

# Smarter Balanced Assessment System: Connecting the Mathematics Claims to Classroom Instruction Grades 6-12



Connecticut State Department of Education  
Fall 2014



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*Principals to Actions* e-books will be provided to each participant

**Note:** Thirty *Common Core Standards* flip books will be provided to each RESC, and should be available at each participant table for reference purposes only. These books may not be distributed for participants to keep.

# Food for Thought



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Show this presentation to groups that are attending the Math presentation prior to the ELA presentation. ELA will show the presentation to the earlier group too.

Let the video speak for itself.

[http://www.ted.com/talks/adora\\_svitak?language=en](http://www.ted.com/talks/adora_svitak?language=en)

After video: Reinforce the notion that expectations need to be high. If you set a low expectation, students will “sink” to that level. Teachers need to have the mindset that students CAN achieve at high levels and meet the rigorous levels of the CCS.

## Learning Targets

- I understand the types of learning activities and tasks that will support student mastery of the Standards for Mathematics Content and develop student expertise with the Standards for Mathematical Practice.
- I understand how my classroom instruction supports student learning.
- I understand how classroom activities and tasks align with the summative assessment.



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Page 3

These learning targets should be posted on chart paper for the duration of the workshop.

Unlike instructional objectives, which are about instruction, derived from content standards, written in teacher language, and used to guide teaching during a lesson or across a series of lessons, **learning targets** frame a lesson from the student point of view. A learning target helps students grasp the lesson's purpose--why it is crucial to learn this chunk of information, on this day, and in this way.

With this in mind, the three learning targets stated on this slide inform participants of the learning goals based on the scope of this full-day presentation.

Facilitator, please note that the types of activities found within this presentation support different curricular needs, whether it be developing understanding of the mathematics **content or developing expertise with the mathematical practices**. They are not stand alone activities that should be done just to check off a standard, but should be a part of a larger unit of instruction.

## Success Criteria

- I can explain how the Connecticut Core Standards (CCS) for Mathematics connect to the Smarter Balanced Claims.
- I can meet the scope of the Content Standards and Practice Standards through best practices and by incorporating a variety of strategies and activities in my instruction.

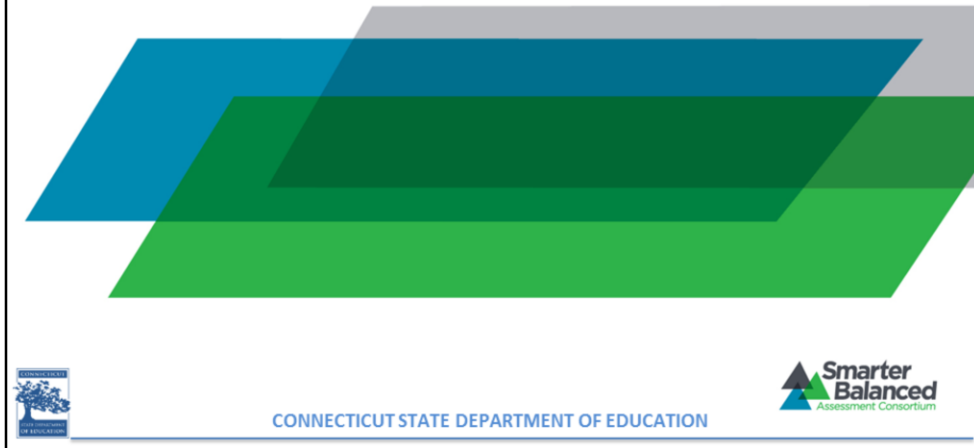


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When presenting this slide, inform participants that these two bullets point frame the scope of learning for this presentation. The success criteria are the Learning Targets written in a student-friendly way, often are posted beginning with the words "I CAN..." indicators that the teacher and the students can use to check their learning against as they work to meet the learning goals. After the completion of a lesson (or in this case, the presentation), students (participants) should revisit the success criteria and be able to tell whether they have met the criteria. Students (participants) should then be part of the development of next steps in planning how they continue to move their learning forward.

## Before We Begin...

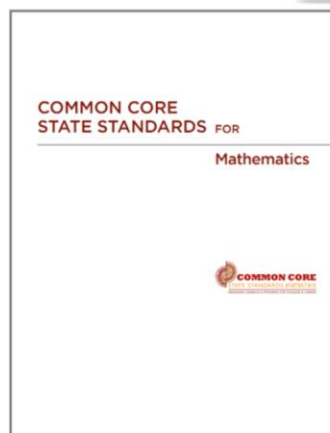


FYI – The Common Core State Standards (CCSS) and Connecticut Core Standards (CCS) are used interchangeably. In Connecticut, we have fully adopted the Common Core State Standards. In order to show our full support of these standards, in Connecticut we refer to them as the Connecticut Core Standards. Therefore, the Common Core State Standards ARE the Connecticut Core Standards.

## The CCS Require Three Shifts in Mathematics



- **Focus** strongly where the standards focus
- **Coherence: Think** across grades and **link** to major topics within grades Handout
- **Rigor:** In major topics, pursue **conceptual understanding**, procedural skill and **fluency**, and **application** with equal intensity



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Slide 6

### Key Shifts of the Common Core State Standards:

Handout 1 from [AchievetheCore.com](http://AchievetheCore.com) provides an explanation of the shifts. It is not necessary to review the handout, but let participants know that this handout that addresses the key shifts is included in their folder. As facilitator, you should remind participants that the shifts do include the following:

#### 1) Focus strongly where the Standards focus

- These standards are a move away from providing a mile-wide, inch-deep curriculum.
- We focus deeply on the **major work** of each grade so that students can gain strong foundations and develop:
  - solid conceptual understanding
  - a high degree of procedural skill and fluency
  - the ability to apply the math they know to solve problems inside and outside the math classroom

#### 2) Coherence: think across grades, and link to major topics within grades

- **Thinking across grades:**
  - The Standards are designed around coherent progressions from grade to grade

- Learning is connected across grades
- Students can build new understanding onto foundations built in previous years
- Each standard is not a new event, but an extension of previous learning
- **Linking to major topics:**
  - Additional or supporting topics shouldn't detract from the focus of the grade but are incorporated within the grade level focus.

### 3) Rigor: in major topics pursue:

- **Conceptual understanding:**
  - The Standards call for conceptual understanding of key concepts
  - Students should see math as more than a set of mnemonics or discrete procedures
- **Procedural skill and fluency:**
  - The Standards call for speed and accuracy in calculation.
  - Providing instruction based on developing understanding of the underlying properties of operations and the relationships across operations will eventually lead to students committing core functions , such as single digit multiplication to memory.
  - **application** with equal intensity.
- **Application:**
  - The Standards call for students to use math flexibly for applications in problem-solving contexts both within and outside mathematics content.

## Key Areas of Focus in Mathematics

Grade	Focus Areas in Support of Rich Instruction and Expectations of Fluency and Conceptual Understanding
K-2	Addition and subtraction - concepts, skills, and problem solving and place value
3-5	Multiplication and division of whole numbers and fractions – concepts, skills, and problem solving
6	Ratios and proportional reasoning; early expressions and equations
7	Ratios and proportional reasoning; arithmetic of rational numbers
8	Linear algebra and linear functions



Shift #1 references “the major work” of the grade. The key areas of focus in mathematics are described by grade band.

(Read the grade-band key areas of focus from slide)



## Key Areas of Focus in High School Mathematics

Conceptual Category	Focus Clusters
<b>Numbers and Quantity</b>	Real numbers and Quantities
<b>Algebra</b>	Seeing Structure in Expressions, Arithmetic with Polynomial and Rational Expressions, Creating Equations, Reasoning with Equations and Inequalities
<b>Functions</b>	Interpreting Functions, Building Functions, and Linear, Quadratic and Exponential Models
<b>Geometry</b>	Similarity, Right Triangles and Trigonometry
<b>Statistics and Probability</b>	Interpreting Categorical and Quantitative Data and Making Inferences and Drawing Conclusions



This is adapted from the High School Publishers Criteria for CCSS for Mathematics. The focus cluster under each conceptual category shows the content from CCSM that is widely applicable as prerequisites for a range of college majors, postsecondary programs and careers. This was informed by postsecondary survey data in Conley *et al.* (2011), "Reaching the Goal: The Applicability and Importance of the Common Core State Standards to College and Career Readiness."

## Shift #3: Rigor

### Required Fluencies for Grades K-6

Grade	Standard	Required Fluency
K	K.OA.5	Add/subtract within 5
1	1.OA.6	Add/subtract within 10
2	2.OA.2 2.NBT.5	Add/subtract within 20 (know single-digit sums from memory) Add/subtract within 100
3	3.OA.7 3.NBT.2	Multiply/divide within 100 (know single-digit products from memory) Add/subtract within 1000
4	4.NBT.4	Add/subtract within 1,000,000
5	5.NBT.5	Multi-digit multiplication
6	6.NS.2,3	Multi-digit division Multi-digit decimal operations



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Slide 9

Shift #3 references required fluencies for Grades K-6.

- Throughout the K-6 standards in CCSSM there are also individual content standards that set expectations for fluency in computation (e.g., fluent multiplication and division within the times tables in Grade 3).
- Such standards are culminations of progressions of learning, often spanning several grades, involving conceptual understanding, thoughtful practice, and extra support where necessary.

# The Standards for Mathematical Content

COMMON CORE STATE STANDARDS for MATHEMATICS

## Ratios and Proportional Relationships

7.RP

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

1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. *For example, if a person walks  $1/2$  mile in each  $1/4$  hour, compute the unit rate as the complex fraction  $1/2 \div 1/4$  miles per hour, equivalently 2 miles per hour.*
2. Recognize and represent proportional relationships between quantities.
  - a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
  - b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
  - c. Represent proportional relationships by equations. *For example, if total cost  $t$  is proportional to the number  $n$  of items purchased at a constant price  $p$ , the relationship between the total cost and the number of items can be expressed as  $t = pn$ .*
  - 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.
3. Use proportional relationships to solve multistep ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.*



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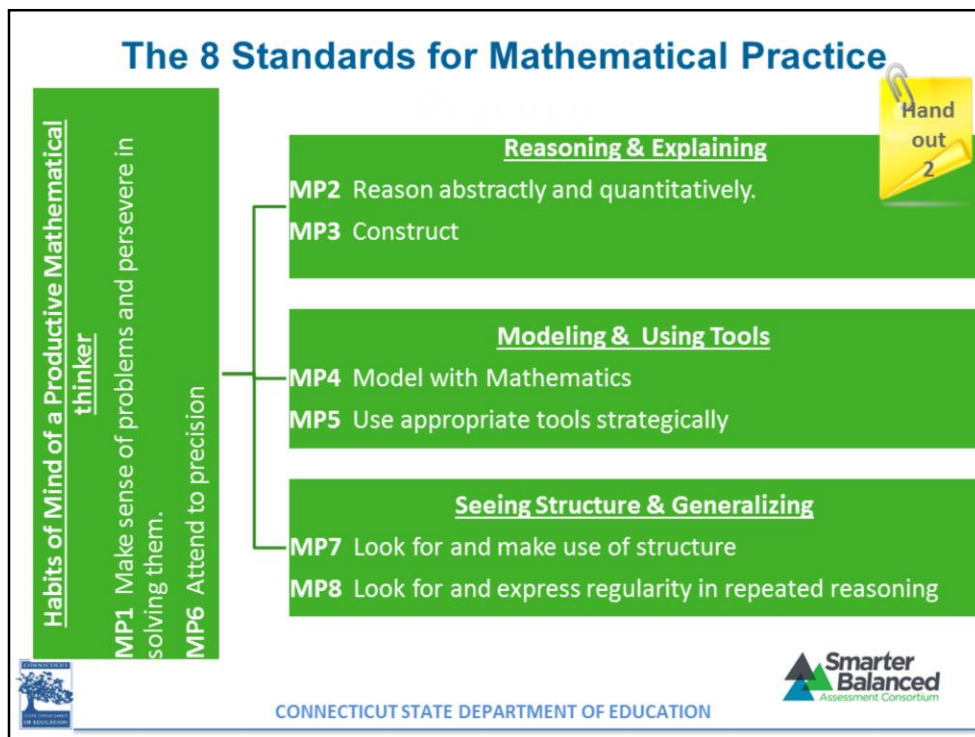


As you know, the CCS for Mathematics is comprised of two equally important components, the Standards for Mathematical Content and the Standards for Mathematical Practice.

The Standards for Mathematical Content specify the mathematics content that should be taught at each grade level, or in the case of high school, the mathematics that all students should study in order to be college and career ready upon graduation from high school.

The K-8 standards are listed by domain and the high school standards are listed in conceptual categories rather than by grade level domains:

- Number and Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics and Probability



This is an overview of the 8 Standards for Mathematical Practice. This template was created by Dr. Bill McCallum, lead head writer of the CCSS mathematics.

These practice standards describe varieties of expertise that mathematics educators AT ALL LEVELS [Kindergarten through HS] should seek to develop in their students.

These “habits of mind” mathematical practices encompass NCTM’S Mathematical process standards and the National Research Council’s mathematical proficiency strands. They carry across all grade levels.

The mathematically proficient student should have such a well-grounded understanding of how to employ the Standards for Mathematical Practice that they become Habits of Mind.

Handout 2 in your packet provides an overview of the 8 Practice Standards. This document describes the student behaviors for each Practice Standard. We will be looking for these required student behaviors as we engage in classroom activities and tasks.

## Reminders...

Keep in mind that the CCS for Mathematics:

- are **NOT** discrete skills to be taught in isolation.
- define both content and practices that should be included in instruction.

Cloning, drilling and killing is **not** an effective instructional practice.

High quality instruction → Improved student achievement



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Page 12

This presentation is **not** about starting with a standardized test and trying to figure out how to prepare your students. **Cloning, drilling and killing is not an effective instructional practice.**

This presentation will focus on how the CCS Standards for Mathematical Content, Standards for Mathematical Practice and the 8 Mathematics Teaching Practices from NCTM's *Principles to Actions* are embodied in the Smarter Balanced Mathematics Claims.

High quality instruction focused on developing students' habits of mind with the Practice Standards is transferable to the Smarter Balanced assessments.

From this point forward we are asking **participants to be in the position of learners**. We will be modeling for you ways to support content, develop expertise with the Standards for Mathematical Practice and incorporate the 8 Mathematics Teaching Practices into your daily instruction.

Much of this may be validating. You may see many of the best practices you are already using in your classroom. We hope to show you multiple pathways to integrating the standards into your instruction. By the end of this presentation, we will specifically connect how these instructional practices connect to the claims of the Smarter Balanced assessment.

Remember, if you are teaching a curriculum aligned to the Connecticut Core Standards , you are preparing your students for college and career readiness. The Smarter Balanced resources such as the Digital Library and the Interim Assessments (addressed later on) can help teachers adjust and modify teaching and learning. The summative assessment will take care of itself.

## NCTM Principles to Actions: Ensuring Mathematical Success for All



The primary purpose of Principles to Actions is to fill the gap between the adoption of rigorous standards and the enactment of practices, policies, programs, and actions required for successful implementation of those standards.

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM



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Page 13

The National Council of Teachers of Mathematics (NCTM) recently published *Principles to Actions: Ensuring Mathematical Success for All*.

(Read the slide for the primary purpose of Principles to Action)

# Guiding Principles for School Mathematics



## 1. Teaching and Learning

2. Access and Equity

3. Curriculum

4. Tools and Technology

5. Assessment

6. Professionalism



**Essential  
Elements  
of Effective  
Mathematics  
Programs**

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM



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14

NCTM's Principles to Actions addresses and documents the realities that exist in too many classrooms, schools, and districts across our nation, including:

- Too much focus on learning procedures without any connection to meaning, understanding, or the applications that require these procedures.
- Too many students are limited by the lower expectations and narrower curricula of remedial tracks from which few ever emerge.
- Too many teachers have limited access to the instructional materials, tools, and technology that they need.

Three aspects of Principles to Actions are new, provocative, and important.

1. Principles to Actions devotes the largest section to Teaching and Learning, the first Guiding Principle, and describes and illustrates eight Mathematics Teaching Practices that research indicates need to be consistent components of every mathematics lesson. We will be connecting these Teaching Practices to the Standards for Mathematical Practice as we move through the tasks for today.
2. For each Guiding Principle, Principles to Actions offers commentary and a table that address productive and unproductive beliefs as part of a realistic appraisal of the obstacles that we face, as well as suggestions for overcoming these obstacles. You have all been given an e-version of the book and it is worth the time to look at these tables. A listing the productive and unproductive beliefs can be found on page 11 of the book.



3. Principles to Actions issues a forceful call to action, asserting that all of us who are stakeholders have a role to play and important actions to take if we are finally to recognize our critical need for a world where the mathematics education of our students draws from research, is informed by common sense and good judgment, and is driven by a nonnegotiable belief that we must develop mathematical understanding and self-confidence in **all** students.

## Eight Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations
4. Facilitate meaningful mathematical discourse
5. Pose purposeful questions
6. Build procedural fluency from conceptual understanding
7. Support productive struggle in learning mathematics
8. Elicit and use evidence of student thinking

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM, p.10



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Page 15

*Principles to Actions* outlines eight Mathematics Teaching Practices that provide a framework for strengthening the teaching and learning of mathematics.

This research-informed framework reflects learning principles and knowledge of mathematics teaching that has accumulated over the last two decades.

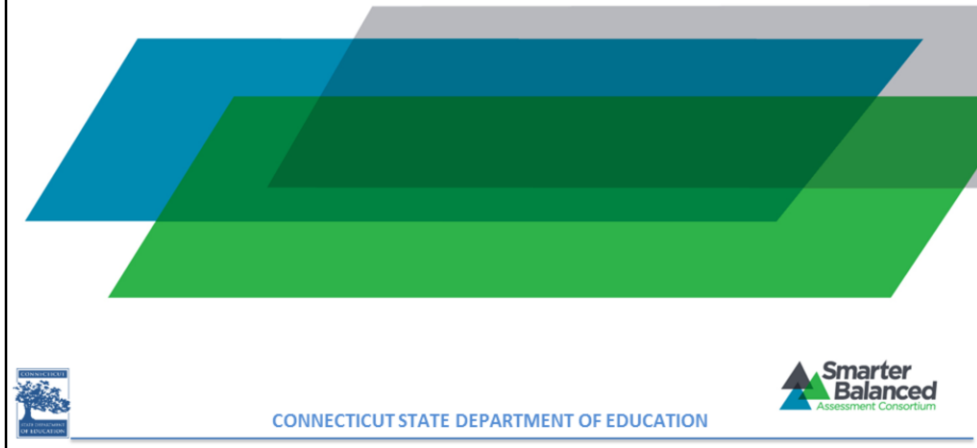
The eight Mathematics Teaching Practices represent a core set of high-leverage practices and essential teaching skills necessary to promote deep learning of mathematics.

Turn to page 3 in Handout 3 (Principles to Action Executive Summary)

The eight practices are... (read from slide).

We will incorporate these teaching practices into our discussion about the relationship between the CCS Standards for Mathematical Content, the Standards for Mathematical Practice and the Smarter Balanced Claims.

# The Mathematics Claims



The Smarter Balanced Claims are summary statements about the knowledge and skills students will be expected to demonstrate on the assessment related to a particular aspect of the CCS for Mathematics.

## Claims for the Mathematics Summative Assessment

### Overall Claim for Grades 3-8

Students can demonstrate **progress toward** college and career readiness in mathematics.

### Overall Claim for Grade 11

Students can demonstrate college and career readiness in mathematics.

#### Claim #1 – Concepts and Procedures

"Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency."

#### Claim #2 – Problem Solving

"Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies."

#### Claim #3 - Communicating Reasoning

"Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others."

#### Claim #4 - Modeling and Data Analysis

"Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems."

From the [Smarter Balanced Mathematics Content Specifications](#)



The Overall Claims are specific to grades 3-8 (progressing towards college and career readiness) and grade 11 (demonstrate college and career readiness). The claims are summary statements about the knowledge and skills students will be expected to demonstrate on the assessment related to a particular aspect of the CT Core Standards for Mathematics. **The Overall Claim scale score will be reported along with an associated achievement level (1,2,3,4)**

The four Mathematics Claims under the Overall Claim across grades 3-8 and 11 are:

- Claim 1 – Concepts and Procedures. Claim 1 items measure the extent to which students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.
- Claim 2 – Problem Solving. Claim 2 items measure the extent to which students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.
- Claim 3 – Communicating Reasoning. Claim 3 items measure the extent to which students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.
- Claim 4 – Modeling and Data Analysis. Claim 4 items measure the extent to which students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

Claims 2 and 4 will be reported as one score.

For additional information about the Smarter Balanced Claims, refer to the Smarter Balanced Mathematics Content Specifications available on the Smarter Balanced Web site.

## Overall Claim and Mathematics Teaching Practices

Overall Claim	Mathematics Teaching Practice
<p><b>Grades 3-8:</b></p> <ul style="list-style-type: none"> <li>Students can demonstrate <b>progress toward</b> college and career readiness in mathematics.</li> </ul> <p><b>Grade 11:</b></p> <ul style="list-style-type: none"> <li>Students can demonstrate college and career readiness in mathematics.</li> </ul>	<p><b>Establishing Mathematics Goals to Focus Learning</b></p> <p>Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses goals to guide instructional decisions.</p> <p><b>Elicit and use evidence of student thinking</b></p> <p>Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning</p>

Just as the Overall Claim is a summary statement about what students know and can do by the end of the school year, the Mathematics Teaching Practices, Establishing Mathematics Goals to Focus Learning and Elicit and use evidence of student thinking, are practices that have overarching implications for instruction throughout the year.

By engaging in a shared understanding among teachers of the mathematics that students are learning and how this mathematics develops along the learning progressions, both prior learning and where it is going, teachers are better able to make decisions to guide instruction .

The establishment of clear goals not only guides teachers’ decision making during a lesson, but also focuses students’ attention on monitoring their own progress toward the intended learning outcomes.

Learning goals situated within mathematics learning progressions and connected to the “big ideas” of mathematics provide a stronger bases for teachers’ instructional decisions.

From Principles to Action, page 53:

“The gathering of evidence of student thinking should neither be left to chance nor occur sporadically. Preparation of each lesson needs to include intentional and systematic plans to elicit evidence that will provide “a constant stream of information

about how student learning is evolving toward the desired goal” (Heritage 2008, p.6).

## Teacher and Student Actions

Establish mathematics goals to focus learning Teacher and student actions	
What are <i>teachers</i> doing?	What are <i>students</i> doing?
<p>Establishing clear goals that articulate the mathematics that students are learning as a result of instruction in a lesson, over a series of lessons, or throughout a unit.</p> <p>Identifying how the goals fit within a mathematics learning progression.</p> <p>Discussing and referring to the mathematical purpose and goal of a lesson during instruction to ensure that students understand how the current work contributes to their learning.</p> <p>Using the mathematics goals to guide lesson planning and reflection and to make in-the-moment decisions during instruction.</p>	<p>Engaging in discussions of the mathematical purpose and goals related to their current work in the mathematics classroom (e.g., What are we learning? Why are we learning it?)</p> <p>Using the learning goals to stay focused on their progress in improving their understanding of mathematics content and proficiency in using mathematical practices.</p> <p>Connecting their current work with the mathematics that they studied previously and seeing where the mathematics is going.</p> <p>Assessing and monitoring their own understanding and progress toward the mathematics learning goals.</p>

NCTM. (2014). Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: NCTM p. 16

The actions listed in this table summarize what teachers and students are doing in mathematics classrooms that establish goals to focus learning.



## Teacher and Student Actions

Elicit and use evidence of student thinking Teacher and student actions	
What are teachers doing?	What are students doing?
Identifying what counts as evidence of student progress toward mathematics learning goals.	Revealing their mathematical understanding, reasoning, and methods in written work and classroom discourse.
Eliciting and gathering evidence of student understanding at strategic points during instruction.	Reflecting on mistakes and misconceptions to improve their mathematical understanding.
Interpreting student thinking to assess mathematical understanding, reasoning, and methods.	Asking questions, responding to, and giving suggestions to support the learning of their classmates.
Making in-the-moment decisions on how to respond to students with questions and prompts that probe, scaffold, and extend.	Assessing and monitoring their own progress toward mathematics learning goals and identifying areas in which they need to improve.
Reflecting on evidence of student learning to inform the planning of next instructional steps.	

NCTM. (2014). Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: NCTM p. 56

The actions listed in this table provide guidance on what teachers and students do in eliciting and using evidence of student thinking in the Mathematics Classroom.

# Claim 1

## Concepts and Procedures



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We will now take a closer look at each of the Mathematics Claims and how the Connecticut Core Standards (CCS) for Mathematics connect to the Smarter Balanced Claims for Mathematics.

## Claim 1: Concepts and Procedures

“Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.”



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Claim 1 items measure the extent to which students are able to explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.

## Rationale for Claim 1

- This claim addresses procedural skills and the conceptual understanding on which developing skills depend. It is important to assess how aware students are of how concepts link together and why mathematical procedures work the way they do.
- Central to understanding this claim is making the connection to these elements of the mathematical practices as stated in the CCS for Mathematics.
  - **MP5. Use appropriate tools strategically.**
  - **MP6. Attend to precision.**
  - **MP7. Look for and make use of structure.**
  - **MP8. Look for and express regularity in repeated reasoning.**



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Read the slide. Tell participants to refer to Handout 2 that describes the student behaviors for each Practice Standard noted on the slide. Give a couple of minutes for them to read those behaviors and then explain that we will be looking for these student behaviors as we engage in classroom activities and tasks.

## Smarter Balanced Assessment Targets

- Provide more detail about the range of content and Depth of Knowledge levels.
- Intended to support the development of high-quality items and tasks that contribute evidence to the claims.



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Each Claim is accompanied by a set of assessment targets that provide more detail about the range of content and Depth of Knowledge levels. The targets are intended to support the development of high-quality items and tasks that contribute evidence to the claims.

# Smarter Balanced Cognitive Rigor Matrix

Handout  
4

Depth of Thinking (Webb) + Type of Thinking (Revised Bloom)	DOK Level 1 Recall & Reproduction	DOK Level 2 Basic Skills & Concepts	DOK Level 3 Strategic Thinking & Reasoning	DOK Level 4 Extended Thinking
<b>Remember</b>	- Recall conversions, terms, facts			
<b>Understand</b>	- Evaluate an expression - Locate points on a grid or number or number line - Solve a one-step problem - Represent math relationships in words, pictures, or symbols	- Specify, explain relationships - Make basic inferences or logical predictions from data observations - Use models (diagrams to explain concepts) - Make and explain estimates	- Use concepts to solve non-routine problems - Use supporting evidence to justify conjectures, generalizations, or connect ideas - Explain reasoning when more than one response is possible - Explain phenomena in terms of concepts	- Relate mathematical concepts to other content areas, other domains - Develop generalizations of the results obtained and the strategies used and apply them to new problem situations
<b>Apply</b>	- Follow simple procedures - Calculate, measure, apply a rule (e.g., rounding) - Apply algorithm or formula - Solve linear equations - Make conversions	- Select a procedure and perform it - Solve routine problem applying multiple concepts or decision points - Retrieve information to solve a problem - Translate between representations	- Design investigation for a specific purpose or research question - Use reasoning, planning, and supporting evidence - Translate between problem & symbolic notation when not a direct translation	- Initiate, design, and conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results
<b>Analyze</b>	- Retrieve information from a table or graph to answer a question - Identify a pattern/trend	- Categorize data, figures - Organize, order data - Select appropriate graph and organize & display data - Interpret data from a simple graph - Extend a pattern	- Compare information within or across data sets or texts - Analyze and draw conclusions from data, citing evidence - Generalize a pattern - Interpret data from complex graph	- Analyze multiple sources of evidence or data sets
<b>Evaluate</b>			- Cite evidence and develop a logical argument - Compare/contrast solution methods - Verify reasonableness	- Apply understanding in a novel way, provide argument or justification for the new application
<b>Create</b>	- Brainstorm ideas, concepts, problems, or perspectives related to a topic or concept	- Generate conjectures or hypotheses based on observations or prior knowledge and experience	- Develop an alternative solution - Synthesize information within one data set	- Synthesize information across multiple sources or data sets - Design a model to inform and solve a practical or abstract situation



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The depth of knowledge levels defined by Smarter Balanced are informed by the Cognitive Rigor matrix. The Cognitive Rigor matrix combines two common taxonomies that categorize levels of cognition and shows how the Smarter Balanced depth of knowledge categories relate to these taxonomies. The Smarter Balanced Cognitive Rigor matrix can be found in the Smarter Balanced Content Specifications for Mathematics. Claim 1 items will be at DOK levels 1 and 2. In terms of Bloom's Types of Thinking, Claim 1 items will require understanding and application skills.

Remind participants that a copy of this is in their folders.

Now let's examine the content specifications.

## Claim 1 Assessment Targets

### Grade 7 SUMMATIVE ASSESSMENT TARGETS

#### Providing Evidence Supporting Claim #1

**Claim #1: Students can explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency.**

Content for this claim may be drawn from any of the Grade 7 clusters represented below, with a much greater proportion drawn from clusters designated “m” (major) and the remainder drawn from clusters designated “a/s” (additional/supporting) – with these items fleshing out the major work of the grade. Sampling of Claim #1 assessment targets will be determined by balancing the content assessed with items and tasks for Claims #2, #3, and #4.<sup>18</sup> Grade level content emphases are summarized in Appendix A and CAT sampling proportions for Claim 1 are given in Appendix B.

#### Ratios and Proportional Relationships (7.RP)

**Target A [m]: Analyze proportional relationships and use them to solve real-world and mathematical problems. (DOK 1, 2)**

Tasks for this target will require students to identify and represent proportional relationships in various formats (tables, graphs, equations, diagrams, verbal descriptions) and interpret specific values in context. (See 7.G Target E for possible context.) Other tasks will require students to compute unit rates, including those associated with ratios of fractions.

Multistep problems involving ratio and percent will be assessed by tasks in Claims 2 and 4.



From the Smarter Balanced Mathematics Content Specifications

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As outlined in the Smarter Balanced Mathematics Content Specifications, the Claim 1 Assessment Targets provide more detail about the range of content and Depth of Knowledge levels that are assessed in Claim 1.


The Assessment Targets were written to support the development of high-quality items and tasks that contribute evidence to the claims.

The Assessment Targets for Claim 1 are derived from the cluster headings of the content standards for the Common Core State Standards.


Targets for Claim 1 – concepts and procedures – are derived from the content standards for Common Core State standards. Use of more fine-grained descriptions would risk a tendency to atomize the content, which might lead to assessments that would not meet the intent of the standards. It is important to keep in mind the importance of developing items and tasks that reflect the richness of the mathematics in the CCSS-M.

## Claim 1 and the Mathematics Teaching Practices

Claim 1	Mathematics Teaching Practices
Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency	<p><b>Use and connect mathematical representations</b></p> <p>Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.</p> <p><b>Build procedural fluency from conceptual understanding</b></p> <p>Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.</p>



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 Smarter  
Balanced  
Assessment Consortium  
Page 27

Classroom instruction that incorporates the mathematics teaching practices, “Use and connect mathematical representations” and “Build procedural fluency from conceptual understanding” will provide opportunities for students to develop the conceptual understandings and carry out mathematical procedures with precision and fluency that are expected for Claim 1.

When teachers employ the practice of using and connecting mathematical representations, students will be engaged in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

Likewise, when teachers employ the practice of building procedural fluency from conceptual understanding, students, over time, will become skillful in using procedures flexibly as they solve contextual and mathematical problems.

The Standards call for speed and accuracy in calculation. Teachers should structure class time and/or homework time for students to practice core functions such as single-digit multiplication so that students have access to more complex concepts and procedures. Note that this is not memorization absent understanding. This is the outcome of a carefully laid out learning progression.

At the same time, we can't expect fluency to be a natural outcome without



addressing it specifically in the classroom and in our materials. Some students might require more practice than others, and that should be attended to.

Additionally, there is not one approach to get to speed and accuracy that will work for all students. All students, however, will need to develop a way to get there.

## Teacher and Student Actions

Use and connect mathematical representations Teacher and student actions	
What are <i>teachers</i> doing?	What are <i>students</i> doing?
<p>Selecting tasks that allow students to decide which representations to use in making sense of the problems.</p> <p>Allocating substantial instructional time for students to use, discuss, and make connections among representations.</p> <p>Introducing forms of representations that can be useful to students.</p> <p>Asking students to make math drawings or use other visual supports to explain and justify their reasoning.</p> <p>Focusing students' attention on the structure or essential features of mathematical ideas that appear, regardless of the representation.</p> <p>Designing ways to elicit and assess students' abilities to use representations meaningfully to solve problems.</p>	<p>Using multiple forms of representations to make sense of and understand mathematics.</p> <p>Describing and justifying their mathematical understanding and reasoning with drawings, diagrams, and other representations.</p> <p>Making choices about which forms of representations to use as tools for solving problems.</p> <p>Sketching diagrams to make sense of problem situations.</p> <p>Contextualizing mathematical ideas by connecting them to real-world situations.</p> <p>Considering the advantages or suitability of using various representations when solving problems.</p>

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM p. 29



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28

The teacher and student actions listed in this table provide a summary of what teachers and students do in using and connecting mathematical representations in teaching and learning mathematics.

## Teacher and Student Actions

### Build procedural fluency from conceptual understanding Teacher and student actions

What are <i>teachers</i> doing?	What are <i>students</i> doing?
<p>Providing students with opportunities to use their own reasoning strategies and methods for solving problems.</p> <p>Asking students to discuss and explain why the procedures that they are using work to solve particular problems.</p> <p>Connecting student-generated strategies and methods to more efficient procedures as appropriate.</p>	<p>Making sure that they understand and can explain the mathematical basis for the procedures that they are using.</p> <p>Demonstrating flexible use of strategies and methods while reflecting on which procedures seem to work best for specific types of problems.</p> <p>Determining whether specific approaches generalize to a broad class of problems.</p>

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM p.47-48



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29

The actions listed in this table summarize what teachers and students are doing in mathematics classrooms to build procedural fluency from conceptual understanding and problem-solving experiences.

# Middle School Activity 1

Illustrative Mathematics

*8.NS Comparing Rational and Irrational Numbers*



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30

We will now work on a task that addresses Rational and Irrational Numbers.

This task is from Illustrative Mathematics. It requires students to understand various representations of quantities and use those in order to make decisions about the problem. Let's take a look at the task.

# Activity 1



For each pair of numbers, decide which is larger without using a calculator. Explain your choices.

- a.  $\pi^2$  or 9
- b.  $\sqrt{50}$  or  $\sqrt{51}$
- c.  $\sqrt{50}$  or 8
- d.  $-2\pi$  or  $-6$

[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/000/336/original/illustrative\\_mathematics\\_336.pdf?1390749912](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/000/336/original/illustrative_mathematics_336.pdf?1390749912)



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 31

Facilitator Note: Direct participants to use Handout 5a for this activity. Ask participants to work through each question without looking at the solutions on page 2 of the handout. Once finished, they should read the solutions on page 2 and compare them to the explanations they provided.

Give groups about 3-5 minutes to share their responses to the question “Is there another way to determine which is larger?” Group members should look at the solutions provided on page 2 of the handout and share different explanations.

Providing the opportunity for students to share their thinking will not only allow each student to demonstrate their conceptual understanding of the underlying mathematics, but will allow for other students to hear different approaches that might build on their understanding of the underlying mathematics.

When students are asked to answer a question, elicit evidence of their understanding of the underlying mathematics by asking “HOW DO YOU KNOW?” or “EXPLAIN YOUR THINKING.”

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 1:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practices (including teacher/student actions)



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Page 32

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity. They will also have access to the e-book if they want to look at the tables for the 8 teaching practices.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

- Domain: The Number System
- Cluster Heading: 8.NS.A (Know that there are numbers that are not rational, and approximate them by rational numbers.)
- Standard: 8.NS.A.2 (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, 6, 7

Under Mathematical Teaching Practices: Use and Connect mathematical representations; Build procedural fluency from conceptual understanding; Elicit and use evidence of student thinking.

Ex: Teacher: provide opportunity to use own reasoning strategy  
selecting a task that allows students to use different

representations

Student: uses multiple forms of representations to make sense of the mathematics

representations

justify their mathematical understanding through other

explaining their decision

Note: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the domain The Number System.

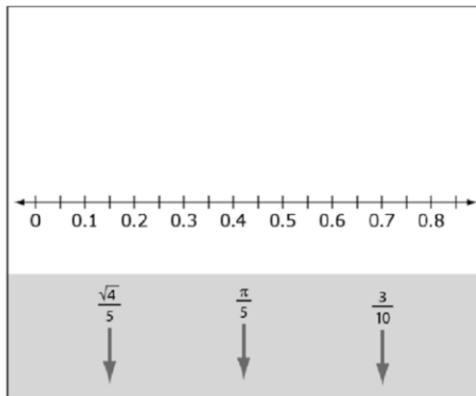
This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

1860



Drag each number to its correct position on the number line.



From the Smarter Balanced Grade 8 Practice Test



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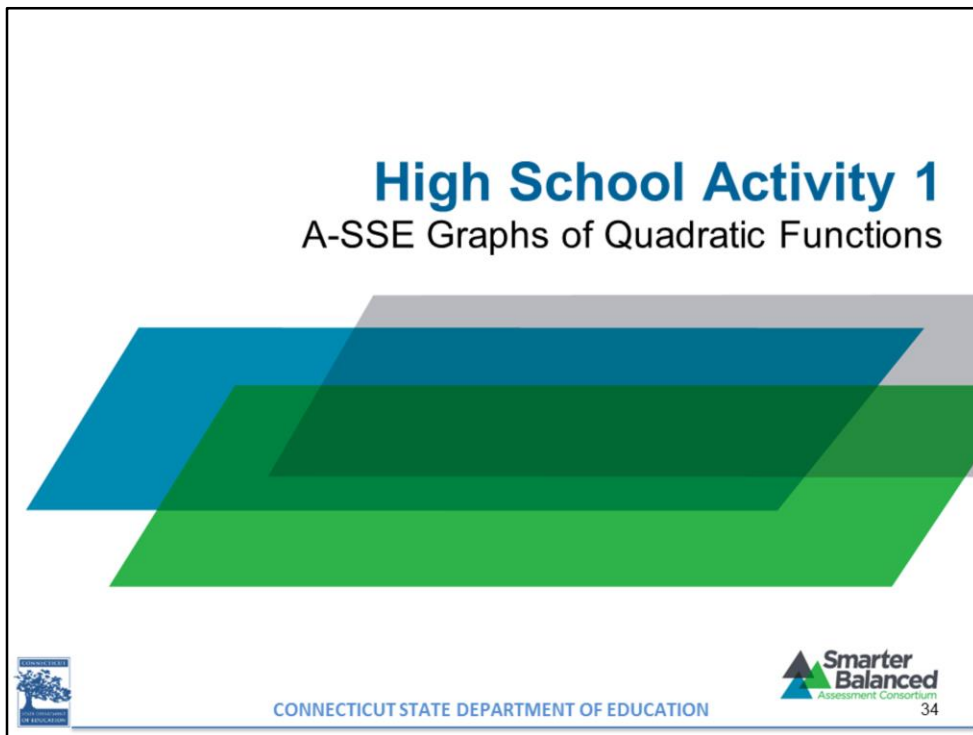
Page 33

This item is from the Smarter Balanced Grade 8 Practice Test. It is a Claim 1 item aligned to Target A “Know that there are numbers that are not rational, and approximate them by rational numbers.” Note that this is the cluster heading from the CCS. It is a DOK level 2 question.

Think about the evidence a teacher can collect from simply looking at the student response to this question. Even if the student places each number correctly on the number line, during instruction, a teacher should ask the question, “How do you know?” The teacher might also ask, “Can anyone explain it in a different way?”

Cloning, drilling and killing exercises, where the student is presented with a number of items similar to this one, do not elicit the same level of evidence about the student’s understanding of the underlying mathematics. Rather, providing students with the opportunity to engage in a few examples with the expectation that they need to explain their thinking, is a far more effective teaching strategy to improve student learning.





We will now work on a task that addresses Graphs of Quadratic Functions.

This task is from Illustrative Mathematics. This task incorporates technology and requires students to understand the structure of equations in order to efficiently find critical points of quadratic functions.

Participants will need to download a graphing calculator if they have not done so already.

On a flip chart have this site <https://wabbit.codeplex.com>

Once they are on this site click download (they may need to click run or open the executable file)

Next click create ROM image using open source and next

Choose the TI-83 Plus SE is fine for our purposes then click finish

They can save to the desktop and can name it TI83

When the pop-up appears, they can click view, enable skin and the calculator will work!

# Activity 1



- a. Graph these equations on your graphing calculator at the same time. What happens? Why?

$$\begin{aligned}y_1 &= (x-3)(x+1) \\y_2 &= x^2-2x-3 \\y_3 &= (x-1)^2-4 \\y_4 &= x^2-2x+1\end{aligned}$$

- b. Below are the first three equations from the previous problem.

$$\begin{aligned}y_1 &= (x-3)(x+1) \\y_2 &= x^2-2x-3 \\y_3 &= (x-1)^2-4\end{aligned}$$

These three equations all describe the same function. What are the coordinates of the following points on the graph of the function? From which equation is each point most easily determined? Explain.

- i. vertex: \_\_\_\_\_
  - ii. y-intercept: \_\_\_\_\_
  - iii. x-intercept(s): \_\_\_\_\_
- c. Make up an equation for a quadratic function whose graph satisfies the given condition. Use whatever form is most convenient.
- i. Has a vertex at  $(-2, -5)$ .
  - ii. Has a y-intercept at  $(0, 6)$ .
  - iii. Has x-intercepts at  $(3, 0)$  and  $(5, 0)$ .
  - iv. Has x-intercepts at the origin and  $(4, 0)$ .
  - v. Goes through the points  $(4, 2)$  and  $(1, 2)$ .



[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/000/388/original/illustrative\\_mathematics\\_388.pdf?1390750122](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/000/388/original/illustrative_mathematics_388.pdf?1390750122)

CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 35

Facilitator Note: Direct participants to use Handout 5b for this activity. Ask participants to work through this activity without looking at the solutions on pages 2 and 3 of the handout. Once finished, they should read the solutions on page 2 and compare them to the explanations they provided.

Give groups about 3-5 minutes to share their responses to the question **“Is there another equation that fits the criteria in part c?”** Group members should look at the solutions provided on pages 2 and 3 of the handout and share different explanations.

Providing the opportunity for students to share their thinking will not only allow each student to demonstrate their conceptual understanding of the underlying mathematics, but will allow for other students to hear different approaches that might build on their understanding of the underlying mathematics.

When students are asked to answer a question, elicit evidence of their understanding of the underlying mathematics by asking **“HOW DO YOU KNOW?”** or **“EXPLAIN YOUR THINKING.”**

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 1:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practices (including teacher/student actions)



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 36

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity. They will also have access to the e-book if they want to look at the tables for the 8 teaching practices.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

- Conceptual Categories: Algebra and Functions
- Cluster Heading: A.SSE.B (Write expressions in equivalent forms to solve problems) AND F.IF.C (Analyze functions using different representations)
- Standard: A.SSE.B.3.a and F.IF.C.7.a (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, 7

Under Mathematical Teaching Practices: Use and connect mathematical representations, Build procedural fluency from conceptual understanding, Elicit and use evidence of student thinking. Establish mathematics goals to focus learning

Ex: Teacher: provide opportunity to use own reasoning strategy  
introducing forms of representations that can be useful to

students

Student: make choices about which forms of representations to use as tools for solving problems  
determine which procedures seem to work best for specific types of problems  
connecting current work with mathematics previously studied

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the conceptual category of Functions.

This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

1915



Determine whether each expression is equivalent to  $(x^3 + 8)$ . Select Yes or No for each expression.

	Yes	No
$(x + 8)^3$	<input type="checkbox"/>	<input type="checkbox"/>
$(x - 2)(x^2 + 2x + 4)$	<input type="checkbox"/>	<input type="checkbox"/>
$(x + 2)(x^2 - 2x + 4)$	<input type="checkbox"/>	<input type="checkbox"/>



From the Smarter Balanced Grade 11 Practice Test

CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 37

This item is from the Smarter Balanced Grade 11 Practice Test. It is a Claim 1 item aligned to Target D “Interpret the structure of expressions.” Note that this is the cluster heading from the CCS. It is a DOK level 1 task.

Think about the evidence a teacher can collect from simply looking at the student response to this question. Even if the student identifies the correct equivalent expressions during instruction, a teacher should ask the question, “How do you know?” The teacher might also ask, “Are there other ways to get the same answer?”

Cloning, drilling and killing exercises, where the student is presented with a number of items similar to this one, do not elicit the same level of evidence about the student’s understanding of the underlying mathematics. Rather, providing students with the opportunity to engage in a few examples with the expectation that they need to explain their thinking, is a far more effective teaching strategy to improve student learning.

## Claim 2 Problem Solving



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Let's move on to Claim 2: Problem Solving

## Claim 2: Problem-Solving

“Students can solve a range of complex, well-posed problems in pure and applied mathematics, making productive use of knowledge and problem-solving strategies.”



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39

Claim 2 items and tasks measure the extent to which students can solve a range of complex, well-posed problems in pure and applied mathematics, making productive use of knowledge and problem-solving strategies.

Keep in mind that not all word problems are Claim 2. Word problems that are procedural are tagged to Claim 1.

## Rationale for Claim 2

- Assessment items and tasks focused on Claim 2 include problems in pure mathematics and problems set in context.
- Problems are presented as items and tasks that are well-posed (that is, problem formulation is not necessary) and for which a solution path is not immediately obvious.
- These problems require students to construct their own solution pathway rather than follow a provided one. Such problems will therefore be less structured than items and tasks presented under Claim 1. Students will need to select appropriate conceptual and physical tools to use.



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Claim 2 items may be pure mathematics or set in context.

As opposed to problems tagged to Claim 4, Claim 2 items are well posed, meaning that the students are **not** required to formulate a model to solve the problem, however, the solution path should not be obvious (this is Claim 1).

Students are required to construct their own solution path. In some cases, there may be one solution path with multiple correct answers, or several solution paths that lead to a single correct answer.



## Rationale for Claim 2

- The evidence required of students to satisfy Claim 2 centers around specific statements of the **mathematical practices** (MP) contained in the CCSSM.
- Though not exclusive, MP1, MP5, MP7, and MP8 are particularly relevant for Claim 2 items.



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Read the slide. Tell participants to refer to Handout 2 that describes the student behaviors for each Practice Standard noted on the slide. We will be looking for these student behaviors as we engage in classroom activities and tasks.

## Claim 2 Assessment Targets

**Target A:** Apply mathematics to solve well-posed problems in pure mathematics and arising in everyday life, society, and the workplace. (DOK 2, 3)

**Target B:** Select and use appropriate tools strategically. (DOK 1, 2)

**Target C:** Interpret results in the context of a situation. (DOK 2)

**Target D:** Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas). (DOK 1, 2, 3)



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42

Unlike Claim 1 assessment targets which are grade-level specific, the Claim 2, 3 and 4 assessment targets are common across all grades.

As you can see, the language of the targets are drawn from the Standards for Mathematical Practice.

Claim 2 Content Standards by Grade Level						
Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	High School
3.OA.A	4.OA.A	5.NBT.B	6.RP.A	7.RP.A	8.EE.B	N-Q.A
3.OA.D	4.NBT.B	5.NF.A	6.NS.A	7.NS.A	8.EE.C	A-SSE.A
3.NBT.A*	4.NF.A	5.NF.B	6.NS.C	7.EE.A	8.F.A	A-SSE.B
3.NF.A	4.NF.B	5.MD.A*	6.EE.A	7.EE.B	8.F.B*	A-CED.A
3.MD.A	4.NF.C	5.MD.C	6.EE.B	7.G.A*	8.G.A	A-REI.2
3.MD.B*	4.MD.A*	5.G.A*	6.EE.C	7.G.B*	8.G.B	A-REI.B
3.MD.C	4.MD.C*		6.G.A*		8.G.C*	A-REI.C
3.MD.D*						A-REI.D
						F-IF.A
						F-IF.B
						F-IF.C
						F-BF.A
						G-SRT.C
						S-ID.C
						S-CP.A

\* Denotes additional and supporting clusters


CONNECTICUT STATE DEPARTMENT OF EDUCATION 43

This table was developed for item writers and identifies CCS domains and content clusters for Claim 2. Items and tasks can center on a single cluster listed, or synthesize across listed clusters within a grade. Note that at the high school level, some clusters that were not included in the Claim 1 targets are included as content to be assessed in Claim 2.


This information is provided in the Smarter Balanced Mathematics Content Specifications.

## Claim 2 and the Mathematics Teaching Practices

Claim 2	Mathematics Teaching Practices
Students can solve a range of complex, well-posed problems in pure and applied mathematics, making productive use of knowledge and problem-solving strategies.	<b>Implement tasks that promote reasoning and problem solving</b>  Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and that allow for multiple entry points and varied solution strategies.



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 Smarter  
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Page 44

Classroom instruction that incorporates the mathematics teaching practice, “Implement tasks that promote reasoning and problem solving” will provide opportunities for students to develop mathematical reasoning and problem solving skills that are expected for Claim 2.

From Principles to Action (page 17):

“To ensure that students have the opportunity to engage in high-level thinking, teachers must regularly select and implement tasks that promote reasoning and problem solving. These tasks encourage reasoning and access to the mathematics through multiple entry points, including the use of different representations and tools, and they foster the solving of problems through varied solution strategies.”

## Teacher and Student Actions

### Implement tasks that promote reasoning and problem solving Teacher and student actions

What are teachers doing?	What are students doing?
<p>Motivating students' learning of mathematics through opportunities for exploring and solving problems that build on and extend their current mathematical understanding.</p> <p>Selecting tasks that provide multiple entry points through the use of varied tools and representations.</p> <p>Posing tasks on a regular basis that require a high level of cognitive demand.</p> <p>Supporting students in exploring tasks without taking over student thinking.</p> <p>Encouraging students to use varied approaches and strategies to make sense of and solve tasks.</p>	<p>Persevering in exploring and reasoning through tasks.</p> <p>Taking responsibility for making sense of tasks by drawing on and making connections with their prior understanding and ideas.</p> <p>Using tools and representations as needed to support their thinking and problem solving.</p> <p>Accepting and expecting that their classmates will use a variety of solution approaches and that they will discuss and justify their strategies to one another.</p>

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM p. 24



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45

The actions listed in this table provide a summary of what teachers and students need to do when implementing tasks that promote reasoning and problem solving in the mathematics classroom.

## Middle School Activity 2

6.EE Seven to the What!



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46

Next we will look at a middle school task from Illustrative Mathematics that is an example of problem solving with pure mathematics. You should note that this task is not straightforward or procedural and requires students to find an entry point into solving the problem.

## Activity 2



- a. What is the last digit of  $7^{2011}$ ? Explain.
- b. What are the last *two* digits of  $7^{2011}$ ? Explain.

[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/000/891/original/illustrative\\_mathematics\\_891.pdf?1390749217](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/000/891/original/illustrative_mathematics_891.pdf?1390749217)



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 47

Facilitator Note: Direct participants to use Handout 7a for this activity. Ask participants to work through this activity without looking at the solutions on pages 2-4 of the handout. Once finished, they should think about other approaches to this problem.

Give groups about 3-5 minutes to look at and discuss the solutions provided on pages 2-4 of the handout. Participants should think about the depth of learning that can result from this type of task as opposed to a bunch of questions about evaluating exponential expressions and how this type of problem allows various entry points into the mathematics.

As we said previously, providing the opportunity for students to share their thinking will not only allow each student to demonstrate their conceptual understanding of the underlying mathematics, but will allow for other students to hear different approaches that might build on their understanding of the underlying mathematics.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practices (including teacher/student actions)



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 48

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity. They will also have access to the e-book if they want to look at the tables for the 8 teaching practices.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

Domain: Expressions and Equations

Cluster: 6.EE.A Apply and extend previous understandings of arithmetic to algebraic expressions

Standard: 6.EE.A.1 (ask a participant to read the standard language from the flip book)

Under SMP: 1, 6, 7 and 8

Under Mathematical Teaching Practices: Implement tasks that promote reasoning and problem solving; Support productive struggle in learning mathematics

Ex: Teacher: encourage students to use varied approaches and strategies to make sense and solve tasks



provide opportunity for explorations that build on and extend current mathematical thinking

Student: use tools and representations as needed to support thinking and problem solving

persevere in exploring and reasoning through the task

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the domain of expressions and equations.

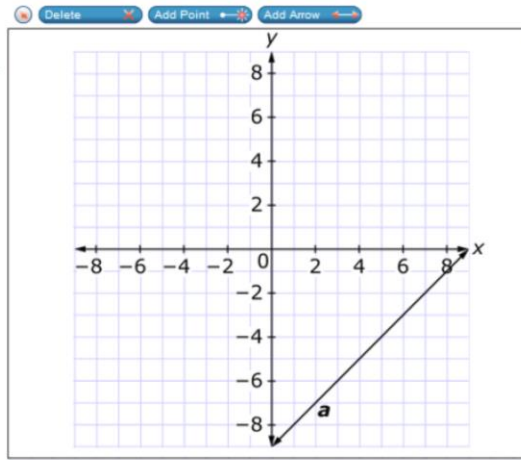
This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

1834

Line  $a$  is shown on the graph. Use the Add Arrow tool to construct line  $b$  on the graph so that:

- Line  $a$  and line  $b$  represent a system of linear equations with a solution of  $(7, -2)$ .
- The slope of line  $b$  is greater than  $-1$  and less than  $0$ .
- The  $y$ -intercept of line  $b$  is positive.



From the Smarter Balanced Grade 8 Practice Test



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 49

This item is from the Smarter Balanced Grade 8 Practice Test. It is a Claim 2 item aligned to target D, identify important quantities in a practical situation and map their relationships and target B, select and use appropriate tools strategically. (DOK 1, 2).

Ask participants to share what a student would need to know to solve this problem and what types of approaches might they take to get there.

Think about the evidence a teacher can collect from simply looking at the student response to this question. If the student graphed line  $b$  to show the correct point of intersection during instruction, a teacher should ask the question, “Are there other lines that will give the same point of intersection?” The teacher might also ask, “Does your line meet the other criteria?”, “Can you explain that to me?”

## High School Activity 2

S-CP Alex, Mel, and Chelsea Play a Game



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50

Now we will look at a high school item from Illustrative Mathematics. Like the last example, this is an example of problem solving with pure mathematics. You should note that this task is not straightforward or procedural and requires students to find an entry point into solving the problem.

## Activity 2



Alex, Mel, and Chelsea play a game that has 6 rounds. In each round there is a single winner, and the outcomes of the rounds are independent. For each round the probability that Alex wins is  $\frac{1}{2}$ , and Mel is twice as likely to win as Chelsea. What is the probability that Alex wins three rounds, Mel wins two rounds, and Chelsea wins one round?



[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/001/035/original/illustrative\\_mathematics\\_1035.pdf?1390751061](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/001/035/original/illustrative_mathematics_1035.pdf?1390751061)

CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 51

Facilitator Note: Direct participants to use Handout 7b for this activity. Ask participants to think about a plan for solving this problem without looking at the solutions on pages 2 and 3. Once finished they should look at the solutions on pages 2 and 3.

Give groups about 3-5 minutes to discuss the different ways that they may approach the problem. Participants should think about how this type of task engages students in the standards for math practice and what students would need to know to solve this problem. They should also think about ways to support the productive struggle that may result from this type of task.

As can be seen, this problem is not straightforward or procedural. This type of task allows students to have various points of entry into the problem. Based upon the student responses a teacher can determine a great deal about the students depth of understanding and provide the appropriate instruction.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practice (including teacher/student actions)



CONNECTICUT STATE DEPARTMENT OF EDUCATION



Page 52

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

- Conceptual Category: Statistics and Probability
- Cluster Heading: S-CP.B Use the rules of probability to compute probabilities of compound events in a uniform probability model
- Standard: S-CP.B.9(ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, 6

Under Mathematical Teaching Practices: Implement tasks that promote reasoning and problem solving; Support productive struggle in learning mathematics

Ex: Teacher: encourage students to use varied approaches and strategies to make sense and solve tasks

provide tasks that require high level cognitive demand

anticipate what the struggles might be and prepare to support

them with questions that scaffold their thinking

Student:           persevere in exploring and reasoning through the task  
                          make sense of tasks by drawing on and making connections  
with their prior understanding and ideas

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the Conceptual Category Statistics and Probability.

This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

At a local fair, the price of admission includes the opportunity for a person to spin a wheel for free ride tickets.

- Each spin of the wheel is a random event.
- The result from each spin of the wheel is independent of the results of previous spins.
- Each spin of the wheel awards tickets according to the probabilities shown below.

### Spin the Wheel

1 ticket	35%
2 tickets	25%
3 tickets	20%
5 tickets	15%
10 tickets	5%

Let  $X$  be the number of tickets a person wins based on 2 spins. There are 13 possible values for  $X$ .

Some values of  $X$  are more common than others. For example, winning only 2 tickets in 2 spins is a somewhat common occurrence with probability 0.1225. It means the person wins 1 ticket on the first spin and 1 ticket on the second spin ( $0.35 \cdot 0.35$ ). A list of the possible values of  $X$  and the corresponding probabilities for most values of  $X$  is shown below.

Fill in the three missing probability values in the table.

$X$	Probability
2	0.1225
3	0.1750
4	<input type="text"/>
5	0.1000
6	0.1450
7	0.0750
8	0.0600
10	<input type="text"/>
11	0.0350
12	0.0250
13	<input type="text"/>
15	0.0150
20	0.0025



This item is from the Smarter Balanced Grade 11 Practice Test. It is a Claim 2 item aligned to Target A, Apply mathematics to solve well-posed problems in pure mathematics and those arising in everyday life, society, and the workplace. DOK 2

Ask participants to share what a student would need to know to solve this problem and what types of approaches might they take to get there.

Again, think about the evidence a teacher can collect from simply looking at the student response to this question. If the student identifies the correct probabilities for some of the questions during instruction, a teacher should ask the question, "How did you get that?" The teacher might also ask, "Does that work for all of the probabilities you are asked to find?"

# Claim 3 Communicating Reasoning



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Now we will look at Claim 3, Communicating Reasoning.



## Claim 3: Communicating Reasoning

“Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.”



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55

Claim 3 items and tasks measure the extent to which students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.

## Rationale for Claim 3

- Claim 3 refers to a recurring theme in the CCSS for Mathematics content and practice standards—the ability to construct and present a clear, logical, convincing argument.
  - For older students, this may take the form of a rigorous, deductive proof based on clearly stated axioms.
  - For younger students, this will involve more informal justifications .
- Assessment tasks that address this claim will typically present a claim or a proposed solution to a problem and will ask students to provide an example, a justification, an explanation, or a counterexample.



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The Smarter Balanced assessments will attend thoroughly to those places in the content standards that call explicitly for communicating mathematics reasoning. For example, many content standards call for students to explain, justify, or illustrate.

This may look differently across grade levels, for example, in high school students may need to construct a deductive proof based on clearly stated axioms, where younger students will need to provide more informal justifications.

Typically, students are presented with a claim or a proposed solution to a problem and will be asked to provide an example, a justification, or a counterexample.

## Rationale for Claim 3

- The evidence required of students to satisfy Claim 3 centers around specific statements of the **mathematical practices** (MP) contained in the CCSSM.
- Though not exclusive, MP3 and MP6 are particularly relevant for Claim 3 items.



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Read the slide. Tell participants to refer to Handout 2 that describes the student behaviors for each Practice Standard noted on the slide. We will be looking for these student behaviors as we engage in classroom activities and tasks

## Targets for Claim 3

**Target A:** Test propositions or conjectures with specific examples. (DOK 2).

**Target B:** Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures. (DOK 3, 4).

**Target C:** State logical assumptions being used. (DOK 2, 3)

**Target D:** Use the technique of breaking an argument into cases. (DOK 2, 3)

**Target E:** Distinguish correct logic or reasoning from that which is flawed and—if there is a flaw in the argument—explain what it is. (DOK 2, 3, 4)

**Target F:** Base arguments on concrete referents such as objects, drawings, diagrams, and actions. (DOK 2, 3)

**Target G:** At later grades, determine conditions under which an argument *does* and *does not* apply. (DOK 3, 4)



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58

Like Claim 2, the assessment targets for Claim 3 are common across all grades.

As you can see, the language of the targets are drawn from the Standards for Mathematical Practice.


Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	HS
3.OA.B	4.OA.3	5.NBT.2	6.RP.A	7.RP.2	8.EE.1	N-RN.A
3.NF.A	4.NBT.A	5.NBT.6	6.RP.3	7.NS.A	8.EE.5	N-RN.B
3.NF.1	4.NBT.5	5.NBT.7	6.NS.A	7.NS.1	8.EE.6	N-RN.3
3.NF.2	4.NBT.6	5.NF.1	6.NS.1	7.NS.2	8.EE.7a	A-SSE.2
3.NF.3	4.NF.A	5.NF.2	6.NS.C	7.EE.1	8.EE.7b	A-APR.1
3.MD.A	4.NF.1	5.NF.B	6.NS.5	7.EE.2	8.EE.8a	A-REI.A
3.MD.7	4.NF.2	5.NF.3	6.NS.6		8.F.1	A-REI.1
	4.NF.3a	5.NF.4	6.NS.7		8.F.2	A-REI.2
	4.NF.3b	5.NF.7a	6.EE.A		8.F.3	A-REI.10
	4.NF.3c	5.NF.7b	6.EE.3		8.G.1	A-REI.11
	4.NF.4a	5.MD.C	6.EE.4		8.G.2	F-IF.1
	4.NF.4b	5.MD.5a	6.EE.B		8.G.4	F-IF.5
	4.NF.C	5.MD.5b	6.EE.6		8.G.5	F-IF.9
	4.NF.7	5.G.B*	6.EE.9		8.G.6	G-CO.C
		5.G.4*			8.G.8	G-CO.9
						G-CO.10
						G-CO.11
						A-APR.B
						A-APR.4
						A-APR.6
						A-REI.C
						F-BF.3
						F-BF.4a
						F-TF.1
						F-TF.2
						F-TF.8
						G-CO.A
						G-CO.B
						G-SRT.A
						G-SRT.B

Like the table we looked at earlier for Claim 2, this table was developed for item writers and identifies CCS domains and content clusters for Claim 3. Items and tasks can center on a single cluster listed, or synthesize across listed clusters within a grade. Note that at the high school level, some clusters that were not included in the Claim 1 targets are included as content to be assessed in Claim 3.


This information is provided in the Smarter Balanced Mathematics Content Specifications.

## Claim 3 and the Mathematics Teaching Practices

Claim 3	Mathematics Teaching Practices
Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.	<p><b>Facilitate meaningful mathematical discourse</b> Effective teaching of mathematics facilitates discourse among students in order to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.</p> <p><b>Pose purposeful questions</b> Effective teaching of mathematics uses purposeful questions to assess and advance student reasoning and sense making about important mathematical ideas and relationships.</p>



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 Smarter  
Balanced  
Assessment Consortium  
Page 60

Classroom instruction that incorporates the mathematics teaching practices, “**Facilitate meaningful mathematical discourse**” and “**Pose purposeful questions**” will provide opportunities for students to build shared understanding of mathematical ideas by analyzing and comparing various approaches and arguments as well as assess and advance student reasoning and sense making which is expected in Claim 3.

From Principles to Action (page 29 and 35):

“Mathematical discourse includes the purposeful exchange of ideas through classroom discussion, as well as through other forms of verbal, visual, and written communication.”

“Purposeful questions allow teachers to discern what students know and adapt lessons to meet varied levels of understanding, help students make important mathematical connections, and support students in posing their own questions.”

## Teacher and Student Actions

Facilitate meaningful mathematical discourse Teacher and student actions	
What are teachers doing?	What are students doing?
<p>Engaging students in purposeful sharing of mathematical ideas, reasoning, and approaches, using varied representations.</p> <p>Selecting and sequencing student approaches and solution strategies for whole-class analysis and discussion.</p> <p>Facilitating discourse among students by positioning them as authors of ideas, who explain and defend their approaches.</p> <p>Ensuring progress toward mathematical goals by making explicit connections to student approaches and reasoning.</p>	<p>Presenting and explaining ideas, reasoning, and representations to one another in pair, small-group, and whole-class discourse.</p> <p>Listening carefully to and critiquing the reasoning of peers, using examples to support or counterexamples to refute arguments.</p> <p>Seeking to understand the approaches used by peers by asking clarifying questions, trying out others' strategies, and describing the approaches used by others.</p> <p>Identifying how different approaches to solving a task are the same and how they are different.</p>



NCTM. (2014). Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: NCTM p. 35

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61

The actions listed in this table provide guidance on what teachers and students do as they engage in meaningful mathematical discourse in the mathematics classroom.

## Teacher and Student Actions

Pose purposeful questions Teacher and student actions	
What are <i>teachers</i> doing?	What are <i>students</i> doing?
<p>Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking.</p> <p>Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification.</p> <p>Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion.</p> <p>Allowing sufficient wait time so that more students can formulate and offer responses.</p>	<p>Expecting to be asked to explain, clarify, and elaborate on their thinking.</p> <p>Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly.</p> <p>Reflecting on and justifying their reasoning, not simply providing answers.</p> <p>Listening to, commenting on, and questioning the contributions of their classmates.</p>



NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM p. 41

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62

The actions listed in this table provide guidance on what teachers and students do when using questions purposefully in the mathematics classroom.



## Middle School Activity 3

### 7.RP Dueling Candidates



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63

The next item is a middle school task from Illustrative Mathematics.

This task is very open ended, giving students the opportunity to use mathematics to defend their claim in a variety of ways. It also requires students to construct and reason with numbers. It is ideally suited to be done in groups which will further promote the discourse in the classroom.

## Activity 3



Joel and Marisa are running for president at their middle school (grades 6-8). After the votes are in, Joel and Marisa are each convinced that they have won the election:

- Joel argues that he has won a larger percentage of the overall vote than Marisa so he should be the new president.
- Marisa argues that she has won a larger percentage than Joel of the 6th grade vote and the 7th grade vote. Since the majority of the grades voted for her, she should be the new president.

Is it possible that both Joel and Marisa are making accurate claims? Explain.



[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/001/589/original/illustrative\\_mathematics\\_1589.pdf?1390749569](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/001/589/original/illustrative_mathematics_1589.pdf?1390749569)

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Page 64

Facilitator Note: Direct participants to use Handout 8a for this activity. Ask participants to work through this activity without looking at the solutions on pages 2-4 of the handout. Once finished, they should think about how they might be able to justify the other person's claim.

Give groups about 3-5 minutes to look at and discuss the solutions provided on pages 2-4 of the handout. Participants should think about the mathematics involved in justifying both claims.

By providing the opportunity for students to share their thinking other students hear different approaches and use the mathematics to support their own claim or refute that of a classmate. This will lead to a deeper understanding of variables that may effect problems.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practice (including teacher/student actions)



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Page 65

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity. They will also have access to the e-book if they want to look at the tables for the 8 teaching practices.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

- Domain: Ratios and Proportional Relationships
- Cluster: 7.RP.A Analyze proportional relationships and use them to solve real-world and mathematical problems
- Standard: 7.RP.A.3 (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, and 3

Under Mathematical Teaching Practices: Pose purposeful questions; Facilitate meaningful mathematical discourse;

Ex: Teacher: engage students in purposeful sharing of mathematical ideas and reasoning

Student: ask questions that require justification and explanation  
listen to and critique reasoning of peers  
explaining ideas and reasoning to others

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the Domain of Ratios and Proportional Reasoning.

This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

1857

Look at the equation.

$$\frac{2}{3} \times \frac{\square}{\square} = n$$

Sarah claims that for any fraction multiplied by  $\frac{2}{3}$ ,  $n$  will be less than  $\frac{2}{3}$ .

To convince Sarah that this statement is only sometimes true:

**Part A:** Drag one number into each box so the product,  $n$ , is less than  $\frac{2}{3}$ .

**Part B:** Drag one number into each box so the product,  $n$ , is **not** less than  $\frac{2}{3}$ .

From the Smarter Balanced Grade 6 Practice Test

1  
2  
3  
4  
5  
6  
7  
8  
9

Create

**Part A:** Product  $n$  is less than  $\frac{2}{3}$

$$\frac{2}{3} \times \frac{\square}{\square} = n$$

**Part B:** Product  $n$  is not less than  $\frac{2}{3}$

$$\frac{2}{3} \times \frac{\square}{\square} = n$$



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Page 66

This item is from the Smarter Balanced Grade 6 Practice Test. It is a Claim 3 item aligned to Target A, test propositions or conjectures with specific examples using content from Number and Operations with Fractions. DOK 3.

Again, simply asking students to provide a correct fraction for each part, does not provide them with the opportunity to explain their reasoning. Using a question like this during instruction should allow for students to share their answers and note that there are multiple correct answers. Teachers should facilitate a discussion that allows students to generalize what the correct answer can be:

Part A may be any fraction less than 1.

Part B may be any fraction greater than 1.

## High School Activity 3

A-SSE Taxes and Sales



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67

The next task is from Illustrative Mathematics and addresses Algebra.

This task is about using structure in the computation to make a general argument. It also allows for students to justify their arguments using different representations.

## Activity 3



Judy is working at a retail store over summer break. A customer buys a \$50 shirt that is on sale for 20% off. Judy computes the discount, then adds sales tax of 10%, and tells the customer how much he owes. The customer insists that Judy first add the sales tax and then apply the discount. He is convinced that this way he will save more money because the discount amount will be larger.

- a. Is the customer right?
- b. Does your answer to part (a) depend on the numbers used or would it work for any percentage discount and any sales tax percentage? Find a convincing argument using algebraic expressions and/or diagrams for this more general scenario.



[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/000/677/original/illustrative\\_mathematics\\_677.pdf?1390750155](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/000/677/original/illustrative_mathematics_677.pdf?1390750155)

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Page 68

**Facilitator Note:** Direct participants to use Handout 8b for this activity. Ask participants to work through this activity without looking at the solutions on pages 2 and 3 of the handout. Once finished, they should think about in what ways they can justify their answer.

Give groups about 3-5 minutes to look at and discuss the solutions provided on pages 2-4 of the handout. Participants should think about the various approaches to justifying the response to this question.

By providing the opportunity for students to justify their answer in a variety of ways, they will see connections between different representations.

**Note to facilitator:** Point out to participants that the content of percent is grade 7, but the reasoning to use the structure of the expressions to justify their answers would not be expected until high school.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practice (including teacher/student actions)



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Page 69

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity. They will also have access to the e-book if they want to look at the tables for the 8 teaching practices.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

- Conceptual Category: Algebra
- Cluster Heading: A.SSE Seeing structure in Expressions
- Standard: A.SSE.B (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, 3 and 7

Under Mathematical Teaching Practices: Pose purposeful questions; Facilitate meaningful mathematical discourse; Use and connect mathematical representations

Ex: Teacher: engage students in purposeful sharing of mathematical ideas and reasoning

ask questions that require justification and explanation



Student: ask students to use drawings to support and explain reasoning  
listen to and critique reasoning of peers  
explaining ideas and reasoning to others  
describe and justify reasoning with drawings, diagrams and  
other representations

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the Conceptual Category of Algebra.

This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

2029

The radius of sphere Y is twice the radius of sphere X. A student claims that the volume of sphere Y must be exactly twice the volume of sphere X.

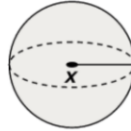
**Part A:** Drag numbers into the boxes to create one example to evaluate the student's claim.

**Part B:** Decide whether the student's claim is true, false, or cannot be determined. Select the correct option.

0  
1  
2  
3  
4  
5  
6  
7  
8  
9

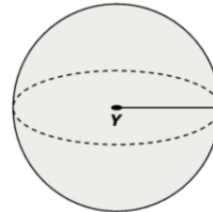
Delete

**Part A:**



Radius =  in

Volume =  $\frac{4}{3}\pi$   in<sup>3</sup>



Radius =  in

Volume =  $\frac{4}{3}\pi$   in<sup>3</sup>

**Part B:**

True   False   Cannot be determined



From the Smarter Balanced Grade 11 Practice Test

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Page 70

This item is from the Smarter Balanced Grade 11 Practice Test. It is a Claim 3 item aligned to Target A, apply mathematics to solve well-posed problems arising in everyday life, society and the workplace. It is a DOK 3 item.

During instruction, a teacher should ask the student to further explain why they decided whether the student's claim is true, false, or cannot be determined.

# Claim 4 Modeling and Data Analysis



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Now we will look at Claim 4, Modeling and Data Analysis.

## Claim 4: Modeling and Data Analysis

“Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.”



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Claim 4 items and tasks measure the extent to which students can analyze complex, real-world scenarios and construct and use mathematical models to interpret and solve problems.

Note to facilitator: **Read this definition of modeling drawn directly from the standards.**

“Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decision-making.” (p.72, CCSSM)

As such, modeling is the bridge across the “school math”/“real world” divide that has been missing from many mathematics curricula and assessments . Modeling is the twin of mathematical literacy, the focus of the PISA international comparison tests in mathematics. CCSSM features modeling as both a mathematical practice at all grades and a conceptual category in high school. (Smarter Balanced Content Specifications pg. 71)

## Rationale for Claim 4

- In the real world, problems do not come neatly “packaged.” Real-world problems are complex and often contain insufficient or superfluous data.
- Assessment tasks will involve *formulating* a problem that is tractable using mathematics; that is, formulating a model. This will usually involve making assumptions and simplifications.
- Students will need to select from the data at hand or estimate data that are missing. (Such tasks are therefore distinct from the well-formulated problem-solving tasks described in Claim 2.)
- Students will identify variables in a situation and construct relationships between them. Once students have formulated the problem, they will tackle it (often in a decontextualized manner) before interpreting their results and then checking the results for reasonableness.



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A key feature of items and tasks in Claim 4 is that the student is confronted with a contextualized, or “real world” situation and must decide which information is relevant and how to represent it.

“Real world” situations do not necessarily mean questions that a student might really face; it means that mathematical problems are embedded in a practical, application context.

Read the slide. This language comes directly from the Smarter Balanced Mathematics Content Specifications.

In this way, items and tasks in Claim 4 differ from those in Claim 2, because while the goal is clear, the Claim 4 problems themselves are not yet fully formulated (well-posed) in mathematical terms.

Items/tasks in Claim 4 assess student expertise in choosing appropriate content and using it effectively in formulating models of the situations presented and making appropriate inferences from them.

Claim 4 items and tasks should sample across the content domains, with many of these involving more than one domain.

Items and tasks of this sort require students to apply mathematical concepts at a

significantly deeper level of understanding of mathematical content than is expected by Claim 1.

## Rationale for Claim 4

- The evidence required of students to satisfy Claim 4 centers around specific statements of the ***mathematical practices*** (MP) contained in the CCSSM.
- Though not exclusive, MP2, MP4, and MP5 are particularly relevant for Claim 4 items.



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Read the slide. Tell participants to refer to Handout 2 that describes the student behaviors for each Practice Standard noted on the slide. We will be looking for these student behaviors as we engage in classroom activities and tasks.

## Targets for Claim 4

**Target A:** Apply mathematics to solve problems arising in everyday life, society, and the workplace. (DOK 2, 3)

**Target B:** Construct, autonomously, chains of reasoning to justify mathematical models used, interpretations made, and solutions proposed for a complex problem. (DOK 2, 3, 4)

**Target C:** State logical assumptions being used. (DOK 1, 2)

**Target D:** Interpret results in the context of a situation. (DOK 2, 3)

**Target E:** Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon. (DOK 3, 4)

**Target F:** Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas). (DOK 1, 2, 3)

**Target G\*:** Identify, analyze and synthesize relevant external resources to pose or solve problems. (DOK 3, 4)

\*Assessed in Performance Tasks only



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75

Like Claims 2 and 3, the assessment targets for Claim 4 are common across all grades.

As you can see, the language of the targets are drawn from the Standards for Mathematical Practice.



## Claim 4 Clusters and Standards

Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	HS
3.OA.A	4.OA.A	5.NBT.B	6.RP.A	7.RP.A	8.EE.3	N-Q.A
3.OA.D	4.NF.B	5.NF.A	6.NS.A	7.NS.A	8.EE.4	A-SSE.B
3.MD.A	4.MD.A*	5.NF.B	6.NS.C	7.EE.B	8.EE.B	A-CED.A
3.MD.C	4.MD.B*	5.MD.A*	6.EE.B	7.G.A*	8.EE.C	A-REI.A
3.MD.D*	4.MD.C*	5.MD.B*	6.EE.C	7.G.B*	8.F.B*	A-REI.B
		5.MD.C	6.G.A*	7.SP.A*	8.G.B	F-IF.B
		5.G.A*	6.SP.A*	7.SP.B*	8.G.C*	F-IF.C
			6.SP.B*	7.SP.C*	8.SP.A*	F-BF.A
						S-ID.A
						S-ID.B
						S-IC.1
						S-IC.B
						A-REI.C
						F-LE.A
						F-LE.B
						F-TF.5
						G-GMD.3
						G-MG

\*Denotes additional and supporting clusters



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76

Like the tables we looked at earlier for Claims 2 and 3, this table was developed for item writers and identifies CCS domains and content clusters for Claim 4. Items and tasks can center on a single cluster listed, or synthesize across listed clusters within a grade. Note that at the high school level, some clusters that were not included in the Claim 1 targets are included as content to be assessed in Claim 4.


This information is provided in the Smarter Balanced Mathematics Content Specifications.

## Claim 4 and the Mathematics Teaching Practices

Claim 4	Mathematics Teaching Practices
Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.	<b>Support Productive Struggle in Learning Mathematics</b> Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.



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Assessment Consortium  
Page 77

Classroom instruction that incorporates the mathematics teaching practice, “[Support Productive Struggle in Learning Mathematics](#)” will provide opportunities for students to engage in productive struggles as they grapple with mathematical ideas and relationships that is needed to formulate the problems to be solved for Claim 4.

From Principles to Action (page 48):

“Such instruction embraces a view of students’ struggles as opportunities for delving more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct solutions. In contrast to productive struggle, unproductive struggle occurs when students “make no progress towards sense-making, explaining, or proceeding with a problem or task at hand (Warshauer 2011).”

“Teaching that embraced and uses productive struggle leads to long-term benefits, with students more able to apply their learning to new problem situations (Kapur 2010).”

## Teacher and Student Actions

### Support productive struggle in learning mathematics Teacher and student actions

What are teachers doing?	What are students doing?
<p>Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.</p> <p>Giving students time to struggle with tasks, and asking questions that scaffold students' thinking without stepping in to do the work for them.</p> <p>Helping students realize that confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.</p> <p>Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.</p>	<p>Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusion and struggle.</p> <p>Asking questions that are related to the sources of their struggles and will help them make progress in understanding and solving tasks.</p> <p>Persevering in solving problems and realizing that is acceptable to say, "I don't know how to proceed here," but it is not acceptable to give up.</p> <p>Helping one another without telling their classmates what the answer is or how to solve the problem.</p>

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM p. 52



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78

This table summarizes teacher and student actions that embrace struggle as a natural aspect of learning in the mathematics classroom.

# Middle School Activity 4

## Understanding Proportional Relationships



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79

In this video you will see how a grade 7 teacher utilizes the formative assessment process and establishes an environment where productive struggle is part of the instruction.

## Activity 4

Handout  
9a



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This task comes from a lesson from the Shell Center.

Facilitator Note: As participants watch this video from the Teaching Channel they should think about the following questions:

How does Ms. Walker encourage her students to take responsibility for their learning?

Why does Ms. Walker use feedback questions instead of comments when responding to student work?

What is powerful about grade level teachers looking at student work together?

Participants should collect evidence for these questions on handout 9a.

Give groups about 3-5 minutes to discuss their responses to these questions and each group can share out.

As this lesson demonstrates, asking purposeful questions, applying the formative assessment process and looking at student evidence to guide instruction lead to an environment where students are experience struggle for the purpose of learning, thus making their learning more meaningful.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practice (including teacher/student actions)



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Page 81

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this video.

For this particular video, under “Standards for Mathematical Content,” participants should have noted:

- Domain: Ratios and Proportional Relationships
- Cluster: 7.RP.A Analyze proportional relationships and use them to solve real-world and mathematical problems
- Standard: 7.RP.A.2 (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, and 4

Under Mathematical Teaching Practices : Pose purposeful questions; Support productive struggle in learning mathematics; Use and connect mathematical representations

Ex: Teacher: ask questions that require justification and explanation  
ask students to use drawings to support and explain reasoning  
anticipate what students might struggle with

Student: give time for students to struggle with tasks  
explaining ideas and reasoning to others  
describe and justify reasoning with drawings, diagrams and  
other representations  
helping one another

This activity should be part of a larger unit of study aligned to the domain ratio and proportional reasoning.

This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

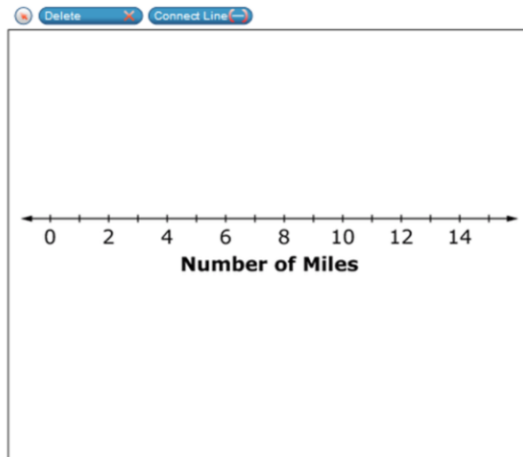
1798

A boat takes 3 hours to reach an island 15 miles away.

The boat travels:

- at least 1 mile but no more than 6 miles during the first hour
- at least 2 miles during the second hour
- exactly 5 miles during the third hour

Use the Connect Line tool to show the range of miles the boat could have traveled during the **second** hour, given the conditions above.



From the Smarter Balanced Grade 6 Practice Test



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Page 82

Allow participants 5 minutes to work on this problem. Once finished they should think about how providing students with the opportunity to engage in productive struggle will prepare them for a similar task on the assessment.

This item is from the Smarter Balanced Grade 6 Practice Test. It is a Claim 4 item aligned to:

Target F, Identify important quantities in a practical situation and map their relationships

Target G, Identify, analyze and synthesize relevant external resources to pose or solve problems.

This is a item at DOK level 3

Point out to participants that this problem differs from a claim 2 item in that while the goal is clear, the problem is “neatly packaged.”

Answer: The students should have a line that goes from 4 to 9.



# High School Activity 4

## A-SSE Course of Antibiotics



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83

This task presents a real world application of finite geometric series. As part of cooperative group work, this task will engage students in the mathematical practices.

## Activity 4



Susan has an ear infection. The doctor prescribes a course of antibiotics. Susan is told to take 250 mg doses of the antibiotic regularly every 12 hours for 10 days.

Susan is curious and wants to know how much of the drug will be in her body over the course of the 10 days. She does some research online and finds out that at the end of 12 hours, about 4% of the drug is still in the body.

- What quantity of the drug is in the body right after the first dose, the second dose, the third dose, the fourth dose?
- When will the total amount of the antibiotic in Susan's body be the highest? What is that amount?
- Answer Susan's original question: Describe how much of the drug will be in her body at various points over the course of the 10 days.

[http://s3.amazonaws.com/illustrativemathematics/illustration\\_pdfs/000/000/805/original/illustrative\\_mathematics\\_805.pdf?139075011](http://s3.amazonaws.com/illustrativemathematics/illustration_pdfs/000/000/805/original/illustrative_mathematics_805.pdf?139075011)



3

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Page 84

Facilitator Note: Direct participants to use Handout 9b for this activity. Ask participants to work through this activity without looking at the solutions on pages 2-4 of the handout. Once finished, they should think about how this type of activity helps to engage students in productive struggle as seen in the video.

Give groups about 3-5 minutes to look at and discuss the solutions provided on pages 2-4 of the handout. Participants should think about the mathematics involved, anticipate where students might struggle and how they could address that productive struggle in the class.

By providing the opportunity for students to share their thinking other students hear different approaches and use the mathematics to support their own claim or refute that of a classmate. This will lead to a deeper understanding of variables that may effect problems.

## Bringing It Back to the Standards



Using the “Bringing it Back to the Standards and the Teaching Practices” graphic organizer, identify which standards and teaching practices were addressed in Activity 2:

- Standards for Mathematical Content
- Standards for Mathematical Practice
- Mathematics Teaching Practice (including teacher/student actions)



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Page 85

**Note to facilitator:** Each table should work with one copy of Handout #6, “Bringing it Back to the Standards and the Teaching Practices” graphic organizer.

Inform participants that they may refer to Handouts 2 (Practice Standards) and 3 (Principles to Action Executive Summary) to jot down the standards and teaching practices addressed in this activity.

For this particular activity, under “Standards for Mathematical Content,” participants should have noted:

Conceptual Category: Algebra

Cluster: A.SSE Seeing structure in expressions

Standard: A.SSE.B.4 (ask a participant to read the standard language from the flip book)

Under SMP: 1, 2, 4 and 8

Under Mathematical Teaching Practices: Implement tasks that promote reasoning and problem solving, Support productive struggle in learning mathematics

Ex: Teacher: encourage students to use varied approaches and strategies to make sense and solve tasks

provide tasks that require high level cognitive demand

anticipate what the struggles might be and prepare to support them with questions that scaffold their thinking

Student:           persevere in solving problems  
                      ask questions related to source of struggle

NOTE: Examples of student and teacher actions should be aligned to the above standards for math practice and math teaching practices. Facilitator needs to guide participants to note how the MTP are aligned to and supportive of the SMP.

This activity should be part of a larger unit of study aligned to the conceptual category of Algebra.

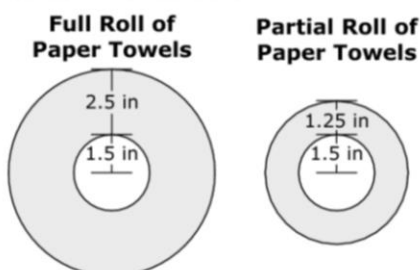
This will help us to confirm the alignment of the activity and eventually the overall unit with the CCS.

## Bringing it Back to the Assessment

2032



The diagram shows the end view of a roll of paper towels when it is full and the end view of the roll after some of the paper towels have been used.



When the full roll of paper towels is unrolled, it has a length of 528 inches of paper towels of uniform width and thickness. Enter the length, in inches, of the paper towels remaining on the partial roll.

From the Smarter Balanced Grade 11 Practice Test



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Page 86

This item is from the Smarter Balanced Grade 11 Practice Test. It is a Claim 4 item aligned to Target A, apply mathematics to solve problems arising in everyday life, society and the workplace. This is a DOK level 3 item.

The content being assessed here builds upon area of a circle which is first introduced in grade 7. From the Smarter Balanced Math content specifications (pg. 72), “Tasks generating evidence for claim 4 in a given grade will draw upon knowledge and skills articulated in the progression of standards up to that grade with strong emphasis on the major work of the grades.” This is also true for claim 2.

Again, ask participants to recognize how this problem differs from a claim 2 item in that while the goal is clear, the problem is not “neatly packaged”.

# Supporting Students Who Will Take the Smarter Balanced Assessments



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What else should teachers do to support students who will take the Smarter Balanced assessments?

## Support for Students

- Providing high quality instruction throughout the year.
- Provide opportunities for students to engage with the Smarter Balanced Practice Tests and Training Tests.
  - Practice Tests are available by grade level
  - Training Tests are available by grade-band
- Available on the Smarter Balanced Web site

<http://www.smarterbalanced.org/practice-test/>



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Besides providing high quality instruction throughout the year, teachers should also provide students with opportunities to engage with the Smarter Balanced Practice and Training Tests. The Practice and Training Tests are available on the Smarter Balanced Web site.

## Purpose of the Practice Tests

- Allows teachers, students, parents, and other interested parties to experience a full grade-level assessment
- Provides an opportunity for students to become familiar with the keyboard commands and embedded universal tools, designated supports, and accommodations
- Provides an opportunity for students who use assistive technology to test the functionality prior to testing



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Read to the slide



## Practice Tests

- Grade-level scoring guides are available for download
- Important Limitations
  - The Practice Tests do not encompass the full range of content that students will encounter on the operational assessments in 2015, and **should not be used to guide instructional decisions.**



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## Training Tests

- The Training Tests are designed to provide students and teachers with opportunities to quickly familiarize themselves with the software and navigational tools that they will use on the Smarter Balanced Assessments.
- The Training Tests are organized by grade bands (grades 3 to 5, 6 to 8, and high school) and each test contains 14-15 questions.
- The questions were selected to provide students with an opportunity to practice a range of question types.
- The Training Tests do not contain performance tasks. Similar to the Practice Test, the Training Tests include all embedded universal tools, designated supports, and accommodations.



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# How Does the Smarter Balanced Assessment System Support Instruction?



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Page 92

# The Smarter Balanced Assessment System

The Smarter Balanced Assessment System includes:

- Digital Library resources to help educators implement the *formative assessment process* to improve teaching and learning
- *Interim assessments* to check student progress throughout the year and help teachers plan and improve instruction (Note: the interim assessments are not intended to be used for accountability purposes)
- Year-end *summative assessments* that are used for accountability purposes



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Page 93

Along with the summative assessment that is used for accountability, the Smarter Balanced Assessment System also includes a Digital Library which contains tools and resources to support the formative assessment process.

The system also includes an interim assessment component which can be used throughout the year to gauge student progress toward mastery of the skills measured by the summative assessment and to assess targeted concepts at strategic points during the school year.

# Questions



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Allow participants time to ask questions to clarify their understanding of the material presented throughout the day.

## Success Criteria

- I can explain how the Connecticut Core Standards (CCS) for Mathematics connect to the Smarter Balanced Claims.
- I can meet the scope of the Content Standards and Practice Standards through best practices and by incorporating a variety of strategies and activities in my instruction.



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Ask participants: Please reflect back on the Success Criteria presented at the beginning of the presentation. How well did you meet the success criteria?

# Resources



- CT Core Standards: <http://ctcorestandards.org/>
- Connecticut Dream Team 2014 Math Resources: [http://ctcorestandards.org/?page\\_id=3771](http://ctcorestandards.org/?page_id=3771)
- Achieve the Core: <http://achievethecore.org/>
- Illustrative Mathematics: <https://www.illustrativemathematics.org/>
- 

Additional resources are included in participant folder



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This slide includes some resources

## Resources

- Smarter Balanced Assessment Consortium:  
<http://www.smarterbalanced.org/>
- Link to CSDE Student Assessment Smarter Balanced page:  
<http://www.sde.ct.gov/sde/cwp/view.asp?a=2748&q=334488>



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\* Please see the Resources page in your folder for a more extensive listing.