSS to your iPhone with a link in the tab, eResources (Click on CCSS Apps).

If it seems as if the CCSS-M is just piling on more work to the many things that you already have to teach your students, consider flipping your classroom. The math department at Byron High School in Minnesota decided to prepare its students for the problem-solving skills required on the SBAC assessment by using



this approach for homework.¹² Instead of lecturing about a topic and then assigning practice problems to be done outside of class, the instructors videotaped their lectures so that students could spend time during class working on their homework problems with the benefit of their teachers' help.

Teachers can adapt and transform textbook problems that do not require much mathematical thinking into a task that engages students in the Mathematical Practices. Dan Meyer explains how he changes dull mathematics lessons into engaging problems that start students reasoning about mathematics. His presentation can be seen at <http://www.youtube.com/watch?v=NWUFjb8w9Ps>. Caulfield, Harkness, and Riley reported how they transformed a traditional textbook question on finding the probabilities of a spinner from a one-right-answer problem to a two-day investigation, during which students used proportional reasoning, geometric properties, and probabilistic thinking while using what today are called the CCSS Mathematical Practices.¹³ (This article was written before the Common Core State Standards Initiative came into existence.)

Teachers need to practice the art of questioning every day because this technique is vital for developing students' understanding of the Mathematical Practices and their use of mathematical reasoning. To build up a storehouse of effective questions, insert key questions into your daily lesson plans until they automatically come to mind during instruction. NCTM has a useful two-part resource on "Asking Good Questions and Promoting Discourse" at <http://www.nctm.org/resources/content.aspx?id=25149>.

Conclusion

The Common Core Standards, implemented with the Mathematical Practices, are designed to improve the way instruction is managed for all students.¹⁴ The NAD math standards align well with the CCSS-M, and, as the elementary 2012 NAD mathematical standards have demonstrated, make it possible to integrate faith with learning mathematics a central goal of the NAD curriculum guide. The new curriculum will equip Adventist teachers to better prepare all their students for their future as members of society and of the heavenly kingdom. ✍



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