Ohio's New Learning Standards for Mathematics

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Ohio | Department of Education

Opportunities in the Common Core State Standards for Mathematics

Ohio Student Success Summit
April 24, 2015

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Brief History of Standards

- 1989: Standards released by the National Council of Teachers of Mathematics
- Early 1990s: States developed standards in various subjects
- 2001: No Child Left Behind Act required state standards and assessments in English language arts (ELA), mathematics, and (later) science
- 2000s: Growing recognition:
  - State standards were shallow and repetitive
  - State standards varied widely in quality, rigor, and topics
  - State standards were not preparing students for college and careers
  - Most careers will require some post-secondary training
  - Not enough progress compared to international peers

Brief History of Standards (cont.)

- 2007: Governors and state superintendents began discussing shared standards across interested states
- 2009: Common Core State Standards Initiative launched
  - 48 states participated in the development of standards in ELA and mathematics
  - Broad, bipartisan effort
- 2010: Common Core State Standards released
  - Ohio adopted the Common Core in June 2010 along with Ohio's own standards in science and social studies
  - By late 2011, Common Core adopted by 45.5 states and the District of Columbia

Shifts in Mathematics

1

Focus

- Identifies key ideas, understandings and skills for each grade or course
- Stresses deep learning, which means applying concepts and skills within the same grade or course

Shifts in Mathematics

2

Coherence

- Progressions of learning within and across grades
- Concepts and skills that are developed over a defined period of time

Shifts in Mathematics

3

Rigor

- the standards highlight conceptual understanding,
- procedural skill and fluency, and
- application

Mathematical Practices

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

Standards Domain Progression

<table>
<tr><th>K</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>HS</th></tr>
<tr><td>Counting & Cardinality</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Number and Operations in Base Ten</td><td colspan="2">Ratios and Proportional Relationships</td><td></td><td rowspan="2">Number & Quantity</td></tr>
<tr><td colspan="3"></td><td colspan="3">Number and Operations – Fractions</td><td colspan="3">The Number System</td></tr>
<tr><td colspan="6" rowspan="2">Operations and Algebraic Thinking</td><td colspan="3">Expressions and Equations</td><td>Algebra</td></tr>
<tr><td colspan="2"></td><td>Functions</td><td>Functions</td></tr>
<tr><td colspan="9">Geometry</td><td>Geometry</td></tr>
<tr><td colspan="6">Measurement and Data</td><td colspan="3">Statistics and Probability</td><td>Statistics & Probability</td></tr>
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High School Mathematical Pathways

Typical in U.S.

- **Two main pathways:**
  - **Traditional: Two algebra courses and a geometry course, with statistics and probability in each**
  - **Integrated: Three courses, each of which includes algebra, geometry, statistics, and probability**

Typical outside U.S.

- **Both pathways:**
  - **Complete the Ohio's Learning Standards in the third year**
  - **Include the same "critical areas"**
  - **Require rethinking high school mathematics**
  - **Prepare students for a menu of fourth-year courses**

Mathematics Curriculum Requirements

- Four High School Credits/Units
- Algebra II or its Equivalent

Content Shifts

Common Core State Standards for Mathematics

K-8 Content Shifts

- Primary focus on number in grades K-5
- Fractions as numbers on the number line, beginning with unit fractions
- Fluency with standard algorithms, supported by strategies based in place value and properties of operations
- Much statistics in grade 6-8
- Much algebra and geometry in grades 7-8

High School Content Shifts

- Number and quantity
  - Number systems, attention to units
- Modeling
  - Threaded throughout the standards
- Geometry
  - Proof for all, transformations
- Algebra and functions
  - Organized by mathematical practices
- Statistics and probability
  - Inference for all, based on simulation

New Perspectives on Familiar Content

Pythagorean Theorem

- 8.G.6. Explain a proof of the Pythagorean theorem and its converse.
- 8.G.8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
- G-SRT.4. Prove theorems about triangles. *Theorems include … the Pythagorean Theorem proved using triangle similarity.*
- G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
- G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem …
- F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to calculate trigonometric ratios.

- *The Pythagorean Theorem is not just "$a^2 + b^2 = c^2$."*

Sequences as Functions

- F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
- F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.★
- F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

- *Emphasize connections among patterns, sequences, and functions.*

Rules of Exponents

- 8.EE.1. Know and apply the properties of integer exponents to generate equivalent numerical expressions.
- N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

- *These ideas support many HS standards on exponential functions.*

Solving Equations

- 8.EE.7.a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
- A-REI.A. Understand solving equations as a process of reasoning and explain the reasoning
- A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$;

- *This last standard supports the many different techniques for solving different types of equations.*

Seeing Structure in Expressions

- A-SSE.1. Interpret expressions that represent a quantity in terms of its context.
- A-SSE.2. Use the structure of an expression to identify ways to rewrite it.
- A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

- *"Simplest form" depends on the purpose.*
- Reason generally with specific numbers
- See specific numbers in general expressions

Content Shifts in Grade 7 and Earlier

- Unit fractions, fractions as numbers on the number line
- Area models for multiplication
- Proportional relationships
  - Unit rates, graphs, tables, formulas, contexts
  - Compare with non-proportional relationships
- Use properties of operations to explain operations with rational numbers

Closing Points

- Too few high school and college graduates are mathematically literate
  - Few students use algebra or geometry to support reasoning
- We need to work together, across high school and higher education
  - None of us are broadly successful
  - Every one of us has ideas to contribute
- Consider careers and client disciplines
  - Employers and faculty outside of mathematics departments value the Standards for Mathematical Practice (see David Conley's work)

Mathematics Resources

- Model Curriculum
- Transition Tools
- Professional Development
- PARCC Math
- Math Pearltrees
- FAQs

Model Curriculum

- Content Elaborations
- Expectations for Learning

- Instructional Strategies
- Instructional Resources and Tools
- Common Misconceptions
- Diverse Learners
- Connections

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