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TI STEM Exchange

# Understanding Students' Ways of Thinking in Mathematics

March 3, 2022 6:00 – 7:30 pm CT



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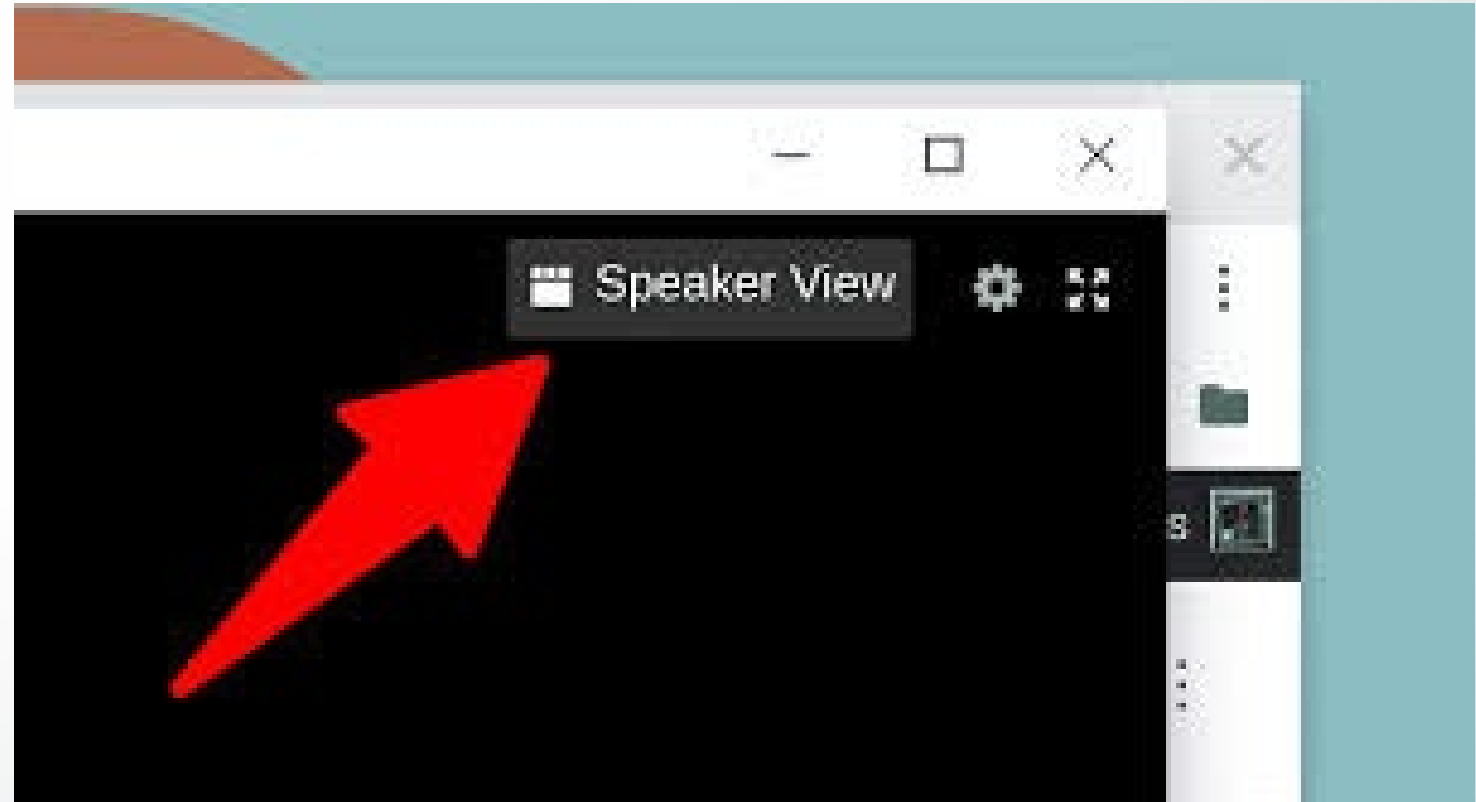
# TI STEM Exchange





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MODERATOR

## Mary Pittman, Ph.D.

**Director, TNTP & President, Colorado Council of Teachers of Mathematics**

Mary Pittman's vast mathematics career includes middle school mathematics teacher, Director of Mathematics for Boulder Valley (CO) School District, PK–12 Mathematics Specialist at the Colorado Department of Education, and Director for TNTP. Mary is President of the Colorado Council of Teachers of Mathematics, and received the State Leadership Service Award in Mathematics from the Association of State Supervisors of Mathematics, and the Floyd G. Hudson Service Award from the Council for Learning Disabilities.





# Tonight's Agenda

## Learn and Engage

- » Learn about a set of free instructional resources, the *Formative Conversation Starters*;
- » Understand the purposeful design of these resources and see how they play out with students;
- » Share ideas with other attendees and consider ways to utilize these resources in your setting, and how they foster equity.





# Tonight's Presenters





PANELIST

## Ted Coe, Ph.D.

### Director of Content Advocacy and Design at NWEA

Ted Coe brings over 25 years of experience as a teacher, professor, department chair, administrator, and nonprofit director. He is energetic and passionate about mathematics teaching and learning and has worked full time as a high school mathematics teacher, a community college faculty member, the mathematics chair at two community colleges, as an assistant dean at the university level, and as Director of Mathematics at Achieve. As NWEA's Director of Content Advocacy and Design, Ted works to promote high-quality mathematical experiences for all.





PANELIST

## Tammy Baumann, Ph.D.

### Mathematics Content Director at NWEA

Tammy Baumann is a Mathematics Content Director, focusing on content quality and alignment initiatives in mathematics. She recently joined NWEA after being part of the team at Open Up Resources, Michigan State University and several local school districts. She brings over 20 years of experience in K–12 education, serving as a teacher, instructional coach, building administration and curriculum director.

     @TammyBaumann4





PANELIST

## Anita Brown

### Math Content Designer at NWEA

Anita Brown serves as a Math Content Designer at NWEA. She holds a BS in Mathematics from the University of Illinois Urbana-Champaign, and had a brief career as a computer programmer before pursuing her teaching license. Her work positions since have fostered her teaching voice, her love of students, and her pursuit of social justice.





# Formative Conversation Starters



# Formative Conversation Starters

Creating opportunities to listen to student thinking

Ted Coe, Tammy Baumann, Anita Brown, NWEA

March 3, 2022

# Allow Me to Explain...

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Mathematics learning, at a minimum, means learning:

- + Ways of thinking
- + Habits of thinking
- + Ways of doing

# Ways of Thinking (Example)

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- + How many years was it from December 7, 1941, to December 7, 2014?
  
- + How did you figure it out?

# One possibility:

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- + There are 59 years from 1941 to 2000.
- + There are 14 years from 2000 to 2014.
- + That means there are  $59+14 = 73$  years between 1941 and 2014.

# Another:

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Shift the whole thing by one year. The elapsed time from 1941 to 2014 is the same as 1940 to 2013. From here a counting up method is exceptionally efficient.

# Calling a truce in the math wars: Joanna Weiss

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That afternoon, Fortmann put concepts in my head that I'd never really thought about. For instance, that subtraction is just “un-addition,” the ultimate distance between two numbers. In my head, negative numbers turned from a series of tricks to memorize into a concept I could visualize.



# Ways of Thinking (Another Example)

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- + What does it really mean to say something is out of proportion?
- + Does your meaning extend to:
  - The equation  $y = rx$

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“What does it mean in general to say that one quantity is proportional to another quantity? Be as precise as you can.”

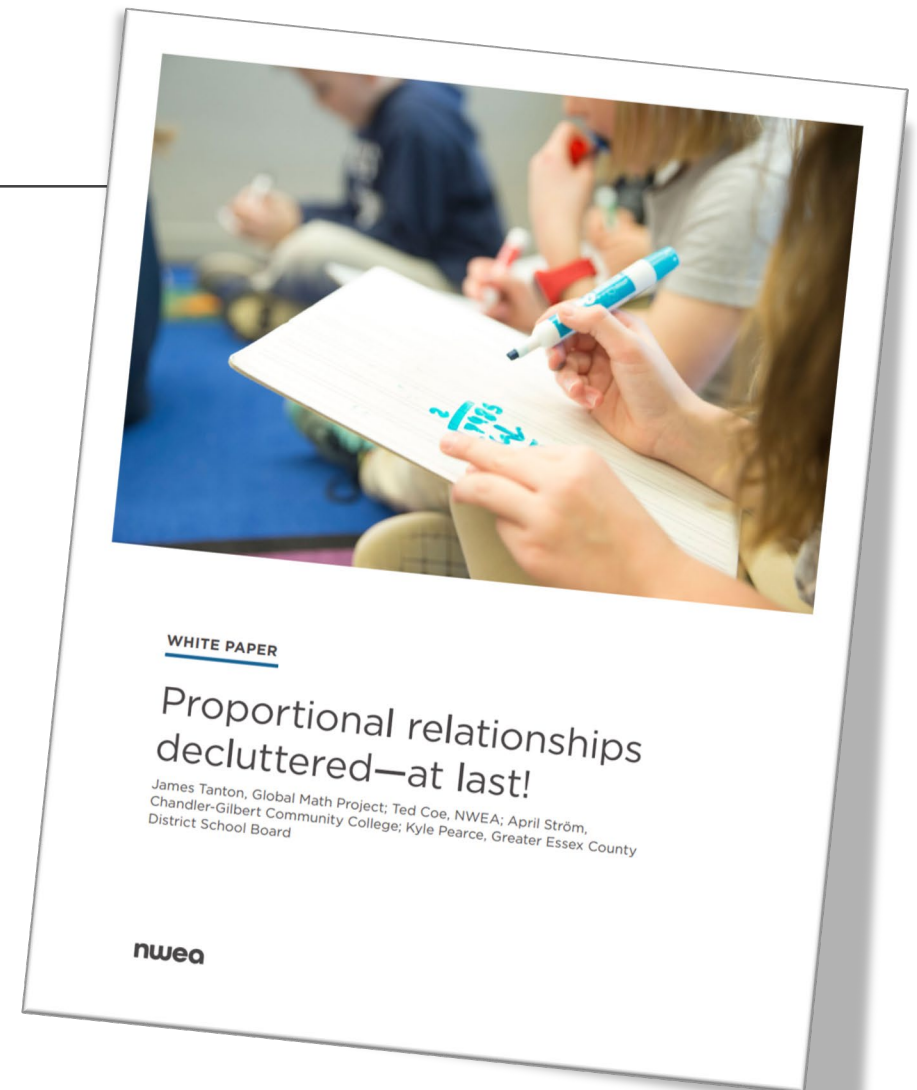
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“The confusing jumble of responses here is disturbing. At the very least it points to a lack of a common understanding within the school mathematics community of this very basic and important subject.”

# Decluttered

Many common scenarios in the world, in everyday life, and in mathematics involve two or more quantities that we can naturally measure,

- + whose measures can or do adopt a variety of possible values,
- + whose measures seem related to each other, and
- + the measures “scale in tandem.”



# NCTM Teaching Practices

## Effective Mathematics Teaching Practices

**Establish mathematics goals to focus learning.** Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

**Implement tasks that promote reasoning and problem solving.** Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

**Facilitate meaningful mathematical discourse.** Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Meaningful mathematics discourse must center on mathematical meanings!

appro

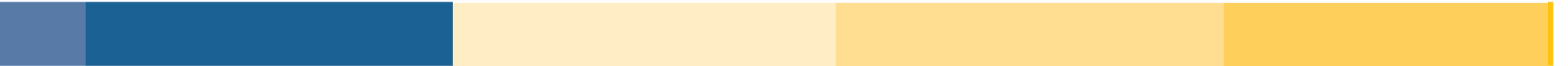
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**Elicit and use student thinking to adjust instruction continually in ways that support learning.** Effective teaching of mathematics elicits evidence of student thinking to adjust instruction continually in ways that support learning.

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Mathematics learning, at a minimum, means learning:

- + Ways of thinking that are empowered by...
- + Habits of thinking, along with an ability to make sense of and use some...
- + Ways of doing to do something bigger with mathematics.



# Re-examining Standards

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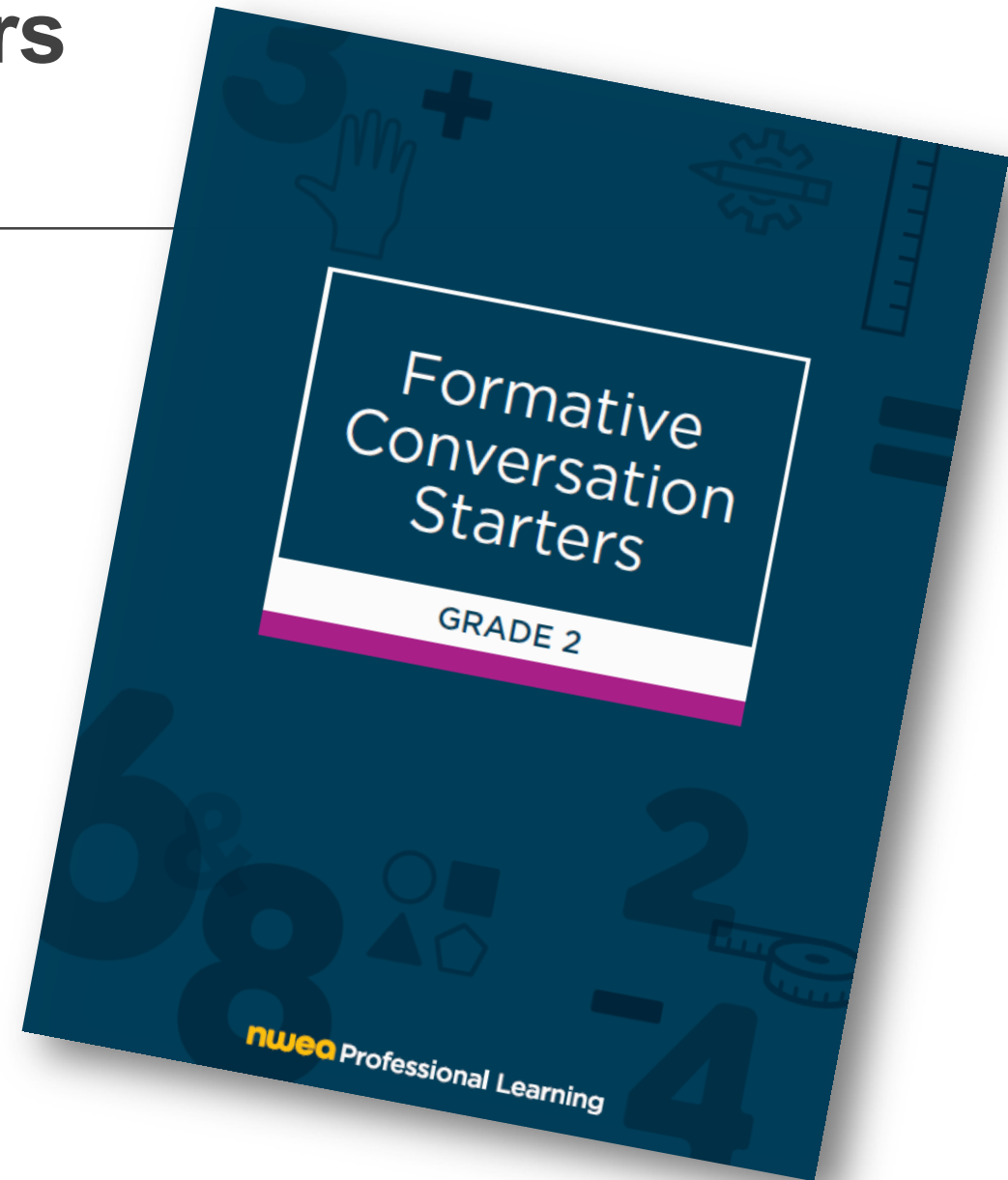
- + A renewed urgency to focus on mathematics that transcends “grade-level standards”:
  - Ways of thinking continue to grow through ongoing grades. They need to be reinforced throughout the following years.
  - Re-packing the mathematics? It still needs to make sense – all the way down.
  - We need clear, shared meanings about (and not just around) the mathematics.

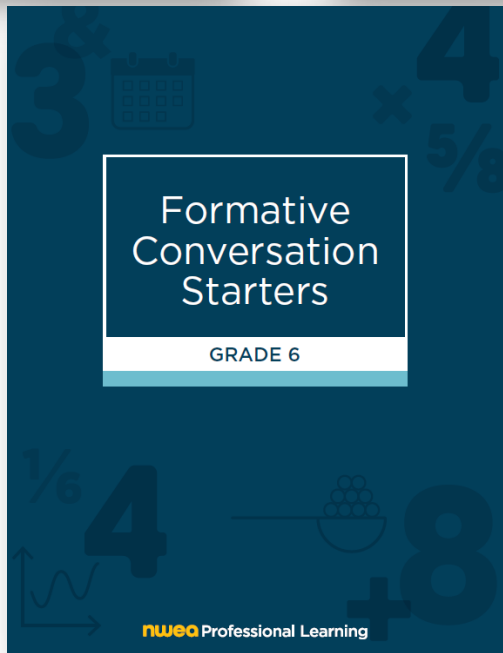
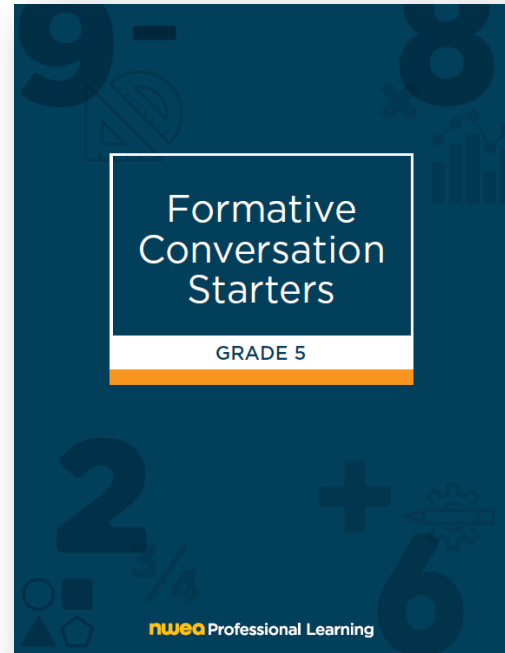
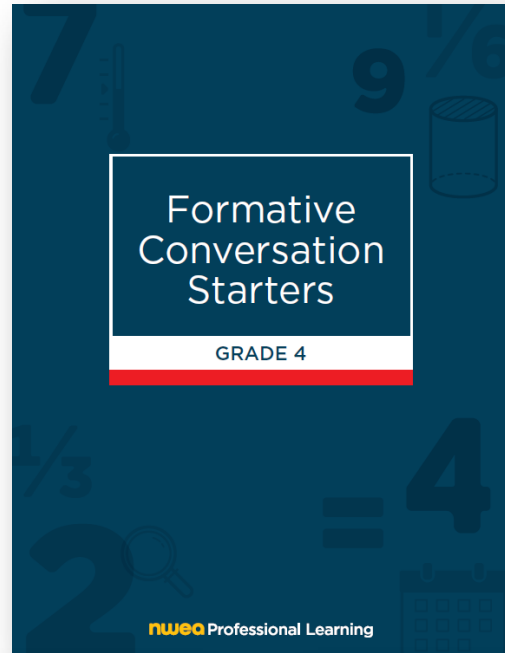
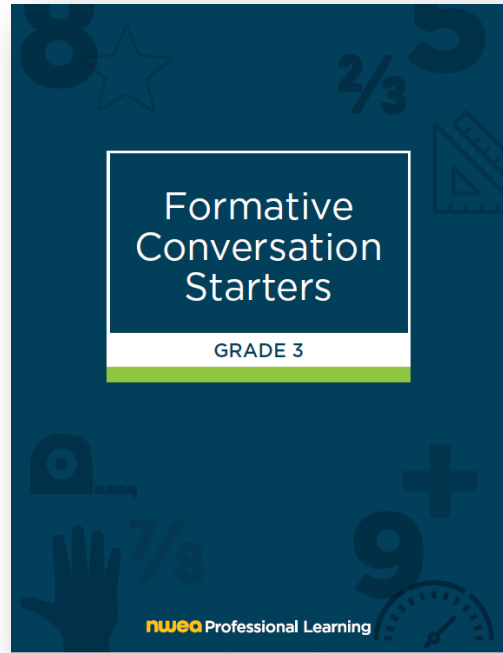
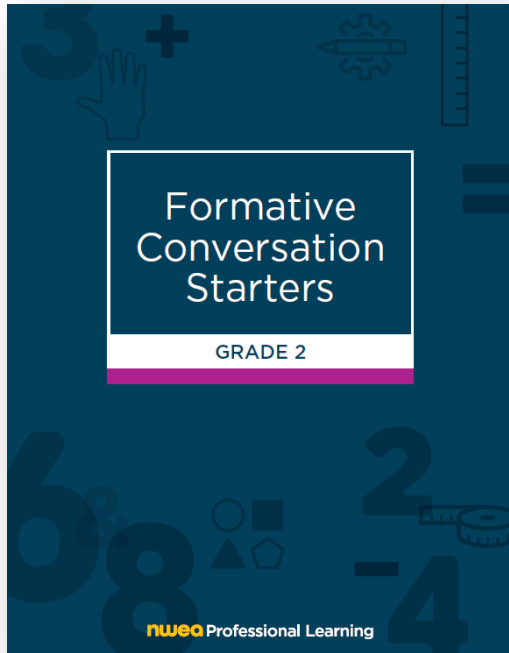


# Formative Conversation Starters

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- + Grounded in enduring ways of thinking that transcend grade levels.
- + Invite opportunities to *listen* to how students are thinking.
- + Accessible, easy to use, safe, and free.





# BINS (Big Ideas to Nurture Sense-making)

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+ Operations

+ Place Value

+ Comparisons

+ Measurement

+ Fractions

+ Formulas

+ Variables

+ Covarying Quantities

+ Proportional Relationships

+ The Equal Sign

# BINS: Operations

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- + **Operations:** Students begin to develop meanings for operations in kindergarten (e.g., addition is putting together). As they progress, the numbers involved—and operational meanings—extend. Students should develop ways of thinking that enable them to connect operation meanings to everyday use of those operations. Operations should never be disconnected from meaning. Division of fractions, for example, is still a form of division and should connect to a meaning of division.

# FCS: Operations (Sample)

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In mathematics, what does division do for us?

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- **Without computing, what is one meaning of division you can use to make sense of  $10 \div (0.2)$  (or  $10 \div \frac{1}{5}$ )?**

# FCS: Operations (Sample)

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In mathematics, what does division do for us?

- Without computing, what is one meaning of division you can use to make sense of  $10 \div (0.2)$  (or  $10 \div \frac{1}{5}$ )?
- **Without computing, what is one meaning of division you can use to make sense of  $(-10) \div (0.2)$  (or  $(-10) \div \frac{1}{5}$ )?**

# FCS: Operations (Sample)

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In mathematics, what does division do for us?

- Without computing, what is one meaning of division you can use to make sense of  $10 \div (0.2)$  (or  $10 \div \frac{1}{5}$ )?
- Without computing, what is one meaning of division you can use to make sense of  $(-10) \div (0.2)$  (or  $(-10) \div \frac{1}{5}$ )?
- **Without computing, describe how you can estimate the value of  $(-10) \div (-0.3)$  using division as comparison (copies of, or times as large language).**



# BINS: Fractions

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A fraction is a single number. It is a number just as 1, or 100, or 37,549 are, and it has a location on the number line. Students should be able to think of a fraction as a number and treat it as such. The fraction  $a/b$  can be thought of as  $a$  copies of  $1/b$  where  $1/b$  is the length of a single part when the interval from 0 to 1 is partitioned into  $b$  parts. Two fractions are equivalent when they share a location on the number line.

# The Formative Conversation Starters - Structure

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# 4.4

## ITEM ALIGNMENT

CCSS: 4.NF.A.2

*This item focuses on ordering fractions. However, it also provides opportunities to talk about*

*the meanings of the numerators and denominators, the importance of the same whole, comparisons, and thinking with fraction understanding.*

## THE CONVERSATION STARTER

Move the fractions so that they are in order from least to greatest.

least     greatest

$\frac{3}{8}$

$\frac{5}{6}$

$\frac{11}{12}$

$\frac{1}{2}$

# About \_\_\_\_\_, but also About \_\_\_\_\_.

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## Fraction Task Activity Directions:

- ❑ Shortly you will be sent to breakout rooms
- ❑ Please click on the link to the FCS in the chat.
- ❑ Open the link to the JamBoard which is now in the chat.
- ❑ Select the board with the same number as your breakout room
- ❑ Follow the direction on your Jamboard. This will be a 10 min. activity.

# 4.4

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## 4.4A

### A. Content: Fractions (Meaning)

What is a fraction?

Is a fraction two numbers or one number?

What other words are used when talking about fractions? What do they mean?

What do you think of when you see the fraction  $\frac{3}{8}$ ?

- If it means “3 out of 8,” then what does  $\frac{8}{3}$  mean?

## 4.4 D

### D. Content: Fractions (Meaning)

Look at this diagram.



How could you use this diagram to show that  $\frac{2}{5}$  is 2 times as large as  $\frac{1}{5}$ ?

How could you use this diagram to show that  $\frac{2}{5}$  is 2 times as large as  $\frac{2}{10}$ ?

How could the diagram represent  $\frac{2}{5}$ ?

There are five circles in the diagram, but is there a way you could use the five circles to show  $\frac{2}{3}$ ?

# Questioning

Listen, don't teach...yet. It isn't about right or wrong *right now*, it's about insight into student thinking.

- Can you tell me more about that?
- You look like you're really thinking about this. What are you thinking?
- Can you draw me a picture/write an equation?
- How did you get that answer?
- Is there another way that you could find that answer?



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# Video Clip #1

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# Video Clip #2

# Reflecting on Formative Conversation Starters

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- + What was impactful?
- + What questions would you want to ask these students?
- + What questions do you have?

# Thank you

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TI STEM Exchange

# Closing Comments

Understanding Students' Ways of Thinking in Mathematics



*TI Education Technology is transforming the way teachers teach and students learn STEM (science, technology, engineering and mathematics) subjects.*

*Joanie Funderburk*

*Strategic Alliance Director | Texas Instruments*





TI STEM Exchange

# Engaging Students in Science: Using Crosscutting Concepts to Prompt Student Sensemaking of Phenomena

Wednesday, May 4 6:00 – 7:30 pm CT

More information and registration will be available soon at <https://education.ti.com/en/resources/ti-stem-exchange>





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# TI STEM Exchange

Thank you!

