A Closer Look at the Common Core Standards for Mathematics

Exploring the Domain Progressions in Grades K–8

Tool Kit 2
Expected Outcomes

- Build understanding of the mathematical concepts within each domain and how they progress across grades.
- Build understanding of the coherence in the standards.
- Discuss how the progressions in the standards can be used to inform teaching and learning.
Principle #1: Increases in student learning occur only as a consequence of improvements in the level of content, teachers’ knowledge and skill, and student engagement.

Principle #2: If you change one element of the instructional core, you have to change the other two.

Richard Elmore, Ph.D., Harvard Graduate School of Education
For over a decade, research studies of mathematics education in high-performing countries have pointed to the conclusion that the mathematics curriculum in the United States must become substantially more focused and coherent in order to improve mathematics achievement in this country. To deliver on the promise of common standards, the standards must address the problem of a curriculum that is ‘a mile wide and an inch deep.’

- Common Core State Standards for Mathematics, page 3
Coherence

Content standards and curricula are coherent if they are ... articulated over time as a sequence of topics and performances that are logical and reflect ... the sequential or hierarchical nature of the disciplinary content ...

What and how students are taught should reflect not only the topics that fall within a certain academic discipline, but also the key ideas that determine how knowledge is organized and generated within that discipline.

- Common Core State Standards for Mathematics, page 3
These Standards endeavor to follow such a design, not only by stressing conceptual understanding of key ideas, but also by continually returning to organizing principles such as place value or the laws of arithmetic to structure those ideas.

- Common Core State Standards for Mathematics, page 4
For each grade level from kindergarten through grade 8, the Critical Areas outline the essential mathematical ideas for each grade level.

Mathematics | Grade 2

In Grade 2, instructional time should focus on four critical areas: (1) extending understanding of base-ten notation; (2) building fluency with addition and subtraction; (3) using standard units of measure; and (4) describing and analyzing shapes.

(1) Students extend their understanding of the base-ten system. This includes ideas of counting in fives, tens, and multiples of hundreds, tens, and ones, as well as number relationships involving these units, including comparing. Students understand multi-digit numbers (up to 1000) written in base-ten notation, recognizing that the digits in each place represent amounts of thousands, hundreds, tens, or ones (e.g., 853 is 8 hundreds + 5 tens + 3 ones).

(2) Students use their understanding of addition to develop fluency with addition and subtraction within 100. They solve problems within 1000 by applying their understanding of models for addition and subtraction, and they develop, discuss, and use efficient, accurate, and generalizable methods to compute sums and differences of whole numbers in base-ten notation, using their understanding of place value and the properties of operations. They select and accurately apply methods that are appropriate for the context and the numbers involved to mentally calculate sums and differences for numbers with only tens or only hundreds.

(3) Students recognize the need for standard units of measure (centimeter and inch) and they use rulers and other measurement tools with the understanding that linear measure involves an iteration of units. They recognize that the smaller the unit, the more iterations they need to cover a given length.

(4) Students describe and analyze shapes by examining their sides and angles. Students investigate, describe, and reason about decomposing and combining shapes to make other shapes. Through building, drawing, and analyzing two- and three-dimensional shapes, students develop a foundation for understanding area, volume, congruence, similarity, and symmetry in later grades.
Grade 2 Overview

Operations and Algebraic Thinking

- Represent and solve problems involving addition and subtraction.
- Add and subtract within 20.
- Work with equal groups of objects to gain foundations for multiplication.

Number and Operations in Base Ten

- Understand place value.
- Use place value understanding and properties of operations to add and subtract.

Measurement and Data

- Measure and estimate lengths in standard units.
- Relate addition and subtraction to length.
- Work with time and money.
- Represent and interpret data.

Geometry

- Reason with shapes and their attributes.

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.
Represent and solve problems involving addition and subtraction.

1. Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.

Add and subtract within 20.

2. Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.

Work with equal groups of objects to gain foundations for multiplication.

3. Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.

4. Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends.
## Domains for K-8

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# Domains for K-8

## Common Core State Standards – Mathematics

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Ohio Department of Education (12/14/10)
Review the clusters of standards within the domain.

Start with the lowest grade for which the domain begins and cut out each cluster of standards.

Start with one cluster and explore how the concept progresses through the grades. How does the concept change and increase in rigor and complexity for the student?

Use arrows and identify new concepts that are introduced in subsequent grades and follow them through the years.

Use different color and highlight the verbs that describe how each concept or standard progresses from one year to the next.
Progression of Overviews

Grade K Overview
Counting and Cardinality
- Know number names and the count sequence.
- Count to tell the number of objects.
- Compare numbers.

Operations and Algebraic Thinking
- Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

Number and Operations in Base Ten
- Work with numbers 11-19 to gain foundations for place value.

Measurement and Data
- Describe and compare measurable attributes.
- Classify objects and count the number of objects in categories.

Geometry
- Identify and describe shapes.
- Analyze, compare, create, and compose shapes.

Grade 1 Overview
Operations and Algebraic Thinking
- Represent and solve problems involving addition and subtraction.
- Understand and apply properties of operations and the relationship between addition and subtraction.
- Add and subtract within 20.
- Work with addition and subtraction equations.

Number and Operations in Base Ten
- Extend the counting sequence.
- Understand place value.
- Use place value understanding and properties of operations to add and subtract.

Measurement and Data
- Measure lengths indirectly and by iterating length units.
- Tell and write time.
- Represent and interpret data.

Geometry
- Reason with shapes and their attributes.

Grade 2 Overview
Operations and Algebraic Thinking
- Represent and solve problems involving addition and subtraction.
- Understand properties of operations and the relationship between multiplication and division.
- Add and subtract within 100.
- Work with equal groups of objects to gain foundations for multiplication.

Number and Operations in Base Ten
- Use place value understanding and properties of operations to perform multi-digit arithmetic.

Measurement and Data
- Measure and estimate lengths in standard units.
- Relate addition and subtraction to length.
- Work with time and money.
- Represent and interpret data.

Geometry
- Reason with shapes and their attributes.

Grade 3 Overview
Operations and Algebraic Thinking
- Represent and solve problems involving multiplication and division.
- Understand properties of multiplication and the relationship between multiplication and division.
- Multiply and divide within 100.
- Solve problems involving the four operations, and identify and explain patterns in arithmetic.

Number and Operations in Base Ten
- Generalize place value understanding for multi-digit whole numbers.
- Use place value understanding and properties of operations to perform multi-digit arithmetic.

Measurement and Data
- Measure and estimate lengths in standard units.
- Relate addition and subtraction to length.
- Work with time and money.
- Represent and interpret data.

Geometry
- Reason with shapes and their attributes.

Grade 4 Overview
Operations and Algebraic Thinking
- Use the four operations with whole numbers to solve problems.
- Gain familiarity with factors and multiples.
- Generate and analyze patterns.

Number and Operations in Base Ten
- Understand the place value system.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.

Number and Operations—Fractions
- Use equivalent fractions as a strategy to add and subtract fractions.
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Measurement and Data
- Convert like measurement units within a given measurement system.
- Represent and interpret data.

Geometry
- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Classify two-dimensional figures into categories based on their properties.

Grade 5 Overview
Operations and Algebraic Thinking
- Write and interpret numerical expressions.
- Analyze patterns and relationships.

Number and Operations in Base Ten
- Understand the place value system.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.

Number and Operations—Fractions
- Use equivalent fractions as a strategy to add and subtract fractions.
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Measurement and Data
- Convert like measurement units within a given measurement system.
- Represent and interpret data.

Geometry
- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Classify two-dimensional figures into categories based on their properties.
Progression of Overviews

**Grade K Overview**
- Counting and Cardinality
  - Know number names and the count sequence.
  - Count to tell the number of objects.
  - Compare numbers.

**Grade 1 Overview**
- Operations and Algebraic Thinking
  - Represent and solve problems involving addition and subtraction.
  - Understand and apply properties of operations and the relationship between addition and subtraction.
  - Add and subtract within 20.
  - Work with addition and subtraction equations.

**Grade 2 Overview**
- Operations and Algebraic Thinking
  - Represent and solve problems involving addition and subtraction.
  - Add and subtract within 20.
  - Work with equal groups of objects to gain foundations for multiplication.

**Number and Operations in Base Ten**
- Understand place value.
- Use place value understanding and properties of operations to add and subtract.

**Measurement and Data**
- Measure and estimate lengths in standard units.
- Relate addition and subtraction to length.
- Work with time and money.
- Represent and interpret data.

**Geometry**
- Reason with shapes and their attributes.
Small Group Discussion

- Where are each of your students in the progression?
- What supports can you use to accelerate learning of students in an effort to bring their understandings and skills to the appropriate level or to go deeper into the content?
- What connections can you find between this domain and the other domains?
Whole Group Discussion

- What are your general impressions of how the content progresses from one grade to the next?
- To what extent do the standards in the domain address the concept of coherence?
- What are some common student misconceptions within this domain?
- How would you use the ideas you explored in this session to inform student assessment and your instruction?
… the ‘sequence of topics and performances’ that is outlined in a body of mathematics standards must also respect what is known about how students learn.

… developing ‘sequenced obstacles and challenges for students … absent the insights about meaning that derive from careful study of learning, would be unfortunate and unwise.’ In recognition of this, the development of these Standards began with research-based learning progressions detailing what is known today about how students’ mathematical knowledge, skill, and understanding develop over time.
One promise of common state standards is that over time they will allow research on learning progressions to inform and improve the design of standards to a much greater extent than is possible today.

- Common Core State Standards for Mathematics, page 5
Expected Outcomes

- Build understanding of the mathematical concepts within each domain and how they progress across grades.
- Build understanding of the coherence in the standards.
- Discuss how the progressions in the standards can be used to inform teaching and learning.
Revisit the meaning of “coherence.” To what extent does the domain you explored bring coherence to the standards?

How will your knowledge of the standards progression in this domain inform your curriculum and guide your instruction?

What questions do you still have about this domain?

How has this activity increased your understanding of the instructional core?
Module 1: A Closer Look at the Common Core State Standards for Mathematics

High School Session

Exploring Standard Progressions across High School Courses

Tool Kit 2
In this session you will

- Participants will continue to build understanding of the model pathways for high school courses (continues from sessions 1 & 2)
- Participants will better understand how the standards can be organized into a 3 year high school sequence
- Participants will begin to understand their content responsibilities within a potentially new course structure
Principle #1: Increases in student learning occur only as a consequence of improvements in the level of content, teachers’ knowledge and skill, and student engagement.

Principle #2: If you change one element of the instructional core, you have to change the other two.

Richard Elmore, Ph.D., Harvard Graduate School of Education
Reminder ...

- **Conceptual categories**: themes that connect mathematics across high school, and contain a set of domains
  - **Domains**: overarching “big ideas” that connect topics across high school courses
  - **Clusters**: groups of standards that describe coherent aspects of the content category within a domain
  - **Standards**: define what students should know and be able to do at each grade level
- **Critical Areas**: units that organize the standards within courses as recommend in Appendix A
## K-HS Standards Progressions

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Ohio Department of Education (12/14/10)
Remember...

- The course structures in Appendix A illustrate possible approaches—*models, not mandates*.
- The standards are *required*, however the organization and course structure are not.
- In Appendix A there are pages that show how standards are organized within each course.
- There are also pages that show how the standards are organized over three years of courses.
Courses in higher level mathematics: Precalculus, Calculus*, Advanced Statistics, Discrete Mathematics, Advanced Quantitative Reasoning, or courses designed for career technical programs of study.

Traditional Pathway
Typical in U.S.

Integrated Pathway
Typical outside of U.S.
Overview of the Traditional Pathway for the Common Core State Mathematics Standards

This table shows the domains and clusters in each course in the Traditional Pathway. The standards from each cluster included in that course are listed below each cluster. For each course, limits and focus for the clusters are shown in italics.

<table>
<thead>
<tr>
<th>Domains</th>
<th>HS Algebra I</th>
<th>Geometry</th>
<th>Algebra II</th>
<th>Fourth Courses</th>
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<tbody>
<tr>
<td><strong>The Real Number System</strong></td>
<td>• Extend the properties of exponents to rational exponents. N.RN.1, 2</td>
<td>• Use properties of rational and irrational numbers. N.RN.3</td>
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<td><strong>Quantities</strong></td>
<td>• Reason quantitatively and use units to solve problems. Foundation for work with expressions, equations and functions N.Q.1, 2, 3</td>
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<td><strong>The Complex Number System</strong></td>
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<td>• Perform arithmetic operations with complex numbers. N.CN.1, 2</td>
<td>• Perform arithmetic operations with complex numbers. (+) N.CN.3</td>
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<td>• Use complex numbers in polynomial identities and equations. Polynomials with real coefficients N.CN.7, (+) 8, (+) 9</td>
<td>• Represent complex numbers and their operations on the complex plane. (+) N.CN.4, 5, 6</td>
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Standards identified within the course
### Overview of Traditional Pathway (Algebra 1, Geometry, Algebra 2)

<table>
<thead>
<tr>
<th>Domains</th>
<th>High School Algebra I</th>
<th>Geometry</th>
<th>Algebra II</th>
<th>Fourth Courses</th>
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</table>
| Seeing Structure in Expressions | • Interpret the structure of expressions.  
  *Linear, exponential, quadratic*  
  A.SSE.1a, 1b, 2  
  • Write expressions in equivalent forms to solve problems.  
  *Quadratic and exponential*  
  A.SSE.3a, 3b, 3c | | • Interpret the structure of expressions.  
  *Polynomial and rational*  
  A.SSE.1a, 1b, 2  
  • Write expressions in equivalent forms to solve problems.  
  A.SSE.4 | | |
| Algebra | • Perform arithmetic operations on polynomials.  
  *Linear and quadratic*  
  A.APR.1 | | • Perform arithmetic operations on polynomials.  
  *Beyond quadratic*  
  A.APR.1  
  • Understand the relationship between zeros and factors of polynomials.  
  A.APR.2, 3  
  • Use polynomial identities to solve | | |
Overview of Integrated Pathway (Math I, Math II, Math III)

This table shows the domains and clusters in each course in the Integrated Pathway. The standards from each cluster included in that course are listed below each cluster. For each course, limits and focus for the clusters are shown in italics.

<table>
<thead>
<tr>
<th>Domains</th>
<th>Mathematics I</th>
<th>Mathematics II</th>
<th>Mathematics III</th>
<th>Fourth Courses</th>
</tr>
</thead>
</table>
| The Real Number System | • Extend the properties of exponents to rational exponents.  
  N.RN.1, 2  
  • Use properties of rational and irrational numbers.  
  N.RN.3 |                                                      |                                                      |                |
| Quantities             | • Reason quantitatively and use units to solve problems.  
  Foundation for work with expressions, equations and functions  
  N.Q.1, 2, 3 |                                                      |                                                      |                |
| The Complex Number System | • Perform arithmetic operations with complex numbers.  
  i as highest power of i  
  N.CN.1, 2  
  • Use complex numbers in polynomial identities and equations.  
  Quadratics with real coefficients  
  N.CN.7, (+) 8, (+) 9 | • Use complex numbers in polynomial identities and equations.  
  Polynomials with real coefficients; apply N.CN.9 to higher degree polynomials  
  (+) N.CN.8, 9 | • Perform arithmetic operations with complex numbers.  
  (+) N.CN.3  
  • Represent complex numbers and their operations on the complex plane.  
  (+) N.CN.4, 5, 6 |                |

Standards identified within the course
<table>
<thead>
<tr>
<th>Domains</th>
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<th>Fourth Courses</th>
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</thead>
</table>
| Seeing Structure in Expressions | • Interpret the structure of expressions.  
  *Linear expressions and exponential expressions with integer exponents*  
  A.SSE.1a, 1b | • Interpret the structure of expressions.  
  *Quadratic and exponential*  
  A.SSE.1a, 1b, 2 | • Interpret the structure of expressions.  
  *Polynomial and rational*  
  A.SSE.1a, 1b, 2 | • Write expressions in equivalent forms to solve problems.  
  *Quadratic and exponential*  
  A.SSE.3a, 3b, 3c |
| Algebra                | • Perform arithmetic operations on polynomials.  
  *Polynomials that simplify to quadratics*  
  A.APR.1 | • Perform arithmetic operations on polynomials.  
  *Beyond quadratic*  
  A.APR.1 | • Understand the relationship between zeros and factors of polynomials.  
  A.APR.2, 3 | |
Progression Mapping Activity

Now it is your turn to begin the process of creating your own course structure

Goals for the Activity:

- To understand how the content within a conceptual category progresses over high school courses
- Begin the process of outlining a high school course structure in which addresses all of the CCSSM content in 3 years (or 4 years with advanced (+) content)
**Progression Mapping Activity**

Choose a cluster to examine

Identify when standards within the cluster would be taught (e.g. N.RN.1, N.RN.2, etc.)

Use the notes section to give further details if needed

Identify additional (+) content as needed

*Remember all non (+) content must be addressed by the end of the 3rd year*

Use the final column to record instructional notes about the given standards progression
Small group discussion questions

- What standards are addressed within the cluster if it spans multiple courses?
- Were all the clusters identified in your critical area matching activity? Were there clusters that were not identified that need to be addressed?
- What advanced content (+) may need to be included in the first three years?
- What are one or two major challenges in implementing the courses you have described?
Highlighting Activity

**GREEN HIGHLIGHT**: Content is similar to what is currently taught in my course

**YELLOW HIGHLIGHT**: Content is not necessarily taught in my course, but it could be added easily

**RED HIGHLIGHT**: Content is new to my course, and I would need support (e.g. instructional and/or materials) to teach this content effectively
Whole Group Discussion: Compare & Contrast

- How are the new content progressions similar to what is currently being taught?

- What content can be added in easily? (e.g. know how to teach it and resources are relatively available)

- What content will take more to implement? (e.g. more professional development, finding supplemental resources, etc)
Whole Group Discussion: Needed Knowledge & Support

What K-8 skills will students need to be successful in the described progression?

What type of support and/or remediation can you anticipate students needing during the transition to the new standards?

What information would you need to know about the K-8 content to prepare for the transition?
Reflection Questions

How will your knowledge of the standards in the model courses inform your curriculum and guide your instruction?

What will be some major changes?

What questions do you still have about course structure?
In the case of either the Traditional or Typical Pathways, students would need to successfully complete all three courses – and should be encouraged to study mathematics through the end of their senior year in ensure readiness for credit-bearing, college mathematics.