How to "go deep" to meet the new math standards
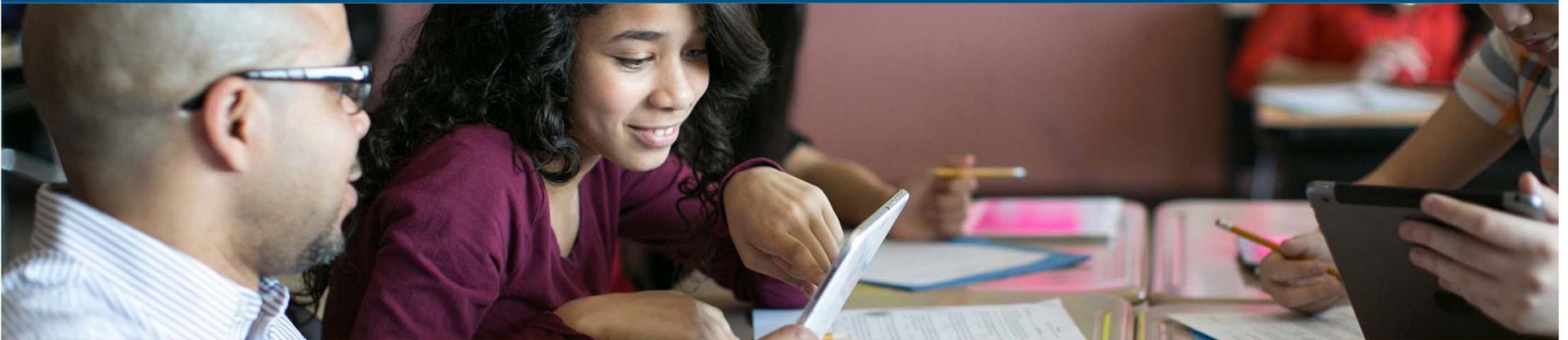
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RENAISSANCE LEARNING

Polling questions:
Agree or Disagree?

1. Not all students are able to think deeply about mathematics.

2. Some students need supports and scaffolding in order to think deeply.

3. Deeper learning means doing increasingly harder math problems

4. Multi-step and longer problems always show deeper understanding.
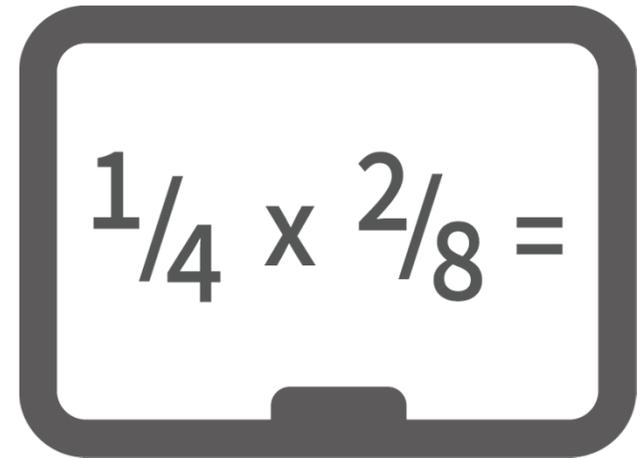
$$\frac{1}{4} \times \frac{2}{8} =$$

Presentation Overview

- The three mathematical practices that tap deeper understanding
- Dispel some common **misconceptions** about Depth of Knowledge
- Enrichment versus acceleration in college and career readiness standards
- The difference between scaffolding instruction and differentiation
- Sample items that help us to look at the new math standards and deeper understanding

Laying some groundwork

- What comes to mind when you think of "cognitive rigor" or deeper understanding as it relates to mathematics instruction, learning, or assessment?
  - "Higher order" verbs?
  - Harder problems?

- First let's start with a few key ideas…
  - Defining Depth of Knowledge (DOK)
  - Mathematical Practices & DOK

Webb's Depth-of-Knowledge Levels

- **DOK-1** – **Recall & Reproduction** - Recall a fact, term, principle, concept; perform a routine procedure – measure, calculate, apply rule (e.g., Problems that provide practice - "Doing the drills")

- **DOK-2** - **Basic Application of Skills/Concepts** - Use of information, conceptual knowledge, select appropriate procedures for a task, two or more steps with decision points along the way, routine problems applying 2+ concepts, organize/display data, interpret/use simple graphs; categorize data; extend patterns (e.g., Word Problems)

- **DOK-3** - **Strategic Thinking** - Requires reasoning, developing a plan or sequence of steps to approach problem; requires some decision making and **justification**; abstract, complex, or non-routine; often more than one possible answer or approach (e.g., Performance Tasks; "playing the game")

- **DOK-4** - **Extended Thinking** – Design & conduct an **original** investigation; requires more time to research, problem solve, and process and collect evidence across **multiple** conditions (real world); non-routine manipulations, across disciplines/content areas/multiple sources (e.g., Projects)

Math Content Standards & Math Practices

Depth + Thinking	Level 1 Recall & Reproduction	Level 2 Skills & Concepts (routine applications)	Level 3 Strategic Thinking (support with data, equations, models, etc.)	Level 4 Extended Thinking (across domains)
Remember	Know math facts, terms			
Understand	Attend to precision Evaluate expressions, plot point	Model with mathematics Estimate, predict, observe, explain relationships	Construct viable arguments Geometry proof	Integrate concepts across domains
Apply	Calculate, measure, make conversions	Make sense of routine problems	Make sense of non-routine problems	Design & conduct a project
Analyze	Identify a pattern Locate information in table	Use tools strategically Classify, organize data, extend a pattern	Reason abstractly Generalize a pattern	Analyze multiple sources of evidence
Evaluate			Critique the reasoning of others	
Create				Design a complex model

DOK Misconception #1:

Not all kids can do this; or Only some kids need supports & scaffolding to get there.

Engaging in "a complex task" with supports/ scaffolding is an essential step along the way to proficiency (Vygotsky's ZPD)

- Do it with others first; DOK 3 and 4 are not meant to only be done alone/independently, *especially at first*

- Oral language & meaningful discourse support deeper thinking and increase initial exposures to the content and student engagement. Talking is NOT cheating!

- **One strategy:** Plan questioning & a series of formative probes applying increasing complexity from DOK 1-2-3-4 over the course of a lesson or unit of study. *Consider all* DOK levels in your planning.

What is being assessed with each task? What mental processing is required?

- Is this a <u>part</u> or a <u>whole</u>? (recall a term – DOK 1)

- What does it mean to be equivalent? (concept – DOK 2)

- Can you divide this into 2, 3…equal parts? (apply procedure – DOK 1)

- Is this a half or not a half? Explain how you know? (multi-step with decisions, evidence, and rationale – DOK 3)
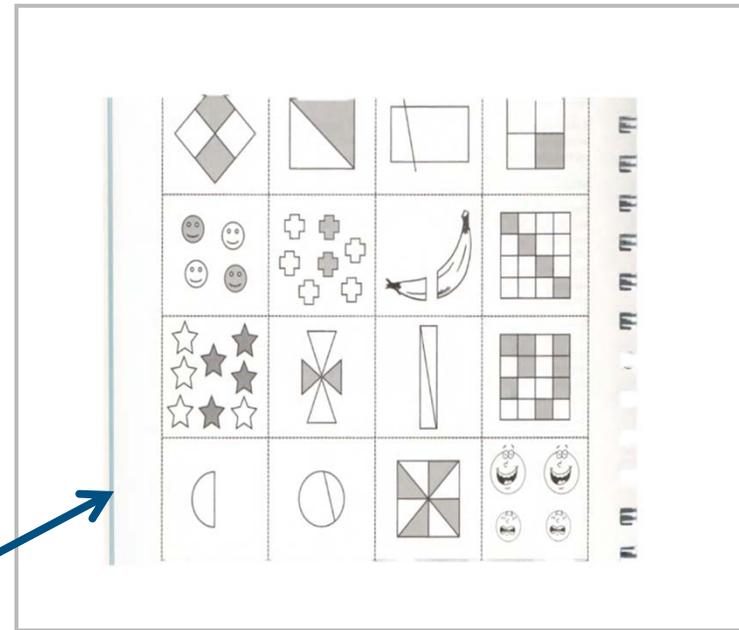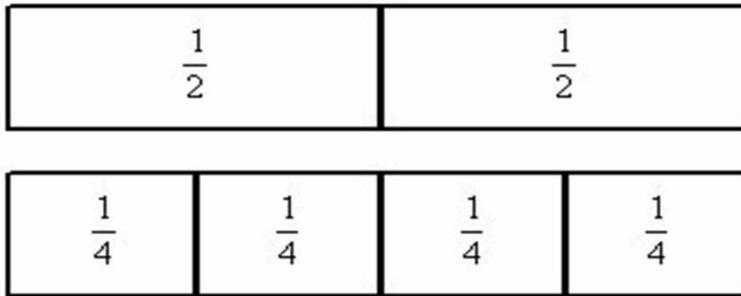
Source: Treacy & Cairnduff. (2009). *Revealing what students think: Diagnostic tasks for fractional numbers*

What is being assessed?
What mental processing is required?

Use a model to determine why two fractions are equivalent

1. Both whole strips are the same length. Using the model, explain why $\frac{1}{2} = \frac{2}{4}$.

$\frac{1}{2}$	$\frac{1}{2}$

$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$

[A]   One $\frac{1}{2}$ strip is the same length as two $\frac{1}{4}$ strips.

[B]   Two $\frac{1}{2}$ strips are the same length as two $\frac{1}{4}$ strips.

[C]   One $\frac{1}{2}$ strip is the same length as one $\frac{1}{4}$ strip.

What is being assessed?
What mental processing is required?

Create a model to show that 2 fractions <u>are</u> OR <u>are not</u> equivalent.

- Look at this strip

1/2	1/2

- Use the strips below to <u>show and explain (in words)</u>
  why 1/2 = 2/4   **AND why**   **1/2 ≠ 1/3**

Why "words" are important…

- Words uncover thinking and reasoning
- Some students get the right answer for the wrong reasons or have incomplete understandings
- Some students get the wrong answers, but actually know more than the problem asks for
- Student explanations of reasoning lead us to know what to ask next

What does the student actually know?

Is ¼ of the square shaded? Explain your answer.

Source:

> 2006 VT Mathematics Partnership Ongoing Assessment Project
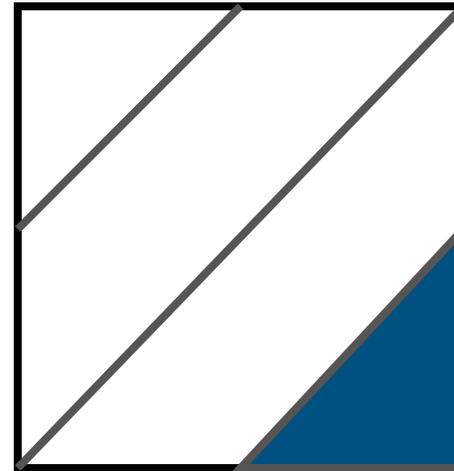
Maria's response:

No, it's not because the parts the square is divided into are not equal. It can't be ¼ of the square unless all of the parts are equal. If the square was like this: or like this: ¼ would be shaded.
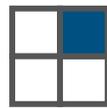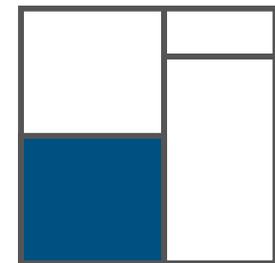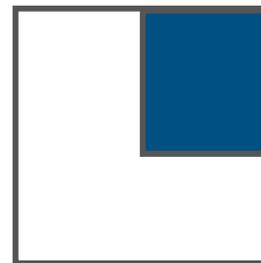
But what if the figure looked like either of these (non-routine, more complex)?

DOK Misconception #2:

Bloom verbs & levels = Webb DOK

The DOK "Wheel of Misfortune" implies that a DOK level is indicated by a particular verb or set of verbs.
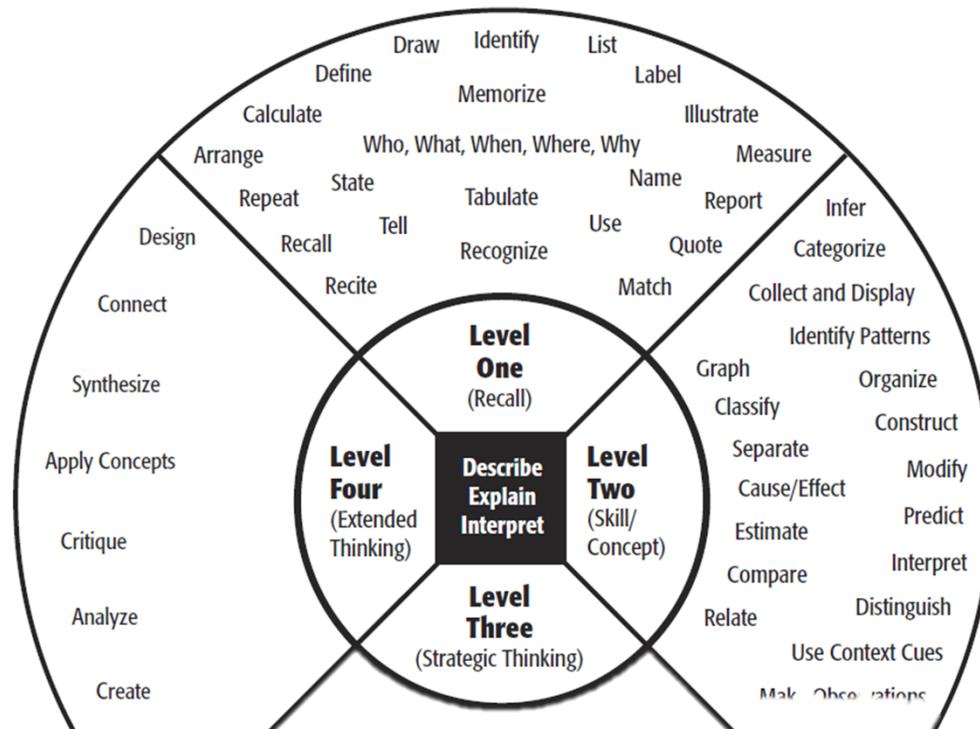
Norman Webb, "It's <u>what comes after the verb</u>, that indicates the complexity of a task."

Which question is "harder?"

Use a division sentence to represent objects divided into equal groups

1. There are 15 softballs. Each bag holds the same number of softballs.

How many softballs are in each bag? Which number sentence matches this?

[A] $15 \div 3 = \square$ [B] $15 - 3 = \square$ [C] $15 \times 3 = \square$ [D] $15 + 3 = \square$

WP: Solve a multiplication problem within 100 involving equal groups

1. Daria has 7 pages in her photo book. There are 10 pictures on each page. How many pictures are in her photo book?

[A] 70 pictures   [B] 63 pictures   [C] 17 pictures   [D] 80 pictures

DOK Misconception #3:

DOK is about <u>difficulty</u>.

- The intended student learning outcome determines the DOK level. **What mental processing must occur?**

- **DOK = Complexity, not difficulty!**

- While verbs may suggest a DOK level, it is what comes after the verb that is the best indicator of the rigor/DOK level and complexity of the task.

  - Describe what information is in the data table; or the rule for rounding a number

  - Describe how the two geometric figures are alike / different.

  - Describe the data, calculations, diagrams, or reasoning that support or prove that your solution is reasonable/correct

  - Describe how this _____ could be used to solve a real world problem and then try it out to see if it works

Instruction and assessment decisions

Constructed Response

Performance Tasks

DOK 1
Recall and Reproduction

Remember	Recall basic math facts, definitions, rules, terms
Understand	Evaluate an expression Locate points on a number line
Apply		

DOK 2
Skills and Concepts

Explain if-then relationships Summarize steps to solve problem

Select a procedure according to the problem context and perform it

DOK 3
Reasoning and Thinking

Explain, generalize or connect ideas using supporting evidence (diagrams, models, calculations)

Use concepts to solve non-routine problems and justify solutions

Analyze			Analyze data to identify a pattern and generalize to a rule or formula
Evaluate			Develop a logical argument for conjectures or proof based on one concept or task
Create			Develop a complex model or approach for a given situation Develop an alternative solution

DOK 4
Extended Thinking

Explain how statistics concepts specifically relate to other content domains.

Devise an approach among many alternatives to research a novel problem

Analyze multiple sources of data to describe real-world phenomena

Evaluate relevancy, accuracy and completeness of information across sources

Synthesize across multiple sources/ data sets

Depth + Thinking	Level 1 Recall & Reproduction	Level 2 Skills & Concepts	Level 3 Strategic Thinking/ Reasoning	Level 4 Extended Thinking
Remember	What is slope?			
Understand	Read, write, and represent these fractions	Explain how you solved this problem. Make and explain your estimate	Construct an argument to show equivalence using area, set, and linear models	
Apply	Convert this fraction to a decimal Add these fractions	Use these data to graph your solution	Conduct the investigation, interpret results, and support conclusions with data	
Analyze	What kind of graph or model is this? Which data point shows ____?	Which graph shows how the data would be displayed?	Interpret what was happening in the event? Justify your interpretation using what you know about slope.	
Evaluate	Which team is the best? (opinion without supporting evidence)		How would you rank these ____? Justify your rankings using data that supports your criteria.	Some say the NFL settlement for player brain injury is not adequate. Evaluate both sides using data to determine the validity of this claim.
Create		Create a card game using fractions. Create scenario explained by a data display.		

Some general rules of thumb…

- If there is one correct answer, it is probably level DOK 1 or DOK 2

  - DOK 1: you either know it (can recall it, locate it, do it) or you don't know it

  - DOK 2 (conceptual): apply one concept, then make a decision before going on *applying a second concept*; express relationship (if-then; cause-effect)

- If more than one answer/approach, <u>requiring</u> evidence, it is DOK 3 or 4

  - DOK 3: Must interpret, provide supporting evidence and reasoning (not just HOW solved, but WHY it works– explain reasoning for each step/decision made)

  - DOK 4: all of "3" + use of multiple sources/data/ texts; initiate & complete an investigation

DOK Misconception #4:

Multi-step or longer tasks always means deeper thinking

- DOK 2 is not simply more than one step, it's applying <u>more than one concept</u>

- <u>DOK 2 is still routine/typical</u> (word problems, making observations, explaining steps taken)

- DOK 3 requires problem interpretation, planning and justification or support for the solution

Here's one way teachers in Hawaii illustrated moving from "less complex" work to "more complex" work in math. Work is posted under descriptors (DOK 1-2-3). Post-its represent each student's progress. They ALL get there!

For each assessment task (or rubric)…ask

- What is its purpose? (What content/skill is being assessed? Is there a 'right' answer?)

- What is the implied/intended rigor? (What mental processing would you expect students to engage in? *Use the CRM to find descriptors.*)

- Which standards does it <u>REALLY</u> assess? (content + intended rigor)

- Does the scoring guide/rubric match content + intended rigor?

- What would student responses tell a teacher if students could/could not do all or part of this task? (open-ended tasks, reasoning used) – *next* instructional decisions are clear

Some Take-Aways

- Begin with daily DOK3 classroom discourse!

- Assessing only at the highest DOK level (the "ceiling") will miss opportunities to know what students do & don't know – go for a range; end "high" in selected/prioritized content

- Performance tasks offer varying levels of DOK embedded in a larger, more complex task

- Planned formative assessment strategies and tools can/should focus on differing DOK levels