Connect the Dots: Promote Mathematical Power with Thoughtful Curriculum Alignment

Grades 3-8
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With slides from isbe and a variety of resources
Let’s talk!
New Illinois Learning Standards

formerly

Common Core State Standards
For Mathematics
Key Shifts

Focus

Coherence

Rigor
Two Kinds of Alignment

1. Alignment **with** the Standards
2. Alignment **across** the grades
Aligning Curriculum – the Next Step

We have: Awareness of New Illinois Learning Standards (Common Core) expectations for specific grades

We need: Greater appreciation of how mathematical concepts develop across the grades
Alignment Across the Grades

One strand, across grades 3-8:

Multiplicative Reasoning
How would you answer these questions?

• If you travel to a foreign country, you exchange dollars for the currency used there. In England you could exchange $3 for 2 £. How many pounds could you exchange for $21?

• Sue and Julie were running equally fast around a track. Sue started first. When she had run nine laps, Julie had run three laps. When Julie had completed fifteen laps, how many laps had Sue run?
Foreign Currency

If you travel to a foreign country, you exchange dollars for the currency used there. In England you could exchange $3 for 2 £. How many pounds could you exchange for $21?

$3 = 2 £
$21  14 £
Running Laps

Sue and Julie were running equally fast around a track. Sue started first. When she had run nine laps, Julie had run three laps. When Julie had completed fifteen laps, how many laps had Sue run?

- Sue 9 laps
- Julie 3 laps
Running Laps

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Sue 9 laps 9 = ?
Julie 3 laps 3 15
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Sue 9 laps
Julie 3 laps
Sue ???
Julie 15 laps
Running Laps

Sue and Julie were running equally fast around a track. Sue started first. When she had run nine laps, Julie had run three laps. When Julie had completed fifteen laps, how many laps had Sue run?

- Sue 9 laps
- Julie 3 laps
- Sue 21 laps
- Julie 15 laps
### Key Areas of Focus in Mathematics

<table>
<thead>
<tr>
<th>Grade</th>
<th>Focus Areas in Support of Rich Instruction and Expectations of Fluency and Conceptual Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>K–2</td>
<td>Addition and subtraction – concepts, skills, and problem solving and place value</td>
</tr>
<tr>
<td>3–5</td>
<td>Multiplication and division of whole numbers, and fractions – concepts, skills, and problem solving</td>
</tr>
<tr>
<td>6</td>
<td>Ratios and proportional reasoning; early expressions and equations</td>
</tr>
<tr>
<td>7</td>
<td>Ratios and proportional reasoning; arithmetic of rational numbers</td>
</tr>
<tr>
<td>8</td>
<td>Linear algebra</td>
</tr>
</tbody>
</table>
Tasks

• Consider each task on p. 1-2.
• Decide on the grade where the task fits best.
• If you have time consider how you would justify your decisions.
Tasks

• A: Fractions and Rectangles
• B: Volume and the Associative Property of Multiplication
• C: Naming the Whole For a Fraction
• D: Jog-A-Thon
• E: Gifts from Grandma, Var. 1
• F: Comparing Money Raised
• G: Fruit Salad
Tasks

• B: Volume and the Associative Property of Multiplication
• E: Gifts from Grandma, Var. 1
• F: Comparing Money Raised
• G: Fruit Salad
1. Juanita spent $9 on each of her 6 grandchildren at the fair. How much money did she spend?

2. Nita bought some games for her grandchildren for $8 each. If she spent a total of $48, how many games did Nita buy?

3. Helen spent an equal amount of money on each of her 7 grandchildren at the fair. If she spent a total of $42, how much did each grandchild get?
Task E. Gifts from Grandma, Var. 1

1. Multiplication: 6 groups of $9 = ?

2. Measurement division: $48 divided into groups of $8. How many groups of $8?

3. Partitive (sharing) division: $42 divided into 7 groups. How much in each group?
Task C: Comparing Money Raised

• Helen raised $12 for the food bank last year and she raised 6 times as much money this year. How much money did she raise this year?

• Sandra raised $15 for the PTA and Nita raised $45. How many times as much money did Nita raise as compared to Sandra?

• Luis raised $45 for the animal shelter, which was 3 times as much money as Anthony raised. How much money did Anthony raise?
Operations and Algebraic Thinking 4.OA

• A. Use the four operations with whole numbers to solve problems.

• CCSS.Math.Content.4.OA.A.2
  Multiply or divide to solve word problems involving MULTIPLICATIVE COMPARISON, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.¹
Strip Model for Comparing Money Raised

1. Helen raised $12 for the food bank last year and she raised 6 times as much money this year. How much money did she raise this year?
Strip Model for Comparing Money Raised

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Last year: $12
This year: $12 $12 $12 $12 $12 $12 $12
Strip Model for Comparing Money Raised

1. Helen raised $12 for the food bank last year and she raised 6 times as much money this year. How much money did she raise this year?

Last year: $12
This year: $12 $12 $12 $12 $12 $12

$12 $12 $12 $12 $12 $12

$12

6 x $12 = $72
3. Luis raised $45 for the animal shelter, which was 3 times as much money as Anthony raised. How much money did Anthony raise?
Similarly, . . .

3. Luis raised $45 for the animal shelter, which was 3 times as much money as Anthony raised. How much money did Anthony raise? $45
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$45

Luis: $15 $15 $15

Anthony: $15 $15 $15
Task B: Volume and the Associative Property

• Use snap cubes to build a rectangular prism that is 2 cubes on one side, 3 cubes on another, and 5 cubes on the third side.

• Explain how you can see that the rectangular prism is being made of 2 groups with 15 cubes in each. Explain how you can also see the rectangular prism is being made of 6 groups with 5 cubes in each. Does it matter which numbers you multiply first when you want to find the volume of a rectangular prism?
Task B: Volume and the Associative Property

$2 \times (3 \times 5)$

$(2 \times 3) \times 5$
Task D: Fruit Salad

• A fruit salad consists of blueberries, raspberries, grapes, and cherries. The fruit salad has a total of 280 pieces of fruit. There are twice as many raspberries as blueberries, three times as many grapes as cherries, and four times as many cherries as raspberries.

• How many cherries are there in the fruit salad?
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- B
- G
- C
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\[
\begin{align*}
R & = 2 \\
B & = 1 \\
G & = 24 \\
C & = 8
\end{align*}
\]

\[
2 + 1 + 24 + 8 = 35 \quad \text{and} \quad 280 \div 35 = 8
\]
How many cherries are there in the fruit salad?

- R 8 x 2 = 16 raspberries
- B 8 x 1 = 8 blueberries
- G 8 x 24 = 192 grapes
- C 8 x 8 = 64 cherries

\[ 16 + 8 + 192 + 64 = 280 \]
6.RP

- Understand ratio concepts and use ratio reasoning to solve problems.
- **CCSS.Math.Content.6.RP.A.1**
  Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*
Tasks

• E: Gifts from Grandma, Var. 1 – 3.OA.A.3
• F: Comparing Money Raised – 4.OA.A2
• B: Volume and the Associative Property of Multiplication – 5.MD.C.5a
• G: Fruit Salad – 6.RP.A.1
Building Multiplicative Reasoning

- Gr. 3: foundation concepts of multiplication and division
- Gr. 4: multiplicative comparison
- Gr. 5: relate associative property of multiplication to the concept of volume
- Gr. 6: expand multiplicative reasoning in context of ratio and proportion
Number and Operations – Fraction 3-5

• Logical Extension of
  – Counting and Cardinality, K – Operations and Algebraic Thinking K-5 and
  – Number and Base Ten K-5.
Leading Up to Fractions

• In grades 1 and 2, students use fraction language to describe partitions of shapes into equal parts.
Developing Fraction Understanding Gr. 3-4

• 3rd - develops understanding of fractions (including vocabulary and notation), especially **unit fractions** (fractions with numerator 1 and denominators 2, 3, 4, 6, 8)

• Explore equivalent fractions on a number line.

• 4th – addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers

• Fundamental prop. of equivalent fractions: \[\frac{2}{3} \times \frac{4}{4} = \frac{8}{12}\]
Developing Fraction Understanding in Grade 5

• Developing fluency with **addition and subtraction of fractions**, and

• Developing understanding of the **multiplication of fractions** and **division of fractions in limited cases** (unit fraction divided by whole numbers and whole numbers divided by unit fraction)
Fraction Tasks

• A: Fractions and Rectangles
• C: Naming the Whole For a Fraction
• D: Jog-A-Thon
Fraction Tasks

• C: Naming the Whole For a Fraction: 3NF.A.1 If the fraction is 2/3 and two parts are shaded, what must be the whole?
• A: Fractions and Rectangles: 4.NF.A.1 Extending concepts of equivalent fractions
• D: Jog-A-Thon: 5.NF.A.1 Add and subtract with equivalent fractions.
Four More Tasks

Task H: Relating Situations to Equations
Task I: Art Class, Var. 1
Task J: Battery Charging
Task K: Mixing Concrete
Four More Tasks

Task H: Relating Situations to Equations - 8.F.B
Task I: Art Class, Var. 1 – 7.RP.A.2
Task J: Battery Charging – 8.FA.2
Task K: Mixing Concrete – 6.RP.A.3a, 7.RP.A.2
### Task G: Mixing Concrete

The table below shows the combination of dry prepackaged mix and water to make concrete. The mix says for every 1 gallon of water stir 60 pounds of dry mix. We know that 1 gallon of water is equal to 8 pounds. Using the information provided in the table, complete the remaining parts of the table.

<table>
<thead>
<tr>
<th>Dry Mix</th>
<th>Water</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>75</td>
<td>10</td>
<td>85 1/6</td>
</tr>
<tr>
<td>2 ½</td>
<td></td>
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## Task G: Mixing Concrete

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<td>60</td>
<td>8</td>
<td>68</td>
</tr>
<tr>
<td>75</td>
<td>10</td>
<td>85</td>
</tr>
<tr>
<td>14 1/6</td>
<td></td>
<td>14 1/6</td>
</tr>
<tr>
<td>2 1/2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Understand ratio concepts and use ratio reasoning to solve problems

- **CCSS.Math.Content.6.RP.A.3**
  Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

- **CCSS.Math.Content.6.RP.A.3.a**
  Make tables of equivalent ratios relating quantities with *whole-number measurements*, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.
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<td>85</td>
</tr>
<tr>
<td>75/6</td>
<td>10/6</td>
<td>85/6 = 14 1/6</td>
</tr>
<tr>
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</tr>
<tr>
<td>14 1/6</td>
<td>2 1/2</td>
<td>14 1/6</td>
</tr>
</tbody>
</table>

\[
\text{Total} = \frac{75}{10} = 10 \div 30 = 1/3\text{ }\text{and } \frac{2}{2} + \frac{1}{3} = \frac{5}{6}
\]
Ratios and Proportional Relationships

7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems.

2. Recognize and represent proportional relationships between quantities.
   [CCSS.Math.Content.7.RP.A.2.b]
   Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
The students in Ms. Baca’s art class were mixing yellow and blue paint. She told them that two mixtures will be the same shade of green if the blue and yellow paint are in the same ratio.

The table below shows the different mixtures of paint that the students made.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Blue</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

How many different shades of paint did the students make?

Some of the shades of paint were bluer than others. Which mixture(s) were the bluest? Show work or explain how you know.
Analyze proportional relationships and use them to solve real-world and mathematical problems.

CCSS.Math.Content.7.RP.A.2

Recognize and represent proportional relationships between quantities.
3. Carefully plot a point for each mixture on a coordinate plane. (Graph paper might help.)

4. Draw a line connecting each point to (0,0). What do the mixtures that are the same shade of green have in common?
Ratios and Proportional Relationships

7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems.

2. Recognize and represent proportional relationships between quantities.

CCSS.Math.Content.7.RP.A.2.d
Explain what a point \((x, y)\) on the graph of a proportional relationship means in terms of the situation, with special attention to the points \((0, 0)\) and \((1, r)\) where \(r\) is the unit rate.
Task F: Battery Charging

• Sam wants to take his MP3 player and his video game player on a car trip. An hour before they plan to leave, he realized that he forgot to charge the batteries last night. At that point, he plugged in both devices so they can charge as long as possible before they leave.

• Sam knows that his MP3 player has 40% of its battery life left and that the battery charges by an additional 12 percentage points every 15 minutes.

• His video game player is new, so Sam doesn’t know how fast it is charging but he recorded the battery charge for the first 30 minutes after he plugged it in.
**Battery Charging, cont.**

<table>
<thead>
<tr>
<th>Time Charging (min.)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Game Battery Charge %</td>
<td>20</td>
<td>32</td>
<td>44</td>
<td>56</td>
</tr>
</tbody>
</table>

- If Sam’s family leaves as planned, what percent of the battery will be charged for each of the two devices when they leave?
- How much time would Sam need to charge the battery 100% on both devices?
Define, evaluate, and compare functions 8.F.A

CCSS.Math.Content.8.F.A.2

Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
Task B: Relating Situations to Equations (Modeling With a Linear Function)

• Which of the following could be modeled by $y=2x+5$? Answer YES or NO for each one.

• Joaquin earns $2.00 for each magazine sale. Each time he sells a magazine he also gets a five-dollar tip. How much money will he earn after selling $x$ magazines?

• YES NO

• Sandy charges $2.00 an hour for babysitting. Parents are charged $5.00 if they arrive home later than scheduled. Assuming the parents arrived late, how much money does she earn for $x$ hours?

• YES NO
Task B: Relating Situations to Equations (Modeling With a Linear Functions), cont.

• Sneak Preview is a members-only video rental store. There is a $2.00 initiation fee and a $5.00 per video rental fee. How much would John owe on his first visit if he becomes a member and rents $x$ videos?
  • YES NO
• Andy is saving money for a new CD player. He began saving with a $5.00 gift and will continue to save $2.00 each week. How much money will he have saved at the end of $x$ weeks?
  • YES NO
Functions 8.F

Use functions to model relationships between quantities. 8.F.B
Mathematical uses of ratio and proportion

- Similar figures
- Slope
- Trigonometry – sine, cosine, tangent
- Constant rates of change
- Science: speed, accelerations, density, surface tension, electric or magnetic field strength, chemical solutions
Every Day Uses of Ratio and Proportion

• Cooking
• Calculating tips
• Miles per gallon
• Taxes
• Discounts
• Descriptive statistics such as birth rate, per capita income, body mass index, rain fall, crop yields, dose of medicine for a given body weight.
Three Useful Resources for Aligning Curriculum

Progression Documents

New Illinois Learning Standards

PARCC Model Content Framework
Progression Documents by Common Core Authors

- K-5 Progression on Counting and Cardinality and Operations and Algebraic Thinking (OA)
- K-5 Progression on Number and Operation in Base 10 (NBT)
- Number and Operations – Fractions 3-5 (NF)
- K-6 Progression on Geometry (G)
- K-5 Progression on Measurement and Data (measurement part) (MD)
- K-5 Progression on Measurement and Data (data part) (MD)
Progression Documents for Middle School

Draft 6-8 Progression on Statistics and Probability

Draft 6-8 Progression on Expressions and Equations

Draft 6-8 Progression on the Number System

Draft 6-7 Progression on Ratios and Proportional Relationships
**Grade 6 Overview**

**Ratios and Proportional Relationships**
- Understand ratio concepts and use ratio reasoning to solve problems.

**The Number System**
- Apply and extend previous understandings of multiplication and division to divide fractions by fractions.
- Compute fluently with multi-digit numbers and find common factors and multiples.
- Apply and extend previous understandings of numbers to the system of rational numbers.

**Expressions and Equations**
- Apply and extend previous understandings of arithmetic to algebraic expressions.
- Reason about and solve one-variable equations and inequalities.
- Represent and analyze quantitative relationships between dependent and independent variables.

**Geometry**
- Solve real-world and mathematical problems involving area, surface area, and volume.

**Statistics and Probability**
- Develop understanding of statistical variability.
- Summarize and describe distributions.

**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.
What Makes a Model Content Framework?

Grade Level Course

Key Advances

Fluency Expectations

In-Depth Focus

Emphasis by Cluster

Within Grade Dependencies

Connections among Standards, Clusters or Domains

Connecting to Mathematical Content and Mathematical Practices

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Content Emphases by Cluster

Green – major
Blue – supporting
Yellow – additional
### Grade 6 Cluster Emphases

| Key: £ Major Clusters; □ Supporting Clusters; ○ Additional Clusters |
|---|---|---|
| **Ratios and Proportional Reasoning** |
| □ Understand ratio concepts and use ratio reasoning to solve problems. |
| **The Number System** |
| □ Apply and extend previous understandings of multiplication and division to divide fractions by fractions. |
| ○ Compute fluently with multi-digit numbers and find common factors and multiples. |
| □ Apply and extend previous understandings of numbers to the system of rational numbers. |
| **Expressions and Equations** |
| □ Apply and extend previous understandings of arithmetic to algebraic expressions. |
| □ Reason about and solve one-variable equations and inequalities. |
| □ Represent and analyze quantitative relationships between dependent and independent variables. |
| **Geometry** |
| □ Solve real-world and mathematical problems involving area, surface area, and volume. |
| **Statistics and Probability** |
| ○ Develop understanding of statistical variability. |
| ○ Summarize and describe distributions. |

Achievethecore.org/focus
How can you use the information we have discussed today?
Resources

• Progression documents
• New Illinois Learning Standards
• Model Content Framework
• Thinking Blocks for Ratios, for Fractions
  www.mathplayground.com

Find links to these at www.mathgarden.weebly.com

• Also, Developing Essential Understanding of Ratios, Proportions & Proportional Reasoning Grades 6-8
  by Joanne Lobato and Amy B. Ellis, NCTM, 2010
Developing Essential Understanding of Ratios, Proportions, & Proportional Reasoning

Grades 6–8
Two articles


Focus Issue

Teaching *children* *mathematics*

OCTOBER 2015 FOCUS ISSUE:

*Between the Wholes:*

*Promoting Fraction and Decimal Understanding*
Connect the Dots: Promote Mathematical Power with Thoughtful Curriculum Alignment

Grades 3-8
October 24, 2015
Joyce Bishop
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mathgarden.weebly.com

With slides from isbe and a variety of resources