Comparing the Common Core State Standards in Mathematics and Japan's Mathematics Curriculum in the Course of Study

Introduction

Through the Common Core State Standards (CCSS) Initiative, states and territories have collaborated in the development of a common core of standards in English Language Arts and mathematics for grades kindergarten through twelve that are now being adopted by states. Designed not only for the purpose of providing strong, shared expectations, the Common Core State Standards will also allow adopting states to collectively create and share high-quality tools such as assessments, curricula, instructional materials (such as textbooks and software), and professional development programs.

As educators and policymakers review the CCSS in mathematics, they will want to consider the way these new standards compare to, and build on, existing standards in mathematics. This brief describes the comparison between the CCSS and the standards found in the Japanese Mathematics Curriculum in the Course of Study (referred to hereinafter as the "Japanese COS").

Common Core State Standards in Mathematics

The K-5 standards provide students with a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions and decimals—which help young students build the foundation to apply more demanding math concepts and procedures successfully, and move into applications. They also provide detailed guidance to teachers on how to navigate their way through knotty topics such as fractions, negative numbers, and geometry, and do so by maintaining a continuous progression from grade to grade. Having built a strong foundation in K-5, students can move to more complex work in geometry, algebra and probability and statistics in the middle grades to gain a rich preparation for high school mathematics. Students who have completed 7th grade and mastered the content and skills through the 7th grade will be well prepared for algebra in grade 8. The high school standards call on students to practice applying mathematical ways of thinking to real world issues and challenges; they prepare students to think and reason mathematically across the major strands of mathematics, including number, algebra, geometry, probability and statistics. Note that the CCSS promote rigor not simply by including advanced mathematical content, but by requiring a deep understanding of the content at each grade level, and providing sufficient focus to make that possible.

The CCSS in mathematics lay out a vision for what all students need to master to be ready for credit-bearing college mathematics courses without remediation. Some of the high school standards are designated by a (+), indicating that they are above the college- and career-ready requirement but necessary for students to take advanced mathematics courses in high school such as calculus, advanced statistics, or discrete mathematics, and to be prepared for Science, Technology, Engineering, and Mathematics (STEM) coursework in college.

The Japanese Course of Study

U.S. educators and researchers have been particularly interested in the standards and curricula used in Japan because its students have consistently performed at the highest levels on international assessments of mathematics such as the Third International Mathematics and Science Study (TIMSS) and the Programme for International Students Assessment (PISA).

Japan has a national curriculum for public education, the Course of Study or "COS," that is revised regularly, and encompasses the material required for all students through the end of elementary school as well as pathways that diverge when students are placed in different academic tracks, beginning in grade 7. Content and performance objectives for students are contained in the nation's curriculum, which is developed by the Ministry of Education.

1775 Eye Street NW • Suite 410 • Washington, DC 20006 • Phone (202) 419-1540 • www.achieve.org

For purposes of this comparison, Achieve analyzed the Japanese COS for grades 1-9 and the courses of study available to secondary students in different pathways (Mathematics I, II, A and B). Because of its quality, the Japanese COS was an important resource in the development of the CCSS.

More About the Secondary Japanese Course of Study (COS): *The three most common courses taken by students in Japan are Mathematics I, II and A. This content represents a baseline for the expectations of high school graduates in Japan, and nearly all students reach this level. Many students also take Mathematics B, which is similar to a Discrete Mathematics course in the U.S.*

Achieve's Analysis

Achieve analyzed the CCSS and the 2008 version of the Japanese COS for the primary and secondary levels to determine how they compare in terms of **rigor, coherence, and focus**. **Rigor** refers to the degree that sets of standards address key content that prepares students for success beyond high school. **Coherence** refers to whether the standards reflect a meaningful structure, revealing significant relationships among topics and suggest a logical progression of content and skills over the years. **Focus** refers to whether the standards suggest an appropriate balance in conceptual understanding, procedural skill, and problem solving with an emphasis on application and modeling; the standards should be teachable within a school year (or across four years of high school), and key ideas in a given grade or topic area should be clear. Standards that are rigorous, coherent, and focused provide better guidance to educators, students, and parents about desired learning outcomes than those that are not. Expert mathematics content analysts conducted a side-by-side comparison of the CCSS and the Japanese COS, looking particularly at the inclusion and treatment of mathematics topics at each grade level. This brief describes the findings.

Major Findings

- ☑ The CCSS and Japanese COS describe similar levels of rigor. Where grade placement discrepancies occur between the two documents, they are usually within one year of each other.
- ☑ The CCSS and the Japanese COS are comparable in their coherence and focus. Yet, there a few key differences that result in the CCSS providing greater detail and specificity.

Detailed Findings

Rigor

Both the CCSS and Japan's COS describe rigorous expectations for students. There are differences in the stages at which students are expected to know specific skills, yet, in most cases the difference is just one grade level. The differences, therefore, do not tend to make either set of standards consistently more rigorous than the other.

- ☑ **Elementary grades:** Japanese expectations for some arithmetic computations, especially during early primary years, are about one year ahead of those in the CCSS. By the end of grade four, however, the CCSS have "caught up," and both documents present substantially similar expectations. For example, both expect that students will be fluent at adding, subtracting, and multiplying with whole numbers; understand and be able to apply place value; and be able to classify simple two-dimensional geometric figures. These expectations form the basis for basic mathematical understanding in elementary school.

1775 Eye Street NW • Suite 410 • Washington, DC 20006 • Phone (202) 419-1540 • www.achieve.org

- **Middle grades:** There are substantial similarities and few differences in the middle grades. Both sets of standards expect students in the middle grades to have knowledge of algebraic expressions, equations and functions. In one of many examples, both expect students to interpret linear equations in two variables as functions. There are a few differences as well. For example, Japan includes operations on polynomials and inversely proportional relationships at grade 8 while the CCSS do not address these concepts until high school. On the other hand, the CCSS expectations for geometry and statistics at grade 8 are more challenging than those in the Japanese COS. The CCSS include similarity, the Pythagorean Theorem and scatter plots, whereas the Japanese COS doesn't present this material until high school.

- **High school:** Expectations for algebra are also largely similar between the two documents. Both include the same set of functions—linear, quadratic, cubic, exponential, trigonometric, and logarithmic (although the brevity of language in the Japanese COS makes it difficult to know precisely how much is expected of students with respect to the trigonometric and logarithmic functions through Mathematics II). The overlap in the types of functions indicates that, like Japan, the CCSS lay the mathematical groundwork for students to be successful in more advanced mathematics, such as College Algebra. When comparisons are made between the CCSS that are beyond the college- and career-ready minimum (as designated by the (+) symbol), and the Japanese COS, the Japanese COS is found to more completely describe the content normally seen in a Calculus course. The CCSS describe content up to that which is normally found in a U.S. Pre-Calculus course.

In short, by the time students reach the college- and career-ready line in the CCSS, they will have encountered nearly all of the content found in the expectations for Japanese students below the pre-calculus level.

Coherence and Focus

Achieve's analysis indicates that the CCSS and the Japanese COS share some key traits of coherence and focus. Both the CCSS and the Japanese COS describe coherent and focused mathematics expectations through secondary school. The content expectations for each grade level in the Japanese COS are presented as general objectives with lists of topics. The CCSS are presented with more detail and specificity. They include explicit grade-level expectations for knowledge and skills. Furthermore, the level of specificity in the CCSS shows the progression of content from one grade to the next, making the coherence and the developing rigor of the content more evident. As a result, teachers who use the CCSS will be more likely to understand the expectations and how content progresses from grade to grade.

- While they are substantially similar in terms of focus, the CCSS provide greater detail about the conceptual knowledge that complements necessary skills. For example, in the 7th grade standard, the CCSS expect students to use the properties of operation in working with expressions, "Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients." On this topic the Japanese COS is less specific, stating in the Lower Secondary Grade 1 (Grade 7) standard that students will "be able to add and subtract simple linear expressions."As a result, teachers who use the CCSS will have greater guidance through the standards themselves regarding both the content and skills students should learn.

- Both the CCSS and the Japanese COS describe the development of algebraic reasoning in similar ways. Both emphasize the role of the properties of numbers and arithmetic in the primary grades as an entrée to developing understanding of algebraic rules (expressions and equations). The Common Core State Standards focus on the properties of operations[1] and the construction of simple number sentences with unknown values, beginning in grade 1, as a way of gradually preparing students for algebraic thinking.

In short, the Common Core State Standards and the Japanese COS share many key traits of coherence and focus. Differences are found in the level of detail and specificity each document uses to describe expectations, making the CCSS potentially more useful to teachers.

1 Associativity and commutativity of addition and multiplication, distributivity of multiplication over addition, the additive identity property of 0, and the multiplicative identity property of 1.

1775 Eye Street NW • Suite 410 • Washington, DC 20006 • Phone (202) 419-1540 • www.achieve.org

Conclusion

Overall, the CCSS and the Japanese COS identify substantially similar bodies of content and are largely well aligned. There are some differences between the two documents in when they introduce particular material, but these differences are usually within one grade level. Policymakers can be assured that in adopting the CCSS, they will be setting learning expectations for students that are on par with those set by the Japanese COS.

Achieve is a bipartisan, nonprofit education reform organization that has worked with states, individually and through the 35-state American Diploma Project, for over a decade to ensure that state K-12 standards, graduation requirements, assessments and accountability systems are calibrated to graduate students from high school ready for college, careers and life. Achieve partnered with NGA and CCSSO on the Common Core State Standards Initiative and a number of its staff and consultants served on writing and review teams. Achieve thanks the Brookhill Foundation for its generous support in making this brief available, and providing educators and policymakers across the nation with a way to more deeply understand the CCSS through comparison to other well-known mathematics expectations. For more information about Achieve, visit www.achieve.org

1775 Eye Street NW • Suite 410 • Washington, DC 20006 • Phone (202) 419-1540 • www.achieve.org