PARCC Model Content Frameworks

Mathematics

Grade 8

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Examples of Key Advances from Grade 7 to Grade 8

- Students build on previous work with proportional relationships, unit rates, and graphing to connect these ideas and understand that the points (x, y) on a nonvertical line are the solutions of the equation $y = mx + b$, where m is the slope of the line as well as the unit rate of a proportional relationship (in the case $b = 0$). Students also formalize their previous work with linear relationships by working with functions — rules that assign to each input exactly one output.

- By working with equations such as $x^2 = 2$ and in geometric contexts such as the Pythagorean theorem, students enlarge their concept of number beyond the system of rationals to include irrational numbers. They represent these numbers with radical expressions and approximate these numbers with rationals.

Fluency Expectations or Examples of Culminating Standards

8.EE.7 Students have been working informally with one-variable linear equations since as early as kindergarten. This important line of development culminates in grade 8 with the solution of general one-variable linear equations, including cases with infinitely many solutions or no solutions as well as cases requiring algebraic manipulation using properties of operations. Coefficients and constants in these equations may be any rational numbers.

8.G.9 When students learn to solve problems involving volumes of cones, cylinders, and spheres — together with their previous grade 7 work in angle measure, area, surface area and volume (7.G.4–6) — they will have acquired a well-developed set of geometric measurement skills. These skills, along with proportional reasoning (7.RP) and multistep numerical problem solving (7.EE.3), can be combined and used in flexible ways as part of modeling during high school — not to mention after high school for college and careers.[1]

Examples of Major Within-Grade Dependencies

- An important development takes place in grade 8 when students make connections between proportional relationships, lines, and linear equations (8.EE, **second cluster**). Making these connections depends on prior grades' work, including 7.RP.2 and 6.EE.9. There is also a major dependency within grade 8 itself: The angle-angle criterion for triangle similarity underlies the fact that a nonvertical line in the coordinate plane has equation $y = mx + b$.[2] Therefore, students must do work with congruence and similarity (8.G.1–5) before they are able to justify the connections among proportional relationships, lines, and linear equations. Hence the indicated

[1] See "Appendix A: Lasting Achievements in K–8."

[2] See page 12 of the *Progression for Expressions and Equations:* http://commoncoretools.files.wordpress.com/2011/04/ccss_progression_ee_2011_04_25.pdf.

geometry work should likely begin at or near the very start of the year.[3]

- Much of the work of grade 8 involves lines, linear equations, and linear functions (8.EE.5–8; 8.F.3–4; 8.SP.2–3). Irrational numbers, radicals, the Pythagorean theorem, and volume (8.NS.1–2; 8.EE.2; 8.G.6–9) are nonlinear in nature. Curriculum developers might choose to address linear and nonlinear bodies of content somewhat separately. An exception, however, might be that when addressing functions, pervasively treating linear functions as separate from nonlinear functions might obscure the concept of function *per se*. There should also be sufficient treatment of nonlinear functions to avoid giving students the misleading impression that all functional relationships are linear (see also 7.RP.2a).

Examples of Opportunities for Connections among Standards, Clusters or Domains

- Students' work with proportional relationships, lines, linear equations, and linear functions can be enhanced by working with scatter plots and linear models of association in bivariate measurement data (8.SP.1–3).

Examples of Opportunities for In-Depth Focus

8.EE.5 When students work toward meeting this standard, they build on grades 6–7 work with proportions and position themselves for grade 8 work with functions and the equation of a line.

8.EE.7 This is a culminating standard for solving one-variable linear equations.

8.EE.8 When students work toward meeting this standard, they build on what they know about two-variable linear equations, and they enlarge the varieties of real-world and mathematical problems they can solve.

8.F.2 Work toward meeting this standard repositions previous work with tables and graphs in the new context of input/output rules.

8.G.7 The Pythagorean theorem is useful in practical problems, relates to grade-level work in irrational numbers and plays an important role mathematically in coordinate geometry in high school.

Examples of Opportunities for Connecting Mathematical Content and Mathematical Practices

Mathematical practices should be evident *throughout* mathematics instruction and connected to all of the content areas highlighted above, as well as all other content areas addressed at this grade level. Mathematical tasks (short, long, scaffolded, and unscaffolded) are an important opportunity to connect content and practices. Some brief examples of how the content of this grade might be connected to the practices follow.

[3] Note that the Geometry cluster "Understand congruence and similarity using physical models, transparencies or geometry software" supports high school work with congruent triangles and congruent figures.

- When students convert a fraction such as $1/7$ to a decimal, they might notice that they are repeating the same calculations and conclude that the decimal repeats. Similarly, by repeatedly checking whether points are on a line through (1, 2) with slope 3, students might abstract the equation of the line in the form $(y - 2)/(x - 1) = 3$. In both examples, students look for and express regularity in repeated reasoning (MP.8).

- The Pythagorean theorem can provide opportunities for students to construct viable arguments and critique the reasoning of others (e.g., if a student in the class seems to be confusing the theorem with its converse) (MP.3).

- Solving an equation such as $3(x - 1/2) = x + 2$ requires students to see and make use of structure (MP.7).

- Much of the mathematics in grade 8 lends itself to modeling (MP.4). For example, standard 8.F.4 involves modeling linear relationships with functions.

- Scientific notation (8.EE.4) presents opportunities for strategically using appropriate tools (MP.5). For example, the computation $(1.73 \times 10^{-4}) \cdot (1.73 \times 10^{-5})$ can be done quickly with a calculator by squaring 1.73 and then using properties of exponents to determine the exponent of the product by inspection.

Content Emphases by Cluster

Not all of the content in a given grade is emphasized equally in the standards. Some clusters require greater emphasis than the others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. In addition, an intense focus on the most critical material at each grade allows depth in learning, which is carried out through the Standards for Mathematical Practice.

To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting material will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade. All standards figure in a mathematical education and will therefore be eligible for inclusion on the PARCC assessment. However, the assessments will strongly focus where the standards strongly focus.

In addition to identifying the Major, Additional, and Supporting Clusters for each grade, suggestions are given following the table on the next page for ways to connect the Supporting to the Major Clusters of the grade. Thus, rather than suggesting even inadvertently that some material not be taught, there is direct advice for teaching it, in ways that foster greater focus and coherence.

Key: ■ Major Clusters; ▣ Supporting Clusters; ○ Additional Clusters

The Number System

▣ Know that there are numbers that are not rational, and approximate them by rational numbers.

Expressions and Equations

■ Work with radicals and integer exponents.

■ Understand the connections between proportional relationships, lines and linear equations.

■ Analyze and solve linear equations and pairs of simultaneous linear equations.

Functions

■ Define, evaluate and compare functions.

■ Use functions to model relationships between quantities.

Geometry

■ Understand congruence and similarity using physical models, transparencies or geometry software.

■ Understand and apply the Pythagorean Theorem.

○ Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.

Statistics and Probability

▣ Investigate patterns of association in bivariate data.

Examples of Linking Supporting Clusters to the Major Work of the Grade

- Know that there are numbers that are not rational, and approximate them by rational numbers: Work with the number system in this grade (8.NS.1–2) is intimately related to work with radicals (8.EE.2), and both of these may be connected to the Pythagorean theorem (8.G, **second cluster**) as well as to volume problems (8.G.9), e.g., in which a cube has known volume but unknown edge lengths.

- Use functions to model relationships between quantities: The work in this cluster involves functions for modeling linear relationships and rate of change/initial value, which supports work with proportional relationships and setting up linear equations.

- Investigate patterns of association in bivariate data: Looking for patterns in scatterplots and using linear models to describe data are directly connected to the work in the Expressions and Equations clusters. Together, these represent a connection to the Standard for Mathematical Practice, MP.4: Model with mathematics.