MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions

Grades K–5

The goal of the initiative

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Improve the quality of instruction in math classrooms by developing deep mathematical content knowledge of teachers and connecting that content knowledge to the practical implementation of a quality curriculum.

Group norms

- Understand that those who work, learn.
- Look for solutions, not blame.
- Focus on systems, not people.
- Recognize that everyone has expertise.
- Be honest.
- Challenge ideas.
- Share talk time.
- Mistakes are expected, respected, and inspected.

Module 5 goals

Participants will

- Engage in a study of standards across grades K–5 related to building conceptual understanding of fractions to see how this idea develops across the grades.
- Identify evidence of the key shifts in the standards and how these key shifts guide decisions about teaching and learning in conjunction with the EngageNY resources.
- Use unit fractions as benchmarks to make sense of magnitude and location of whole numbers and fractions on a number line, and extend reasoning about fractions.
- Investigate the impact of selecting student responses that highlight specific strategies or misconceptions and making connections between these responses and the intended learning to deepen students' mathematical understanding.

Math Content Module 5
Grades K–5

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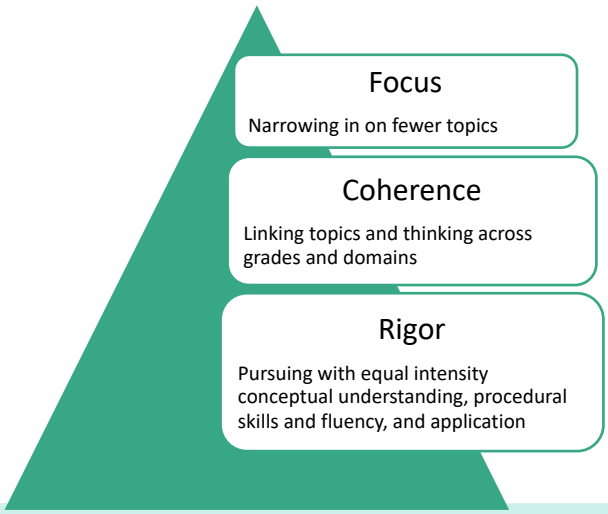
MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Session 1: Key Shifts in Action—Through an EngageNY Lesson
Grades K–5

Key shifts of the Louisiana Student Standards for Mathematics



Math Content Module 5, Session 1
Grades K–5

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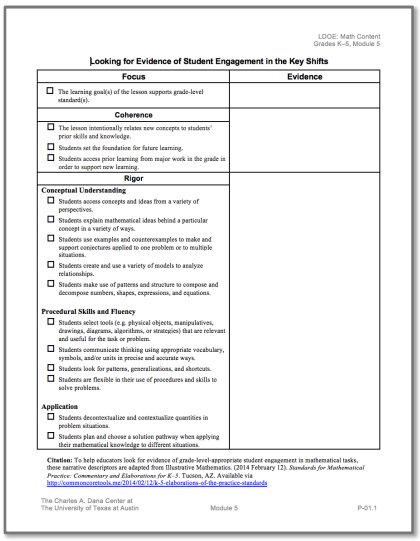
Evidence of the key shifts

Use the handout to:

- Check off student behaviors/actions that you observed.
- Record any observations you made that serve as evidence.



LDOE: Math Content
Grades K–5, Module 5

Looking for Evidence of Student Engagement in the Key Shifts

Focus	Evidence
☐ The learning goal(s) of the lesson supports grade-level standard(s).	
Coherence	
☐ The lesson intentionally relates new concepts to students' prior skills and knowledge.	
☐ Students set the foundation for future learning.	
☐ Students access prior learning from major work in the grade in order to support new learning.	
Rigor	
Conceptual Understanding	
☐ Students access concepts and ideas from a variety of perspectives.	
☐ Students explain mathematical ideas behind a particular concept in a variety of ways.	
☐ Students use examples and counterexamples to make and support conjectures applied to one problem or to multiple situations.	
☐ Students create and use a variety of models to analyze relationships.	
☐ Students make use of patterns and structure to compose and decompose numbers, shapes, expressions, and equations.	
Procedural Skills and Fluency	
☐ Students select tools (e.g. physical objects, manipulatives, drawings, diagrams, algorithms, or strategies) that are relevant and useful for the task or problem.	
☐ Students communicate thinking using appropriate vocabulary, symbols, and/or units in precise and accurate ways.	
☐ Students look for patterns, generalizations, and shortcuts.	
☐ Students are flexible in their use of procedures and skills to solve problems.	
Application	
☐ Students decontextualize and contextualize quantities in problem situations.	
☐ Students plan and choose a solution pathway when applying their mathematical knowledge to different situations.	

Citation: To help educators look for evidence of grade-level-appropriate student engagement in mathematical tasks, these narrative descriptors are adapted from Illustrative Mathematics. (2014 February 12). *Standards for Mathematical Practice: Commentary and Elaborations for K–5*. Tucson, AZ. Available via http://commoncoretools.me/2014/02/12/k-5-elaborations-of-the-practice-standards

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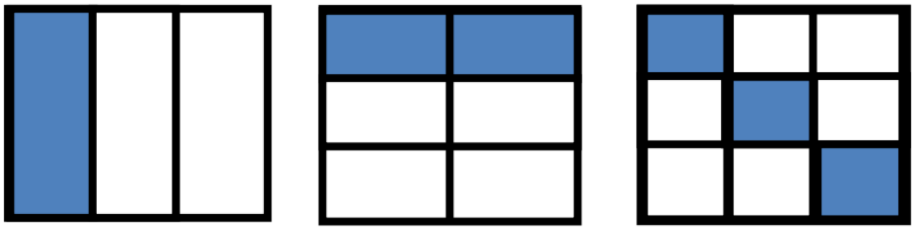
Using unit fractions to reason about numbers

Mr. Ray is knitting a scarf. He says that he has completed one-fifth of the total length of the scarf.

- Draw a picture of the final scarf.
- Label what he has finished and what he still has to make.
- Draw a number bond with 2 parts to show the fraction he has made and the fraction he has not made.

Using unit fractions to reason about numbers



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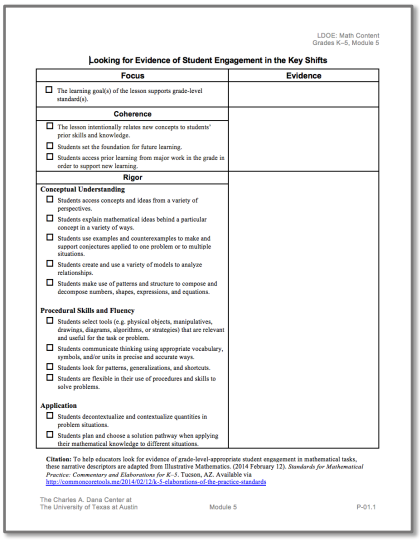

LDOE: Math Content
Grades K–5, Module 5

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☐ The learning goal(s) of the lesson supports grade-level standard(s).	
Coherence	
☐ The lesson intentionally relates new concepts to students' prior skills and knowledge. ☐ Students set the foundation for future learning. ☐ Students access prior learning from major work in the grade in order to support new learning.	
Rigor	
Conceptual Understanding ☐ Students access concepts and ideas from a variety of perspectives. ☐ Students explain mathematical ideas behind a particular concept in a variety of ways. ☐ Students use examples and counterexamples to make and support conjectures applied to one problem or to multiple situations. ☐ Students create and use a variety of models to analyze relationships. ☐ Students make use of patterns and structure to compose and decompose numbers, shapes, expressions, and equations. **Procedural Skills and Fluency** ☐ Students select tools (e.g. physical objects, manipulatives, drawings, diagrams, algorithms, or strategies) that are relevant and useful for the task or problem. ☐ Students communicate thinking using appropriate vocabulary, symbols, and/or units in precise and accurate ways. ☐ Students look for patterns, generalizations, and shortcuts. ☐ Students are flexible in their use of procedures and skills to solve problems. **Application** ☐ Students decontextualize and contextualize quantities in problem situations. ☐ Students plan and choose a solution pathway when applying their mathematical knowledge to different situations.	

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Session 1 reflection

Points to ponder

- How does the relationship between the various models help develop conceptual understanding of fractions?
- How did your understanding of unit fractions help you place the fractions on the number line?
- What numerical reasoning did you use to help you determine equivalent fractions?

MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Session 2: Exploring Coherence in the LSSM
Grades K–5

Investigating vertical alignment in the LSSM

As a group…

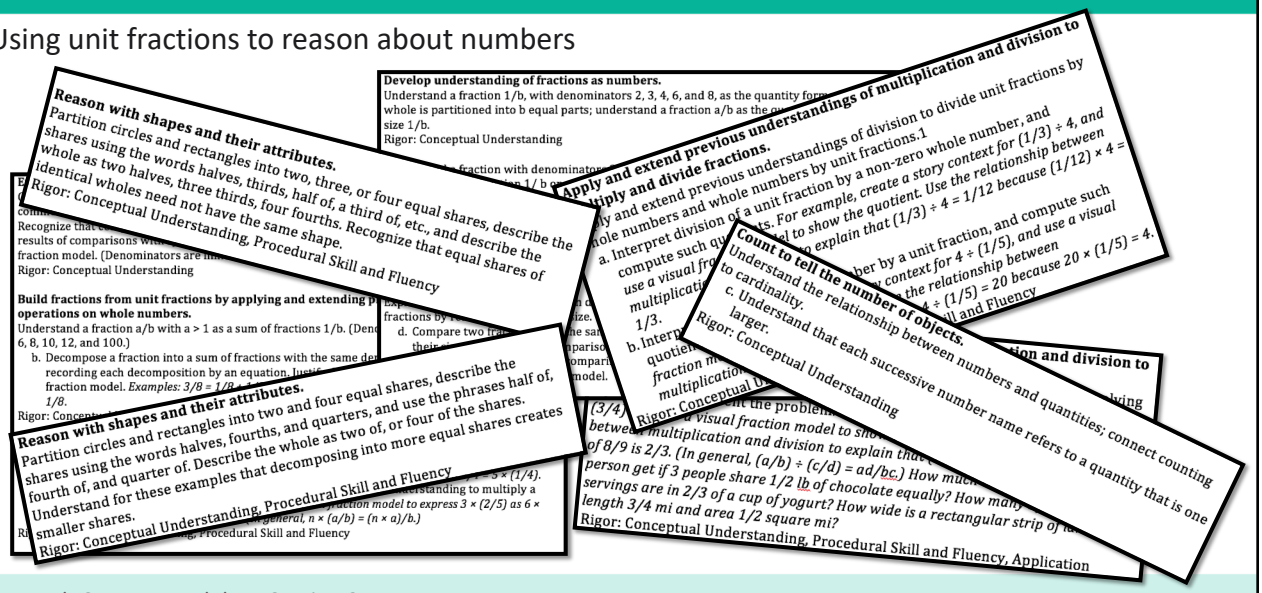
1. Select a big idea for your group to investigate.

   Using unit fractions to reason about numbers

2. Determine what your big idea means.

Vertical alignment

Using unit fractions to reason about numbers



Vertical alignment

Vertical Alignment Chart

LDOE: Math Content
Grades K–5, Module 5

Big Idea: Using unit fractions to reason about numbers

Grade/ Course	LSSM Code	Content Standards
	Cluster A	**Apply and extend previous understandings of multiplication and division to divide fractions by fractions.**
6	6.NS.A.1	Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. For example, create a story context for (2/3) ÷ (3/4) and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that (2/3) ÷ (3/4) = 8/9 because 3/4 of 8/9 is 2/3. (In general, (a/b) ÷ (c/d) = ad/bc.) How much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 3/4- cup servings are in 2/3 of a cup of yogurt? How wide is a rectangular strip of land with length 3/4 mi and area 1/2 square mi? Rigor: Conceptual Understanding, Procedural Skill and Fluency, Application
	Cluster B	**Apply and extend previous understandings of multiplication and division to multiply and divide fractions.**
5	5.NF.B.7a-b	Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.1 a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. For example, create a story context for (1/3) ÷ 4, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that (1/3) ÷ 4 = 1/12 because (1/12) × 4 = 1/3. b. Interpret division of a whole number by a unit fraction, and compute such quotients. For example, create a story context for 4 ÷ (1/5), and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that 4 ÷ (1/5) = 20 because 20 × (1/5) = 4. Rigor: Conceptual Understanding, Procedural Skill and Fluency
	Cluster A	**Extend understanding of fraction equivalence and ordering.**
4	4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.) Rigor: Conceptual Understanding
	Cluster B	**Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.**
	4.NF.B.3b	Understand a fraction a/b with a > 1 as a sum of fractions 1/b. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.) b. Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model. Examples: 3/8 = 1/8 + 1/8 + 1/8 ; 3/8 = 1/8 + 2/8 ; 2 1/8 = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8. Rigor: Conceptual Understanding
	4.NF.B.4a-b	Multiply a fraction by a whole number. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.) a. Understand a fraction a/b as a multiple of 1/b. For example, use a visual fraction model to represent 5/4 as the product 5 × (1/4), recording the conclusion by the equation 5/4 = 5 × (1/4). b. Understand a multiple of a/b as a multiple of 1/b, and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express 3 × (2/5) as 6 × (1/5), recognizing this product as 6/5. (In general, n × (a/b) = (n × a)/b.) Rigor: Conceptual Understanding, Procedural Skill and Fluency
3	**Cluster A**	**Develop understanding of fractions as numbers.**

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Math Content Module 5, Session 2
Grades K–5

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Vertical alignment discussion questions

- What content changes occur from grade to grade?
- Where are concepts introduced, developed, and finalized?
- Does an idea or skill get more complex, and if so, how?
- How are the components of *rigor* (conceptual understanding, procedural skills and fluency, and application) evident in the standards?
- How do the components of rigor change as the big idea is developed across the grades?

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Reflection

How do students use what they know about whole numbers to develop an understanding of fractions?

How does the learning from the primary grades support fraction understanding in the intermediate grades?

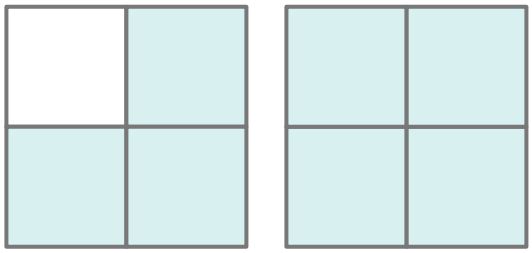
MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Session 3: Deepening Mathematical Content Knowledge for Effective Instruction
Grades K–5

Number and operations—Fractions

What do you see?

What amount does this diagram represent?

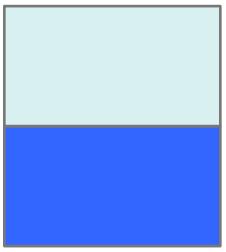


Why is it important to identify the whole?

Number and operations—Fractions

What is the whole?

If this is ½, what is the whole?



How do you know?

Number and operations—Fractions

What is the whole?

If half of your sticky note equals:

1/6, 2/3, 1½, ¾, 1/3, 2 …

What is the whole?

- Work with a partner at your table to find the wholes.
- Explain your thinking to your table group.

Number and operations—Fractions

Fractions on a number line

1. Label the second mark on the number line with a fraction of your choice.
2. Mark and label a third and a fourth point on the number line, and explain what those amounts should be.

Number and operations—Fractions

Reasoning using benchmarks

Number and operations—Fractions

What is a unit fraction?

Why are unit fractions powerful for understanding fractions?

- They represent a unit—an amount or a distance.
- They behave much like whole numbers for counting.
- Properties of operations apply to fraction computations.
- As with whole numbers, fractional amounts can be composed and decomposed in various ways.

Number and operations—Fractions

Comparing fractions

Mental strategies for comparing fractions

Common Numerator	Common Denominator	Benchmarks: 0 ½ 1

1. Draw a fraction card.
2. Determine which strategies make the most sense for comparing the two fractions.
3. Explain your reasoning to your table group.
4. Be prepared to explain your reasoning to the whole group.

Number and operations—Fractions

Reflection

9-1-1

9 — words to describe my learning about fractions.

1 — idea that challenged my thinking.

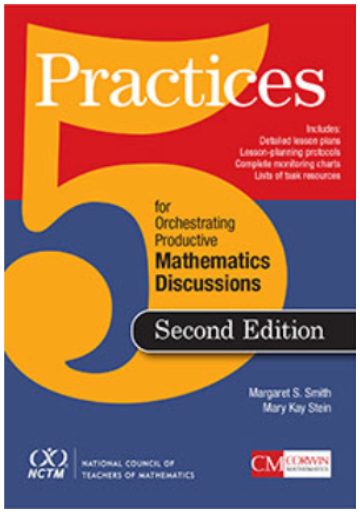
1 — concept I will add to my planning or instruction.

MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Session 4: Instructional Strategies
Grades K–5

The National Council of Teachers of Mathematics book:

5 Practices for Orchestrating Productive Mathematics Discussions



— Smith, M. S., & Stein, M. K. (2018, second edition). *5 practices for orchestrating productive mathematics discussions.* Reston, VA: National Council of Teachers of Mathematics. Available at https://www.nctm.org/Store/Products/5-Practices-for-Orchestrating-Productive-Mathematics-Discussion,-2nd-Edition

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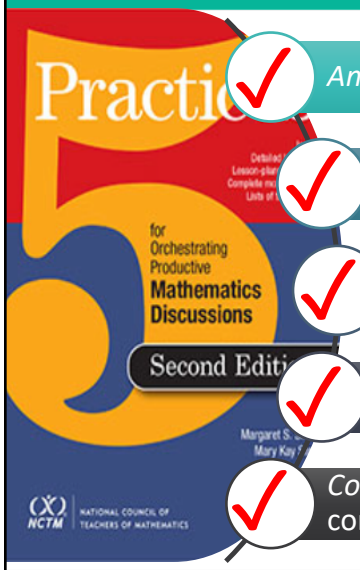
5 Practices for Orchestrating Productive Mathematics Discussions

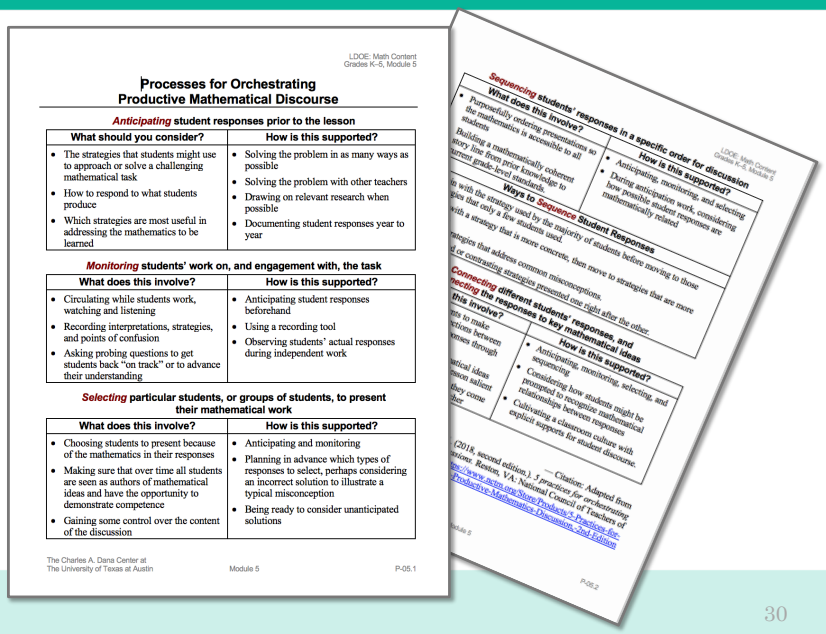


- *Anticipating* student responses prior to the lesson
- *Monitoring* students' work on, and engagement with, the tasks
- *Selecting* particular students to present their mathematical work
- *Sequencing* students' responses in a specific order for discourse
- *Connecting* different students' responses, and connecting the responses to key mathematical ideas

Orchestrating productive mathematics discussions

Read the document to re-familiarize yourself with the discourse process.

- How will this process affect teaching and learning in your classroom?



LDOE: Math Content
Grades K–5, Module 5

Processes for Orchestrating Productive Mathematical Discourse

Anticipating **student responses prior to the lesson**

What should you consider?	How is this supported?
• The strategies that students might use to approach or solve a challenging mathematical task • How to respond to what students produce • Which strategies are most useful in addressing the mathematics to be learned	• Solving the problem in as many ways as possible • Solving the problem with other teachers • Drawing on relevant research when possible • Documenting student responses year to year

Monitoring **students' work on, and engagement with, the task**

What does this involve?	How is this supported?
• Circulating while students work, watching and listening • Recording interpretations, strategies, and points of confusion • Asking probing questions to get students back "on track" or to advance their understanding	• Anticipating student responses beforehand • Using a recording tool • Observing students' actual responses during independent work

Selecting **particular students, or groups of students, to present their mathematical work**

What does this involve?	How is this supported?
• Choosing students to present because of the mathematics in their responses • Making sure that over time all students are seen as authors of mathematical ideas and have the opportunity to demonstrate competence • Gaining some control over the content of the discussion	• Anticipating and monitoring • Planning in advance which types of responses to select, perhaps considering an incorrect solution to illustrate a typical misconception • Being ready to consider unanticipated solutions

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Sequencing **students' responses in a specific order for discussion**

What does this involve?	How is this supported?
• Purposefully ordering presentations so the mathematics is accessible to all students • Building a mathematically coherent story line from prior knowledge to current grade-level standards	• Anticipating, monitoring, and selecting, during anticipation work, considering how possible student responses are mathematically related

Ways to *Sequence* Student Responses

...n with the strategy used by the majority of students before moving to those ...gies that only a few students used.
...with a strategy that is more concrete, then move to strategies that are more ...
...tegies that address common misconceptions.
...or contrasting strategies presented one right after the other.

Connecting **different students' responses, and ...necting the responses to key mathematical ideas**

...this involve?	How is this supported?
...ze to make ...ctions between ...ment through ...atical ideas ...nces salient ...may come ...ker	• Anticipating, monitoring, selecting, and sequencing • Considering how students might be prompted to recognize mathematical relationships between responses • Cultivating a classroom culture with explicit supports for student discourse.

...(2018, second edition). *5 practices for orchestrating ...ctice*. Reston, VA: National Council of Teachers of ...
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Grades K–5, Module 5

...Module 5 P-05.2

Orchestrating productive mathematics discussions

Connecting **different students' responses, and**
connecting **the responses to key mathematical ideas**

What does this involve?	How is this supported?
• Encouraging students to make mathematical connections between different student responses, through questioning • Making the key mathematical ideas that are the focus of the lesson salient • Considering extensions as they come from the students or the teacher	• *Anticipating*, *monitoring*, *selecting*, and *sequencing* • Considering how students might be prompted to recognize mathematical relationships between responses • Cultivating a classroom culture with explicit supports for student discourse

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Orchestrating productive mathematics discussions

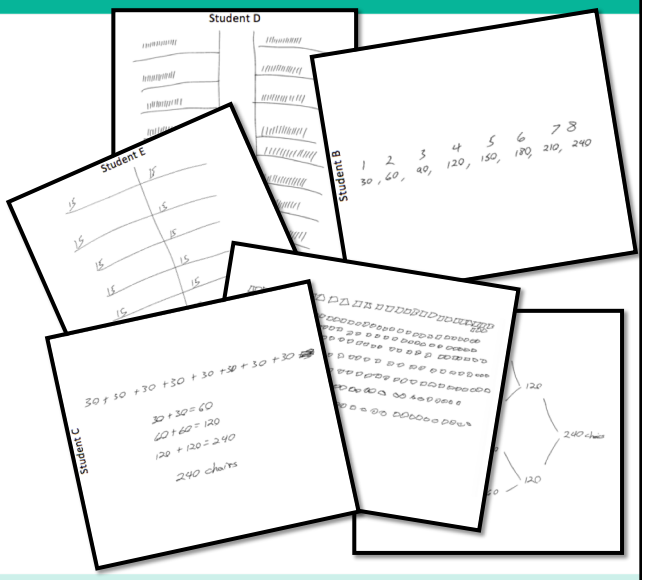
A third-grade class is setting up chairs for a school talent show. The class needs to set up 8 rows of chairs with 30 chairs in each row, leaving space in the middle for a center aisle. The class needs to know how many chairs they need to get out of storage to set up for the show.

Learning goal: How is the structure of multiplication evident in different representations?

Orchestrating productive mathematics discussions

Tape the student work to the chart paper in a way that you think supports student learning.

Write notes to describe how you would make connections between the students' strategies—and how you would connect these strategies to the learning goal.



Orchestrating productive mathematics discussions

Take a few minutes to think about and answer the following questions:

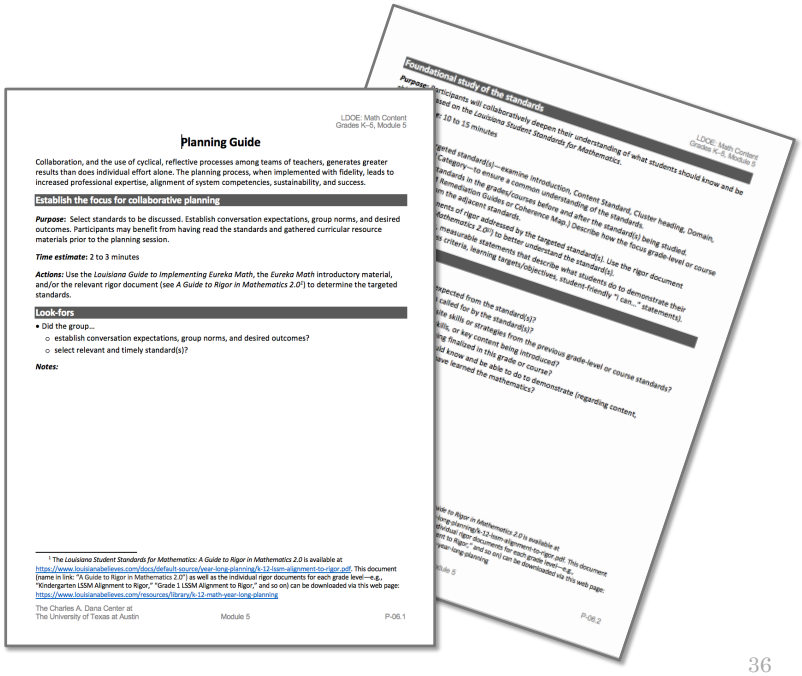
- What strategies can you use to ensure that ALL students engage in mathematical discourse in your classroom?
- What can you do to leverage incorrect or incomplete reasoning or solutions to strengthen the learning of all students?
- Based on your learning for this section, what action step(s) might you take in order to foster student mathematical discourse in your classroom?

MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Session 5: Purposeful Planning of the EngageNY Curriculum
Grades K–5

Tool that promotes effective collaborative planning:

The Planning Guide



LDOE: Math Content
Grades K–5, Module 5

Planning Guide

Collaboration, and the use of cyclical, reflective processes among teams of teachers, generates greater results than does individual effort alone. The planning process, when implemented with fidelity, leads to increased professional expertise, alignment of system competencies, sustainability, and success.

Establish the focus for collaborative planning

Purpose: Select standards to be discussed. Establish conversation expectations, group norms, and desired outcomes. Participants may benefit from having read the standards and gathered curricular resource materials prior to the planning session.

Time estimate: 2 to 3 minutes

Actions: Use the *Louisiana Guide to Implementing Eureka Math*, the *Eureka Math* introductory material, and/or the relevant rigor document (see *A Guide to Rigor in Mathematics 2.0*[1]) to determine the targeted standards.

Look-fors

- Did the group…
  - establish conversation expectations, group norms, and desired outcomes?
  - select relevant and timely standard(s)?

Notes:

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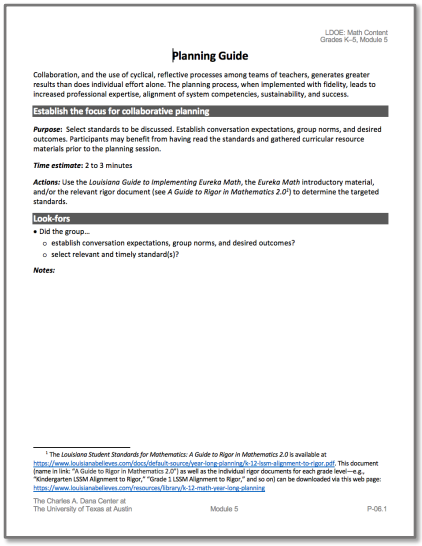
Collaborative planning conversation

Focus standards: Using unit fractions to reason about numbers

- Kindergarten: K.CC.B.4
- Grade 1: 1.G.A.3
- Grade 2: 2.G.A.3
- Grade 3: 3.NF.A.1, 3.NF.A.2, 3.NF.A.3d
- Grade 4: 4.NF.A.2, 4.NF.B.3b, 4.NF.B.4a-b
- Grade 5: 5.NF.B.7a-b



LDOE: Math Content
Grades K–5, Module 5

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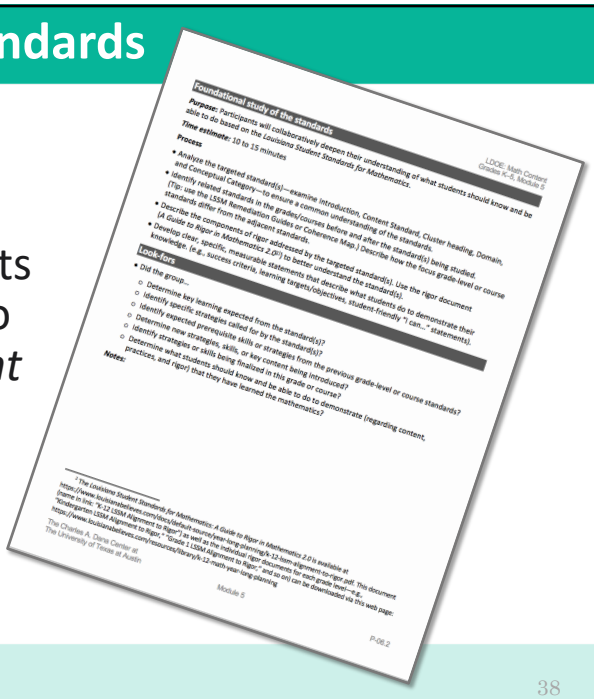
Foundational study of the standards

- ***Purpose:*** Participants will collaboratively deepen their understanding of what students should know and be able to do based on the *Louisiana Student Standards for Mathematics*.
- ***Time estimate:*** 10 to 15 minutes



LDOE: Math Content
Grades K–5, Module 5

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Time estimate: 10 to 15 minutes

Process

- Analyze the targeted standard(s)—examine Introduction, Content Standard, Cluster heading, Domain, and Conceptual Category—to ensure a common understanding of the standards.
- Identify related standards in the grades/courses before and after the standard(s) being studied. (Tip: use the LSSM Remediation Guides or Coherence Map.) Describe how the focus grade-level or course standards differ from the adjacent standards.
- Describe the components of rigor addressed by the targeted standard(s). Use the rigor document (*A Guide to Rigor in Mathematics 2.0*[1]) to better understand the standard(s).
- Develop clear, specific, measurable statements that describe what students do to demonstrate their knowledge. (e.g., success criteria, learning targets/objectives, student-friendly "I can…" statements).

Look-fors

- Did the group…
  - Determine key learning expected from the standard(s)?
  - Identify specific strategies called for by the standard(s)?
  - Identify expected prerequisite skills or strategies from the previous grade-level or course standards?
  - Determine new strategies, skills, or strategies from the previous grade-level or course standards?
  - Identify strategies or skills being finalized in this grade or course?
  - Determine what students should know and be able to do to demonstrate (regarding content, practices, and rigor) that they have learned the mathematics?

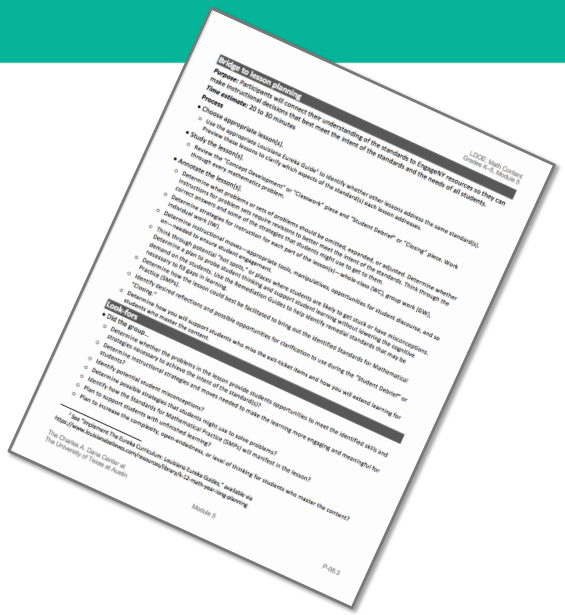
Notes:

[1] The *Louisiana Student Standards for Mathematics: A Guide to Rigor in Mathematics 2.0* is available at https://www.louisianabelieves.com/docs/default-source/year-long-planning/k-12-item-alignment-to-rigor.pdf. This document (name in link: "A Guide to Rigor in Mathematics 2.0") as well as the individual rigor documents for each grade level—e.g., "Kindergarten LSSM Alignment to Rigor," "Grade 1 LSSM Alignment to Rigor," and so on) can be downloaded via this web page: https://www.louisianabelieves.com/resources/library/k-12-math-year-long-planning

The Charles A. Dana Center at
The University of Texas at Austin Module 5 P-06.2

Bridge to lesson planning

- ***Purpose:*** Participants will connect their understanding of the standards to EngageNY resource materials so they can make instructional decisions that best meet the intent of the standards and the needs of all students.
- ***Time estimate:*** 20 to 30 minutes



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Collaborative planning

Work with your grade-level group to …

- Study your grade level's focus standards using the **Foundational study of the standards** (15 minutes).
- Connect your standards conversation to an EngageNY lesson and discuss instructional decisions regarding that lesson using the **Bridge to lesson planning** (30 minutes).

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Grades K–5

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Reflecting on purposeful planning

Points to Ponder

How does purposeful planning help you attend to the components of *rigor*?

What specific instructional strategies did you focus on?

What changes did you make to the EngageNY lesson(s)? Why?

How did your conversation help determine a plan to fill gaps in learning?

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MATHEMATICS CONTENT MODULES

Module 5: Number and Operations—Fractions: Understanding Fractions
Closing and Participant Evaluation Survey
Grades K–5

References

Key resources available via the Louisiana Department of Education web page — K-12 Math Planning Resources, https://www.louisianabelieves.com/resources/library/k-12-math-year-long-planning — include the following:

- *K–12 Louisiana Student Standards for Mathematics (LSSM) | Teachers Companion Documents*
- *Implement The Eureka Curriculum: Louisiana Eureka Guides | Help Students Who Struggle: Remediation Guides*.
- *The Louisiana Student Standards for Mathematics: A Guide to Rigor in Mathematics 2.0*, at https://www.louisianabelieves.com/docs/default-source/year-long-planning/k-12-lssm-alignment-to-rigor.pdf This document (name in link: "K-12 LSSM Alignment to Rigor") as well as the individual rigor documents for each grade level—e.g., "Kindergarten LSSM Alignment to Rigor," "Grade 1 LSSM Alignment to Rigor," and so on) can be downloaded via this web page: https://www.louisianabelieves.com/resources/library/k-12-math-year-long-planning

Other resources referenced include:

Boaler, Jo. (n.d.) "How to Learn Math: For Teachers," Stanford: Center for Professional Development. http://scpd.stanford.edu/ppc/how-learn-math-teachers

Carpenter, T .P., Franke, M. L., Jacobs, V. R., Fennema, E., & Empson, S. B. (1998). A longitudinal study of invention and understanding in children's multi-digit addition and subtraction. *Journal for Research on Mathematics Education, 29*(1), 3–20.

EngageNY, from the New York State Department of Education: Various curriculum resources, available via https://www.engageny.org Including:

(2013 May 14). Video Library Grade 2 Math: Use Modeling and Tools to Solve Three Digit Subtraction Problems 2.NBT.7 https://www.engageny.org/resource/common-core-instruction-use-modeling-and-tools-to-solve-three-digit-subtraction-problems

(2014). Lesson: Grade 3 Mathematics Module 5, Topic E, Lesson 22. Available via https://www.engageny.org/resource/grade-3-mathematics-module-5-topic-e-lesson-22

These curriculum resources are shared under the EngageNY terms of use (https://www.engageny.org/terms-of-use) and the Creative Commons license—Attribution-NonCommercial-ShareAlike 3.0 Unported (CC BY-NC-SA 3.0)—mentioned therein: https://creativecommons.org/licenses/by-nc-sa/3.0

National Council of Teachers of Mathematics. (2014 July). Procedural fluency in mathematics. A position of the National Council of Teachers of Mathematics. http://www.nctm.org/Standards-and-Positions/Position-Statements/Procedural-Fluency-in-Mathematics

National Research Council. (2000). *How people learn: Brain, Mind, Experience, and School*. Washington, DC: The National Academies Press.

Smith, M. S., & Stein, M. K. (2011). *5 practices for orchestrating productive mathematics discussions.* Reston, VA: National Council of Teachers of Mathematics. Available at http://www.nctm.org/Store/Products/5--Practices-for-Orchestrating-Productive-Mathematics-Discussions

Van de Walle, J. A., Karp, K., S., Lovin, L. H., Bay-Williams, J. M. (2017). *Teaching Student-Centered Mathematics: Developmentally appropriate instruction for grades 3–5* (volume II). Third Edition. NY, NY: Pearson.

Module evaluation

Your feedback and comments are important to us. Please complete the module evaluation found at:

http://www.utdanacenter.org/ldoe/surveys