

## CHAPTER 1

# Before the Unit

*Teacher: Know thy impact.*

—John Hattie

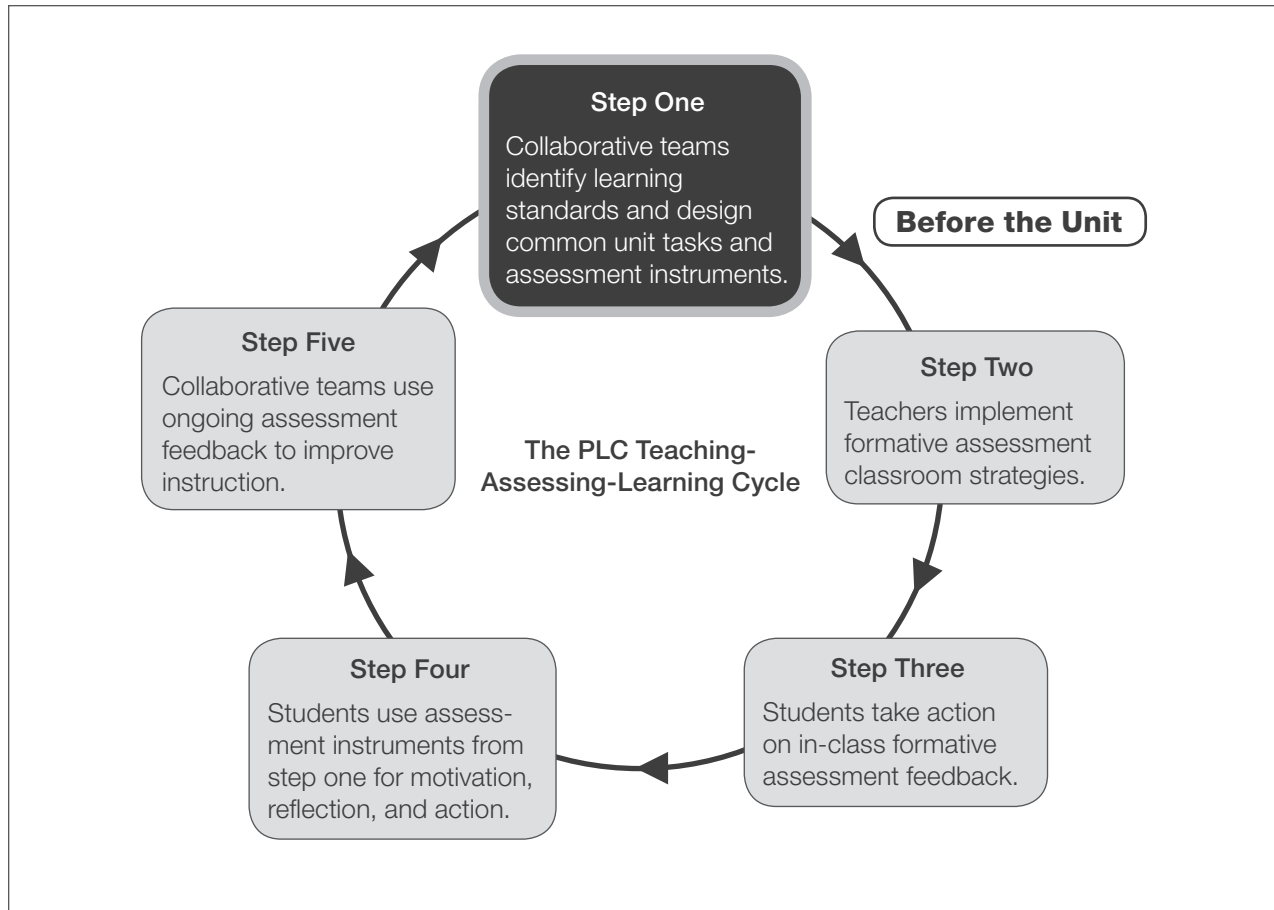
The ultimate outcome of planning before the unit is for you and your team members to gain a clear understanding of the impact of your expectations for student learning and demonstrations of understanding during the unit.

In conjunction with the scope and sequence your district mathematics curriculum provides, your collaborative team prepares a roadmap that describes the knowledge students will know and be able to demonstrate at the conclusion of the unit. To create this roadmap, your collaborative team prepares and organizes your work around five before-the-unit-begins high-leverage team actions.

- HLTA 1. Making sense of the agreed-on essential learning standards (content and practices) and pacing
- HLTA 2. Identifying higher-level-cognitive-demand mathematical tasks
- HLTA 3. Developing common assessment instruments
- HLTA 4. Developing scoring rubrics and proficiency expectations for the common assessment instruments
- HLTA 5. Planning and using common homework assignments

These five team pursuits are based on step one of the PLC teaching-assessing-learning cycle (Kanold, Kanold, & Larson, 2012) shown in figure 1.1 (page 8). This cycle drives your pursuit of a meaningful formative assessment and learning process for your team and for your students throughout the unit and the year.

In this chapter, we describe each of the five before-the-unit-begins high-leverage team actions in more detail (the what) along with suggestions for how to achieve these pursuits (the how). Each HLTA section ends with an opportunity for you to evaluate your current reality (your team's progress). The chapter ends with time for reflection and action (setting your Mathematics at Work priorities for team action).



Source: Kanold, Kanold, & Larson, 2012.

**Figure 1.1: Step one of the PLC teaching-assessing-learning cycle.**

# HLTA 1: Making Sense of the Agreed-On Essential Learning Standards (Content and Practices) and Pacing

*An excellent mathematics program includes curriculum that develops important mathematics along coherent learning progressions and develops connections among areas of mathematical study and between mathematics and the real world.*

—National Council of Teachers of Mathematics

In most middle school mathematics courses, there will be ten to twelve mathematics units (or chapters) during the school year. These units may also consist of several learning modules depending on how your middle school curriculum and courses are structured. An ongoing challenge is for you and your team to determine how to best make sense of and develop understanding for each of the agreed-on essential learning standards within the mathematics unit.

Recall there are four critical questions every collaborative team in a PLC asks and answers on an ongoing unit-by-unit basis.

1. What do we want all students to know and be able to do? (The essential learning standards)

2. How will we know if they know it? (The assessment instruments and tasks teams use)

3. How will we respond if they don't know it? (Formative assessment processes for intervention)

4. How will we respond if they do know it? (Formative assessment processes for extension and enrichment)

High-Leverage Team Action	1. What do we want all students to know and be able to do?	2. How will we know if they know it?	3. How will we respond if they don't know it?	4. How will we respond if they do know it?
Before-the-Unit Action				
HLTA 1. Making sense of the agreed-on essential learning standards (content and practices) and pacing	<div></div>			

 = Fully addressed with high-leverage team action

## The What

This first high-leverage team action enhances clarity on the first PLC critical question for collaborative team learning: What do we want all students to know and be able to do? In light of the Common Core State Standards for mathematics, the essential learning standards for the unit—the guaranteed and viable mathematics curriculum—include the essential standards students will learn, when they will learn each

essential standard (the pacing of the unit), and how they will learn it via process standards such as the Common Core Standards for Mathematical Practice or NCTM's eight teaching practices (2014, p. 10). For example, the Standards for Mathematical Practice “describe varieties of expertise that mathematics educators at all levels should seek to develop in their students” (National Governors Association Center for Best Practices [NGA] & Council of Chief State School Officers [CCSSO], 2010, p. 6). Following are the eight Standards for Mathematical Practice, which we include in full in appendix A (page 177).

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning. (NGA & CCSSO, 2010, pp. 6–8)

While schools and districts use many names for learning standards—*learning goals*, *learning targets*, *learning objectives*, and so on—this handbook references the broad mathematical concepts and understandings for the entire unit as *essential learning standards*. The essential learning standards will become the focus for your analysis of student performance during the unit. For more specific lesson-by-lesson daily outcomes, we use *daily learning objectives* or *questions*. We use the terms *learning goals* or *learning targets* to reference the *outcome* for student proficiency in each standard. The daily learning objectives and the tasks and activities representing those objectives help students *understand* the essential learning standards for the unit in order to demonstrate proficiency (outcomes) on those standards. The daily learning objectives articulate for students what they are to learn *that day* and at the same time provide insight for teachers on how to assess students on the essential learning standards at the end of the unit. It is important to keep in mind that your daily learning objectives must maintain the same expectation for developing student understanding and not allow the student learning experience to become strictly procedural.

A unit of instruction connects topics in mathematics that are naturally grouped together—the essential ideas or content standard clusters. The essential learning standards are framed as overarching questions for a unit posed to the class. It might take three to five days of instruction and two to three daily learning objectives to fully answer the essential question. The *context* of the lesson is the driving force for the entire lesson-design process. Each lesson context centers on clarity of the mathematical content and the processes for student learning.

The crux of any successful mathematics lesson rests on your collaborative team identifying and determining the daily learning objectives that align with the essential learning standards for the unit. Although you might develop daily learning objectives for each lesson as part of curriculum writing or review, your collaborative team should take time during lesson-design discussions to make sense of the essential learning standards for the unit and to consider how the essential learning standards for the unit are connected.

This involves unpacking the mathematics content as well as the Mathematical Practices or processes each student will engage in as he or she learns the mathematics of the unit. *Unpacking*, in this case, means making sense of the mathematics listed in the standard, making sense of how the content connects to content learned in other mathematics courses as well as within the current course, and making sense of how students might develop both conceptual understanding and procedural skill with the mathematics listed in the standard. Collaboratively unpacking the standards is one strategy to address one of the eight research-informed instructional practices identified by NCTM (2014) in *Principles to Actions: Ensuring Mathematical Success for All*, “Establish Mathematics Goals to Focus Learning.” When collaborative teams unpack a standard and situate the “learning goals within the mathematical landscape” they support students in making mathematical connections and developing deep understanding of the content (p. 13).

This first high-leverage team action supports NCTM’s curriculum principle and professionalism principle: *teachers collaboratively examine and prioritize the mathematics content and mathematical practices that students are to learn* (2014, p. 99). For more detail on these connections, see appendix E, page 189.

## The How

As you and your collaborative team unpack the mathematics content standards (the essential learning standards) for a unit, it is also important to decide which Standards for Mathematical Practice will receive focused development throughout the unit of instruction and what mathematical tasks you will use during the unit to help students learn both the essential content standards and the Mathematical Practices or process standards. Thus, your collaborative team identifies, explores, and discusses:

1. The meaning of the essential *content* learning standards for the unit
2. The intentional Mathematical Practices or processes for student learning to be developed during the unit
3. The mathematical tasks (higher- and lower-level cognitive demand) to be used during the unit

## Unpacking a Learning Standard

How can your team explore the general unpacking of content and linking the content to student Mathematical Practices for any unit? By participating in deep discussions about the meaning of the essential learning standards before the unit begins.

In order to develop clarity around the mathematical content and practices for any given unit, it is necessary to follow a process of unpacking the essential learning standards. As you organize each unit for the course, your team should identify learning objectives that develop understanding for the essential standards, Mathematical Practices and processes for learning, and specific instructional strategies you will commit to use as part of your daily instruction.

## Making Sense of Essential Learning Standards for a Unit

As you read through the sample unit in figure 1.2 (page 12), you will notice that the essential learning standards offer clarity on the depth of instruction and focus of the content. In general, there is coherence among the essential learning standards as to how they progress through the grades 6–8 domains, such as

Ratios, Proportions, and Functions; Expressions and Equations; or Geometry. In order to deeply understand the intent within each essential learning standard of a unit, it is important to consider and reference the essential learning standards within that domain for the preceding and succeeding grade or course. Visit the University of Arizona's website (<http://ime.math.arizona.edu/progressions>) if you need more information on these progressions for the CCSS. Exploration of the mathematics standards at this grain size helps you and your team members develop confidence in exploring the mathematics you will teach and discussing uncertainties regarding the depth of conceptual understanding the standard requires.

Consider the eighth-grade mathematics unit aligned to the content standard cluster *Understand congruence and similarity using physical models, transparencies, or geometry software* (8.G.1–8.G.5; NGA & CCSSO, 2010, pp. 55–56) shown in figure 1.2.

<p><b>Unit Name:</b> Congruence and Similarity</p> <p><b>Unit Number:</b> 16</p>
<p><b>Essential Learning Standards</b></p> <p><b>1. Understand congruence and similarity using physical models, transparencies, or geometry software.</b></p> <p><b>8.G.1:</b> Verify experimentally the properties of rotations, reflections, and translations:</p> <ul style="list-style-type: none"> <li>a. Lines are taken to lines, and line segments to line segments of the same length.</li> <li>b. Angles are taken to angles of the same measure.</li> <li>c. Parallel lines are taken to parallel lines.</li> </ul> <p>Develop Mathematical Practices 5 and 6: “Use appropriate tools strategically” and “Attend to precision.”</p> <p><b>8.G.2:</b> Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.</p> <p>(Prerequisite knowledge: 7.G.2)</p> <p><b>8.G.3:</b> Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</p> <p>Develop Mathematical Practices 3 and 7: “Construct viable arguments and critique the reasoning of others” and “Look for and make use of structure.”</p> <p><b>8.G.4:</b> Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.</p> <p>Develop Mathematical Practices 3 and 6: “Construct viable arguments and critique the reasoning of others” and “Attend to precision.”</p> <p>(Prerequisite knowledge: 7.G.1)</p> <p><b>8.G.5:</b> Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.</i></p> <p>(Prerequisite knowledge: 7.G.5)</p>

Source for standards: NGA & CCSSO, 2010, pp. 55–56.

**Figure 1.2: Essential learning standards for a grade 8 geometry unit.**

In this specific case for congruence and similarity, some team members may already have deep knowledge of this level of geometry, and others may only know about the essential learning standards on a very

superficial level. For example, what is the intended congruence and similarity difference between 8.G.2 and 8.G.4? Some team members may not yet comprehend the depth of understanding they must have in order to meet this essential learning standard for their students.

You can use the congruence and similarity unit discussion tool in figure 1.3 to help inform your team understanding of the congruence and similarity standards. You can also examine an appropriate progression of essential learning standards and identify the depth of the essential learning standards for developing student knowledge around congruence and similarity of two-dimensional figures through dilations, rotations, translations, and reflections. Additionally, you and your collaborative team can plan and discuss *how* you want students to demonstrate understanding of the mathematics content through the identified Mathematical Practices or processes for the unit.

**Directions:** Work with your collaborative team to answer the following questions based on your team decisions regarding unpacking grade 8 geometry standards you will teach during a congruence and similarity unit from figure 1.2.

1. What do congruence and similarity mean? Do we have a common understanding of these concepts as a team?
2. How do we help students understand the difference between translation, rotation, reflection, and dilation?
3. What is the difference between demonstrating two shapes are congruent through a sequence of transformations versus demonstrating two shapes are similar through a sequence of transformations?
4. What instructional strategies can you use to help students transition to using a coordinate grid for describing transformations? What other grade 7 or 8 content domains or clusters naturally link with this unit?
5. Which Mathematical Practices or processes should we highlight during this unit? Do you agree with the choices indicated by this district and the grade 8 teacher team?
6. Do you need additional resources to gain clarity on any of these standards?

**Figure 1.3: Discussion tool on essential learning standards for a congruence and similarity unit in grade 8.**

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

In order to help your collaborative team build lessons, it is helpful to break down the essential standards of a unit into the daily learning objectives, which in turn will help you build daily lessons using appropriate mathematical tasks that represent the standards.

The key element of this first high-leverage team action is to personally and collaboratively make sense of the essential learning standards with an eye toward *planning* for student engagement in the Mathematical Practices and processes that support them. This needs to occur *before* the unit begins in order to take full advantage of instructional time during the unit. In the case of the content standard cluster from domain 8.G, without your collaborative team's focus on unpacking the essential learning standards, students might be limited to demonstrating how a shape rotates, translates, or reflects. If this were to happen, students will not engage in the higher-level process of describing a sequence of movements for how one shape is transformed to a new location.

Your collaborative team may need to use outside resources to make sense of the mathematics involved in the learning standards within a unit. The background information in your school textbook or digital teacher's editions can be a good source for this foundational knowledge, as can resources from the National Council of Teachers of Mathematics ([www.nctm.org](http://www.nctm.org)), such as their *Essential Understanding* series.

In general, your team can use figure 1.4 as a discussion tool for any unit that is part of your grade level or course curriculum, as you break down the major essential learning standards for understanding.

After using the discussion tool in figure 1.4, you and your collaborative team can use the results of your conversations to create a transparent map of the unit and to articulate the unit intent to all team members. When unpacking the essential learning standards, your collaborative team develops understanding of the essential learning standards, more specific daily learning objectives, and the necessary prerequisite knowledge and vocabulary and identifies appropriate mathematical practices to support student learning.



**Directions:** Discuss the following prompts or questions with your collaborative teams to unpack essential learning standards, the prerequisite skills for the unit, the associated Mathematical Practices or processes relevant to the current unit of study for your course, and the pacing decisions for the unit.

1. List the agreed-on four to six essential learning standards for this unit.
2. As you discuss each essential learning standard, what are the daily learning objectives that might support that standard over several days?
3. What is the time frame available to teach this unit, and how will that time be distributed for each essential learning standard?
4. What prerequisite mathematics knowledge is necessary to support student learning during this unit?
5. What is the mathematics vocabulary necessary to support student learning during this unit?
6. What are specific teaching strategies, tasks, and tools that will most effectively support each essential learning standard for the unit?
7. Which Mathematical Practices or processes should we highlight during the unit in order to better engage students in the process of understanding each essential learning standard? Identify them, and discuss.
8. What specific lessons will highlight mathematical modeling that represents the standards for the unit?

**Figure 1.4: Discussion tool for making sense of the agreed-on essential learning standards for the unit.**

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

### ***Making Sense of the Unit Content Progression***

Figure 1.5 is a sample unit plan designed to support HLTA 1—Making sense of the agreed-on essential learning standards—for a grade 8 unit that addresses congruence and similarity.

<b>Unit Name:</b> Congruence and Similarity	<b>Unit Number:</b> 1
<b>Time Frame</b> Twenty fifty-minute class periods (including the review and test)	
<b>Essential Learning Standards</b> Understand congruence and similarity using physical models, transparencies, or geometry software.	<b>Potential Learning Objectives for the Unit</b>
<b>8.G.1:</b> Verify experimentally the properties of rotations, reflections, and translations: a. Lines are taken to lines, and line segments to line segments of the same length. b. Angles are taken to angles of the same measure. c. Parallel lines are taken to parallel lines.	I can verify experimentally the properties of rotations, reflections, and translations: a. Lines are taken to lines, and line segments to line segments of the same length. b. Angles are taken to angles of the same measure. c. Parallel lines are taken to parallel lines.
<b>Mathematical Practices</b> Use appropriate tools strategically. Attend to precision.	I can use tools appropriately to model and investigate the properties of rotations, reflections, and translations. I can attend to precision in my use of proper vocabulary and properties.
<b>8.G.2:</b> Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (Prerequisite knowledge: 7.G.2)	I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations.
<b>8.G.3:</b> Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.	I can describe the effect of translations, rotations, and reflections on two-dimensional figures using coordinates.  I can describe the effect of dilations on two-dimensional figures using coordinates.
<b>Mathematical Practices</b> Construct viable arguments and critique the reasoning of others. Look for and make use of structure.	In order to identify the effect of transformations, I am able to look for and make use of structure. I can construct viable arguments and critique the reasoning of others to describe the effect of transformations on a given figure.
<b>8.G.4:</b> Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. (Prerequisite knowledge: 7.G.1)	I can demonstrate that two figures are similar by using the properties of dilations, rotations, reflections, and translations of two-dimensional figures.  I can describe a sequence of transformations between two figures that exhibits the similarity between them.
<b>Mathematical Practices</b> Construct viable arguments and critique the reasoning of others. Attend to precision.	I can construct viable arguments and critique the reasoning of others as they describe that a two-dimensional figure is similar or not similar to another figure. I can attend to precision as I describe the sequence of transformations to demonstrate similarity.

continued →

<b>Overarching Unit Mathematical Practices</b> Make sense of problems and persevere in solving them. Model with mathematics.	I can demonstrate perseverance in all problems I encounter. I can generate models to represent my thinking and use models to help develop understanding.
<b>Prerequisite Knowledge</b> List standards linked to content taught in the previous grade or course.	
<p><b>7.G.1:</b> Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.</p> <p><b>7.G.2:</b> Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.</p> <p><b>7.G.5:</b> Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.</p> <p><b>6.NS.6c:</b> Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.</p>	
<b>Mathematical Practices</b> Make sense of problems and persevere in solving them. Construct viable arguments and critique the reasoning of others. Model with mathematics. Attend to precision. Look for and make use of structure.	
<b>Key Mathematics Vocabulary</b> <ul style="list-style-type: none"> <li>• Rotation</li> <li>• Reflection</li> <li>• Translation</li> <li>• Dilation</li> <li>• Congruent</li> <li>• Similarity, similar</li> <li>• Two-dimensional</li> <li>• Coordinate plane</li> <li>• Coordinates</li> <li>• Angles, lines, line segments, parallel lines</li> <li>• Transformations</li> </ul>	

Source: Adapted from DI25 Consortium, Lincolnshire, Illinois.

Source for standards: NGA & CCSSO, 2010, pp. 43, 49–50, 55–56.

**Figure 1.5: Sample geometry unit plan for congruence and similarity.**

Once your team identifies the essential standards for the unit (notice that the team in the grade 8 example decided not to teach essential standard 8.G.5 in this unit due to length issues), you turn your focus to developing the essential learning standard progression of the unit. You decide how much time to dedicate to each essential learning standard. As with any planning, this is a starting point to understanding the depth of student understanding required for the unit and how to organize the development of the mathematical concepts within the unit. Your team shares how each concept is connected to previous standards and upcoming standards to make explicit and logical connections among the unit's content for the students. Figure 1.6 (pages 18–19) provides a sample unit progression across these standards, for use with grade 8 students.

Unit Plan: Twenty Instructional Days				
Day 1	Day 2	Day 3	Day 4	Day 5
<b>8.G.1:</b> I can verify experimentally the properties of rotations, reflections, and translations. Exploration Using Geometry Software Students will manipulate shapes through translations and reflections to make conjectures about their observations.	<b>8.G.1:</b> I can verify experimentally the properties of rotations, reflections, and translations. Exploration Using Geometry Software Students will manipulate shapes through rotations to make conjectures about their observations.	<b>8.G.1:</b> I can verify experimentally the properties of rotations, reflections, and translations. Informal Assessment Students create a transformation to prove the properties of transformations.	<b>8.G.1:</b> I can verify experimentally the properties of rotations, reflections, and translations. Students will engage in a final vocabulary activity using the Frayer Model to finalize understanding about the properties of transformations.	<b>8.G.2:</b> I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will discuss congruence and begin creating congruent figures through translations.
Day 6	Day 7	Day 8	Day 9	Day 10
<b>8.G.2:</b> I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will explore congruent figures that are reflected over the x-axis and y-axis.	<b>8.G.2:</b> I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will explore congruent figures that are reflected over other lines.	<b>8.G.2:</b> I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will explore rotations of shapes and identify if they are congruent.	<b>8.G.2:</b> I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will create rotations that result in congruent figures and noncongruent figures using physical models and geometry software.	<b>8.G.2:</b> Informal Assessment I can demonstrate the congruence of two-dimensional figures using the properties of rotations, reflections, and translations. Students will create a sequence of transformations for a peer to decide if they are congruent.

continued →

Day 11	Day 12	Day 13	Day 14	Day 15
<b>8.G.3:</b> I can describe the effect of translations, rotations, and reflections on two-dimensional figures using coordinates. Students will apply their knowledge of transformations and learn how to use coordinates to describe a transformation or a series of transformations.	<b>8.G.3:</b> I can describe the effect of translations, rotations, and reflections on two-dimensional figures using coordinates. Students will apply their knowledge of transformations and learn how to use coordinates to describe a transformation or a series of transformations.	<b>8.G.4:</b> I can demonstrate that two figures are similar by using the properties of dilations, rotations, reflections, and translations of two-dimensional figures. Students will begin to explore the meaning of similar figures and the difference between similar and congruent.	<b>8.G.4:</b> I can demonstrate that two figures are similar by using the properties of dilations, rotations, reflections, and translations of two-dimensional figures. Students will discuss how two figures can be similar using reflections and translations. They will examine examples and nonexamples.	<b>8.G.4:</b> I can demonstrate that two figures are similar by using the properties of dilations, rotations, reflections, and translations of two-dimensional figures. Students will discuss how two figures can be similar using rotations, reflections, and translations. They will examine examples and nonexamples.
Day 16	Day 17	Day 18	Day 19	Day 20
<b>8.G.3 (Part 2):</b> I can describe the effect of dilations on two-dimensional figures using coordinates. Students will explore the effect of dilations on coordinates for two-dimensional figures using models and geometry software. Students will establish generalizations about effects.	<b>8.G.3 (Part 2) and 8.G.4:</b> I can describe the effect of dilations on two-dimensional figures using coordinates. Students will continue building their knowledge of dilations and how to represent the effect of a dilation using coordinates through various tasks.	<b>8.G.4:</b> I can describe a sequence of transformations between two figures that exhibits the similarity between them. Students will be given and will create a sequence of transformations between two figures and describe the sequence.	<b>Review for Unit 1</b> Students will combine all standards together.	<b>Assessment for Unit 1</b>
<b>Notes for Unit 1</b> When working through each standard, we may not need to break up the learning targets by each transformation; however, it may also help students to take an in-depth look at each transformation. This is something we will monitor throughout the unit and make notes on for next year. Also, 8.G.1 will continue to be embedded throughout instruction in this unit. Before moving on to similarity, we will ensure all students have a solid understanding of congruence and how it relates to transformations. Most work and dialogue during this unit will occur in teams of four. Students will present their thinking and listen to the thinking and reasoning of others to fully develop their understanding and their demonstration for the overarching unit, Mathematical Practices 1 “Make sense of problems and persevere in solving them” and 4 “Model with mathematics.”				

*Note: Crossed-out text indicates that only a certain portion of the standard is the focus.*

*Source: Adapted with permission from Aptakic-Tripp CCSD 102, Buffalo Grove, Illinois.*

*Source for standards: NGA & CCSSO, 2010, pp. 55–56.*

**Figure 1.6: Sample unit progression for geometry across standards.**

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The first high-leverage team action is both a district and a teacher team responsibility. The district office does need to provide guidance about the proper scope and sequence of the essential learning standards of the unit to ensure students receive a guaranteed and viable curriculum and to support student mobility issues. At the same time, members of your course- or grade-level team need to be clear on the intent of the essential standards, the rationale for teaching the standards in a specific order, and the nuances of the meaning and intent of each essential standard. In short, you need to own the meaning of each essential learning standard for the unit.

At a minimum, your team should take the time to write a set of notes similar to the ones stated at the end of figure 1.6 as you work to better understand the intent of the mathematics content, the mathematics content progressions, the overarching Mathematical Practices and processes, and the mathematical tasks and applications for that unit.

### **Your Team's Progress**

It is helpful to diagnose your team's current reality and action prior to launching the unit. Ask each member to individually assess your team on the first high-leverage team action using the status check tool in table 1.1. Discuss your perception of your team's progress on making sense of the agreed-on essential learning standards and pacing. It matters less which stage your team is at and more that you and your team members are committed to working together to focus on understanding the essential learning standards and the best mathematical tasks and strategies for increasing student understanding and achievement as your team seeks stage IV—sustaining.

Your responses to table 1.1 will help you determine what you and your team are doing well with respect to your focus on essential learning standards and where you might need to place more attention before the unit begins.

Once your team unpacks and understands the essential learning standards, you are ready to identify and prepare higher-level-cognitive-demand mathematical tasks related to those essential learning standards. It is necessary to include tasks at varying levels of demand during instruction. The idea is to match the tasks and their cognitive demand to the essential learning standard expectations for the unit. Selecting mathematical tasks together is the topic of the second high-leverage team action, HTLA 2.

**Table 1.1: Before-the-Unit Status Check Tool—HLTA 1: Making Sense of the Agreed-On Essential Learning Standards (Content and Practices) and Pacing**

<b>Directions:</b> Discuss your perception of your team’s progress on the first high-leverage team action—making sense of the agreed-on essential learning standards (content and practices) and pacing. Defend your reasoning.			
Stage I: Pre-Initiating	Stage II: Initiating	Stage III: Developing	Stage IV: Sustaining
We do not discuss the essential learning standards of the unit prior to teaching it.	We discuss and reach agreement on the four to six essential learning standards for the unit.	We unpack the intent of each essential learning standard for the unit and discuss daily learning objectives to achieve each essential standard.	We connect the four to six essential learning standards to the Mathematical Practices before the unit begins.
We do not know which essential learning standards other colleagues of the same course or grade level teach during the unit.	We discuss and share how to develop student understanding of the essential learning standards during the unit.	We collaborate with our colleagues to make informed decisions about instruction of the essential learning standards for each lesson in the unit.	We have procedures in place to review the effectiveness of the students’ roles, activities, experiences, and success on the essential learning standards during the unit.
We do not discuss lesson tasks.	We connect and align some lesson tasks to the essential learning standards for the unit.	We share effective teaching strategies for the essential learning standards of the unit.	We have procedures in place that ensure our team aligns the most effective mathematical tasks and instructional strategies to the content progression established in our overall unit plan components.
We do not discuss Mathematical Practices and processes as part of our unit planning.	We discuss Mathematical Practices and processes that best align to the essential learning standards for the unit.	We agree on Mathematical Practices and processes that best align to the learning standards for the unit.	We implement Mathematical Practices and processes that best align to the learning standards for the unit.

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

## HLTA 2: Identifying Higher-Level-Cognitive-Demand Mathematical Tasks

*The function of education is to teach one to think intensively and to think critically.*


—Martin Luther King Jr.

Developing your team’s understanding of the essential learning standards for the unit helped you answer the first critical question of a PLC, What do we want all students to know and be able to do? The *mathematical tasks* you and your team choose to use every day during the unit help you answer this first critical question as well.

The mathematical tasks you choose each day for every unit also partially answer the second critical question of a PLC, How will we know if they know it?

High-Leverage Team Action	1. What do we want all students to know and be able to do?	2. How will we know if they know it?	3. How will we respond if they don't know it?	4. How will we respond if they do know it?
Before-the-Unit Action				
HLTA 2. Identifying higher-level-cognitive-demand mathematical tasks				

 = Fully addressed with high-leverage team action

 = Partially addressed with high-leverage team action

### The What

What is a mathematical task?

NCTM first identified the term *mathematical task* in its (1991, 2008) *Professional Teaching Standards* as “worthwhile mathematical tasks” (p. 24). Melissa Boston and Peg Smith (2009) later provide this succinct definition: “A mathematical task is a single complex problem or a set of problems that focuses students’ attention on a specific mathematical idea” (p. 136).

Mathematical tasks include activities, examples, or problems to complete as a whole class, in small groups, or individually. The tasks provide the rigor (levels of complex reasoning as provided by the conceptual understanding, procedural fluency, and application of the tasks) that students require and thus become an essential aspect of your team’s collaboration and discussion. In short, the tasks are the problems you choose to determine the pathway of student learning and to assess student success along that pathway. As a teacher, you are empowered to decide what and how a student learns through your choice and use of the mathematical tasks and activities that students experience.

The type of instructional tasks you and your team select and use will determine students’ opportunities to develop proficiency in Mathematical Practices and processes and will support the development of conceptual understanding and procedural fluency for the essential learning standards. Your provision of



higher-level-cognitive-demand tasks in lessons, and your sequencing of those tasks to build conceptual knowledge and procedural fluency, are essential aspects of your middle school mathematics lesson planning and lesson implementation.

The implementation of instructional tasks that promote reasoning and sense-making is so critical to student learning of mathematics that it is listed as one of the eight research-informed teaching practices in *Principles to Actions* (NCTM, 2014).

As Glenda Lappan and Diane Briars (1995) state:

There is no decision that teachers make that has a greater impact on students' opportunities to learn and on their perceptions about what mathematics is than the selection or creation of the tasks with which the teacher engages students in studying mathematics. (p. 139)

Mathematical Practice 1—"Make sense of problems and persevere in solving them"—establishes the expectation for regularly engaging your students in challenging, higher- and lower-level-cognitive-demand tasks essential for their development. A growing body of research links students' engagement in higher-level-cognitive-demand mathematical tasks to overall increases in mathematics achievement, not just in the ability to solve problems (Hattie, 2012; Resnick, 2006).

A key collaborative team decision is which tasks to use in a particular lesson to help students attain the daily learning objective. The nature of the tasks with which your students engage provides the common student learning experiences you can draw on to further student learning at various points throughout the unit. Selecting appropriate tasks provides your collaborative team with the opportunity for rich, engaging, and professional discussions regarding expectations about student performance for the unit.

Thus, four critical task questions for your grade-level or course-based collaborative team to consider include:

1. What nature of tasks should we use for each essential learning standard of the unit? Will the tasks focus on building student conceptual understanding, procedural fluency, or a combination? Will the tasks involve application of concepts and skills?
2. What are the depth, rigor, order of presentation, and ways of investigating that we should use to ensure students learn the essential learning standards?
3. How does our collaborative team choose the mathematical tasks that best represent each essential learning standard?
4. How does our team ensure the implementation of the tasks as a team in order to avoid wide variances in student learning across the grade level or course?

Conceptual understanding *and* procedural fluency are essential aspects for students to become mathematically proficient. In light of this, the tasks you choose to form the unit's lessons must include a balance of higher- and lower-level-cognitive-demand expectations for students. Your team will also need to decide which mathematical tasks to use for class instruction and which tasks to use for the various assessment instruments given to students during and at the end of a unit.

Higher-level-cognitive-demand lessons or tasks are those that provide "opportunities for students to explain, describe, justify, compare, or assess; to make decisions and choices; to plan and formulate

questions; to exhibit creativity; and to work with more than one representation in a meaningful way” (Silver, 2010, p. 2). In contrast, lessons or tasks with only lower-level cognitive demand are “characterized as opportunities for students to demonstrate routine applications of known procedures or to work with a complex assembly of routine subtasks or non-mathematical activities” (Silver, 2010, p. 2).

However, selecting a task with higher-level cognitive demand does not ensure that students will engage in rigorous mathematical activity (Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013). The cognitive demand of a mathematical task is often lowered (perhaps unintentionally) during the implementation phase of the lesson (Stein, Remillard, & Smith, 2007). During the planning phase, your team should discuss how you will respond when students urge you to lower the cognitive demand of the task during the lesson. Supporting productive struggle in learning mathematics is one of the eight research-informed mathematics teaching practices outlined in *Principles to Actions* (NCTM, 2014), and strategies to avoid cognitive decline during task implementation are discussed further in chapter 2 (page 83, HLTA 6).

Thus, your teacher team responds to several mathematical task questions before each unit begins:

1. How do we define and differentiate between higher-level-cognitive-demand and lower-level-cognitive-demand tasks for each essential standard of the unit?
2. How do we select common higher-level-cognitive-demand and lower-level-cognitive-demand tasks for each essential standard of the unit?
3. How do we create higher-level-cognitive-demand tasks from lower-level-cognitive-demand tasks for each essential standard of the unit?
4. How do we use and apply higher-level-cognitive-demand tasks for each essential standard during the unit?
5. How will we respond when students urge us to lower the cognitive demand of the task during the implementation phase of the lesson?

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download these questions as a discussion tool.

## The How

A critical step in selecting and planning a higher-level-cognitive-demand mathematical task is working the task before using it with students. Working the task provides insight into the extent to which it will engage students in the intended mathematics concepts, skills, and Mathematical Practices and how students might struggle. Working the task with your team provides information about possible solution strategies or pathways that students might demonstrate.

### ***Defining Higher-Level- and Lower-Level-Cognitive-Demand Mathematical Tasks***

You choose mathematical tasks for every lesson, every day. Take a moment to describe how you choose the daily tasks and examples that you use in class. Do you make those decisions by yourself, with your team members, before the unit begins, the night before you teach the lesson? Where do you locate and choose your mathematical tasks? From the textbook? Online? From your district resources?

And, most importantly, how would you describe the rigor of each task you chose for your students? Rigor is not whether a problem is considered hard. For example, “Solve  $3(5x - 14) = 18$ ” might be a hard

problem for some middle school students, but it is not rigorous. *Rigor of a mathematical task* is defined in this handbook as the level and the complexity of reasoning required by the student during the task (Kanold, Briars, & Fennell, 2012). Rigor is not about memorizing routine procedures.

There are several ways to label the demand or rigor of a task; however, for the purpose of this handbook, tasks are classified as either lower-level cognitive demand or higher-level cognitive demand as defined by Margaret Smith and Mary Kay Stein (1998) in their task-analysis guide and printed in full as appendix C (page 185). *Lower-level-cognitive-demand tasks* are typically focused on memorization or performing standard or rote procedures without attention to the properties that support those procedures (Smith & Stein, 2011).

*Higher-level-cognitive-demand tasks* are tasks for which students do not have a set of predetermined procedures to follow to reach resolution, or, if the tasks involve procedures, they require that students provide the justification for why and how the procedures can be performed. Smith and Stein (2011) describe these procedures as “procedures with connections” (p. 16) as opposed to “procedures without connections,” the designation they use for lower-level-cognitive-demand tasks that are not just based on memorization.

Lower-level-cognitive-demand tasks generally take less time in class and do not require much complex reasoning by students. Their efficiency is appealing. They are much easier to manage in class as a general rule and easily serve direct instruction from the front of the room.

Consider the mathematical task presented in figure 1.7 (page 26), a sixth-grade problem. Examine the criteria listed in appendix C on page 185 and discuss with your colleagues why you believe the Alex problem in figure 1.7 is an example of a higher-level-cognitive-demand task. Which of the higher-level-cognitive-demand criteria seem to be met by this mathematical task for sixth graders? How is this task different from merely asking your students to do the lower-level-cognitive-demand task, “Find  $\frac{1}{4} \div \frac{2}{5}$ ”?

<p>Alex claims that when <math>\frac{1}{4}</math> is divided by a fraction, the result will always be greater than <math>\frac{1}{4}</math>.</p> <p>A. Drag a digit into each box to create an expression that supports Alex's claim.</p> <p>B. Drag a digit into each box to create an expression that contradicts Alex's claim.</p>	1	<p><b>A. Supports Alex's Claim</b></p> $\frac{1}{4} \div \frac{\boxed{\phantom{0}}}{\boxed{\phantom{0}}}$ <hr/> <p><b>B. Contradicts Alex's Claim</b></p> $\text{n.d} = \frac{1}{4} \div \frac{\boxed{\phantom{0}}}{\boxed{\phantom{0}}}$
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	

Source for the task: Smarter Balanced Assessment Consortium, n.d. Used with permission.

**Figure 1.7: Sixth-grade example of a higher-level-cognitive-demand task.**

Ultimately, the level of cognitive demand of the mathematical tasks you choose each day can be viewed as either lower- or higher-level-cognitive-demand as shown in figure 1.8.

<p><b>Lower-Level Cognitive Demand</b></p> <p><i>Memorization:</i> Requires eliciting information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula.</p> <p><i>Procedures without connections:</i> Requires the engagement of some mental processing beyond a recall of information.</p>
<p><b>Higher-Level Cognitive Demand</b></p> <p><i>Procedures with connections:</i> Requires complex reasoning, planning, using evidence, and explanations of thinking.</p> <p><i>Doing mathematics:</i> Requires complex reasoning, planning, developing, and thinking most likely over an extended period of time.</p>

Source: Smith & Stein, 2012.

**Figure 1.8: Four categories of cognitive demand.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

Since many of the revised state mathematics assessments intend to dramatically increase the task rigor compared to current state assessments (Herman & Linn, 2013) there are additional expectations for you to increase the cognitive demand of the mathematical tasks you choose to use during instruction and assessment.

The very nature of the mathematical content expectations requires your students to demonstrate *understanding*, and thus a shift to a *balanced* task approach during the unit—the use of both higher- and lower-level-cognitive-demand tasks. In most middle school classrooms, this will require an increase in the use of higher-level-cognitive-demand tasks.

*Identifying the Cognitive Demand of Your Mathematical Tasks*

As a first step in understanding the nature of the current cognitive-demand level of the tasks you use each day, use the tool in figure 1.9 for sorting unit tasks by cognitive-demand level.

<b>Name of the Unit:</b> For at least two of the essential standards in this unit, provide samples of the types of mathematical tasks students will experience in class, for homework, or on assessments.	
<b>Directions:</b> Sort every task you use into the following four categories.	
<b>Lower-Level Tasks</b>	<b>Higher-Level Tasks</b>
<b>Memorization</b>	<b>Procedures With Connections</b>
<b>Procedures Without Connections</b>	<b>Doing Mathematics</b>

**Figure 1.9: Tool for sorting unit tasks by cognitive-demand level.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

What percent of the current tasks you plan to use fall into the lower-level-cognitive-demand task category? What percent fall into the higher-level-cognitive-demand task category? Do you have a proper balance in terms of the complexity of student reasoning required by the tasks you present to students throughout the unit?

Use figure 1.10 (page 28) to examine a seventh-grade equivalent expressions mathematical task, and then answer the questions at the end.

You can use your answers to the questions in figure 1.10 to guide your collaborative team’s discussion about the use of any higher-level-cognitive-demand task during the unit.



### ***Creating Higher-Level-Cognitive-Demand Tasks***

Higher-level-cognitive-demand tasks are essential for improving student achievement. There are many resources online and in print that can provide examples of higher-level-cognitive-demand tasks for classroom use. For a list of these resources, see appendix D (page 187), or visit **go.solution-tree.com/mathematicsatwork** for a listing of these resources.

However, you and your team should also focus on creating tasks of varying cognitive demand as a team. This will not only ensure better alignment to the essential learning standards for the unit but will also empower your team to have greater ownership and understanding of task design and selection.

There are several strategies you can use to change a lower-level-cognitive-demand task to higher-level cognitive demand. You can use the strategies in figure 1.11 to adjust a mathematical task to a higher level of cognitive demand.

1. Use comparison questions. (When is one situation greater than, equal to, or less than another?)
2. Ask a question across multiple representations in a task.
3. Validate a solution pathway or approach.
4. Require students to provide justifications for (explain) their solutions.
5. Evaluate the error or reasoning in a student solution and provide a correct solution pathway.
6. Create a context. Ask students to write a word problem that creates a context for the given information.
7. Ask students to determine an expression to represent a situation.
8. Create an open-ended debate-type task, so that multiple student responses will satisfy a solution to the mathematical task.

**Figure 1.11: Strategies for increasing the cognitive demand of tasks.**

Visit **go.solution-tree.com/mathematicsatwork** to download a reproducible version of this figure.

The task from figure 1.10 for the essential learning standard 7.EE.1, “Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients” (NGA & CCSSO, 2010, p. 49), represents a higher-level-cognitive-demand task. The task as presented is an example of the first type of higher-level-cognitive-demand task listed in figure 1.11—use comparison questions.

Notice how the task question asks students if the expressions are equivalent by requiring students to compare the given expression to the options listed: a comparison of two quantities. What might a lower-level-cognitive-demand task look like for the same essential learning standard? Contrast the type of understanding required of the student when compared to the more typical lower-level-cognitive-demand mathematics question or task such as:

Simplify  $\frac{1}{2}(2x + 3y)$  and show your work.

This is a lower-level-cognitive-demand mathematical task, as it only requires students to use the distributive property and represents a procedural question without a connection or expectation for understanding the procedure. In general, verbs such as *find*, *solve*, *graph*, and *simplify* tend to be lower-level-cognitive-demand verbs. *Create*, *build*, *conjecture*, *compare*, *contrast*, *explain*, and *justify* tend to create higher-level-cognitive-demand mathematical tasks.

Work with your course- or grade-level collaborative team to clarify or create higher-level-cognitive-demand tasks for the essential learning standards of your unit. You can use the team discussion tool in figure 1.12 to help with this process.

Once you include identifying and creating higher-level-cognitive-demand mathematical tasks as part of your unit planning, your before-the-unit activity will likely change. You will begin to look at tasks and classify them as higher-level or lower-level cognitive demand and then decide the best timing during the unit and lessons to use the higher-level-cognitive-demand tasks. Your goal should be to use an appropriate balance of higher- to lower-level-cognitive-demand questions during your instruction and in the assessment instruments for the unit in order to pursue “conceptual understanding, procedural skills and fluency, and application with equal intensity” (Common Core State Standards Initiative, 2014, p. 1). We will discuss the use of tasks in class during the unit in further detail in chapter 2, HLTA 6 (page 83).

### ***Preparing for the Use of Higher-Level-Cognitive-Demand Tasks***

Before you use any higher-level-cognitive-demand task in class, your teacher team should:

1. Discuss your expectations for *student demonstration of quality work* (both successful and unsuccessful approaches) in defense of their mathematical argument for the task.
2. Discuss how your lesson plan for this problem *promotes student communication of their argument with others* and allows peer-to-peer–based solution defense.

To help your team facilitate this type of discussion, you can use figure 1.13 (page 32) for any common higher-level-cognitive-demand task you plan to use during the unit.

To help your team facilitate this type of discussion, use the questions from figure 1.12 with the following higher-level-cognitive-demand task for grade 7 (see figure 1.14, page 33).



List an essential learning standard for the unit:

---

Identify one lower-level-cognitive-demand task you use for this essential learning standard. Using one of the task-modification strategies from figure 1.10 (page 28), rewrite the task into a higher-level-cognitive-demand task. List both the lower- and higher-level-cognitive-demand task.

Provide a justification for your choice of tasks and the cognitive level of each task, and prepare to discuss these with your team.

Answer the following questions with your collaborative team:

1. How might what you learn about your students' understanding of the essential learning standard differ depending on the cognitive demand of the task you use during instruction?
2. Which strategy helped you to write the higher-level-cognitive-demand task?
3. In what ways might you support the implementation of the higher-level-cognitive-demand mathematical tasks during instruction? What types of teaching strategies or activities could you use?

**Figure 1.12: Team discussion tool for identifying higher-level-cognitive-demand mathematical tasks for the unit.**

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

<p><b>Directions:</b> Use these questions to better understand how you will use any higher-level-cognitive-demand task in class.</p>
<p>What is the essential standard for the lesson? (What do you want students to know and understand about mathematics as a result of this lesson)?</p>
<p>In what ways does the task build on students' previous knowledge? What definitions, concepts, or ideas do students need to know to begin to work on this task? What prompts will you need to help students access their prior knowledge?</p>
<p>What are all the possible solution pathways for the task?</p> <p>Which of these pathways or strategies do you think students will use?</p> <p>What misconceptions might students have?</p> <p>What errors might students make?</p>
<p>What are the language demands of the task? How will you address these challenges if students are stuck during the task?</p>
<p>What are your expectations for students as they work on and complete this task? What tools or technology will they utilize to enhance student-to-student discourse?</p>

Source: Adapted from Smith, Bill, & Hughes, 2008.

**Figure 1.13: Task-analysis discussion tool.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

**Essential learning standard:** I can solve problems involving scale drawings of geometric figures.

A floor plan is a scale diagram of a room or building drawn as if seen from above.

**Part A**

**Task:** On a separate piece of paper, create a floor plan of a house that has 2,500 square feet. There is a living room, kitchen, hallway, dining room, and a bathroom that make up this floor plan. Be sure to show all your work.

The floor plan must meet the following requirements:

The dining room is a perfect square.

The kitchen has dimensions of 35 ft. x 22 ft.

The bathroom has an area of 250 square feet.

The hallway is 3 ft. wide.

The living room is  $\frac{3}{10}$  of the total square feet.

**Part B**

If the volume of the living room is 7,875 cubic feet, how tall are the ceilings? Show all of your work.

**Figure 1.14: Grade 7 higher-level-cognitive-demand task.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

Remember that what determines the cognitive demand of a task is the level and the complexity of reasoning required by the student during the task (Kanold, Briars, & Fennell, 2011). As you plan your lessons, consider the cognitive demand level a student is expected to reach when choosing your daily tasks. For example:

- **Lower-level-cognitive-demand task—**

Solve:  $.4x + 0.03x = 1$

- **Higher-level-cognitive-demand task—**

In the equation  $4x + 0.03x = 1$ , a student attempts to eliminate the decimals by multiplying each term of the equation by 10. Is this an effective solution strategy? If yes, explain why. If not, explain why not and what you would recommend the student to do? Solve the problem correctly showing *all* work.

Since student work should be balanced with respect to the level of cognitive demand across tasks during every lesson, it is important to identify expected levels of cognitive demand and ultimately adapt or create tasks for each essential learning standard in the unit as the standards progress over time.

## Your Team's Progress

It is helpful to diagnose your team's current reality and actions prior to launching the unit. Ask each team member to individually assess your team on the second high-leverage team action using the status check tool in table 1.2. Discuss your perception of your team's progress on identifying higher-level-cognitive-demand mathematical tasks. It matters less which stage your team is at and more that you and your team members are committed to working together to focus on understanding the learning standards and the best activities and strategies for increasing student understanding and achievement as your team seeks stage IV—sustaining.

Your responses will help your team focus on the cognitive demand for your daily mathematical tasks and where you need to place more time and attention before the unit begins. Your intentional use of higher-level-cognitive-demand mathematical tasks will ensure students are aware of and developing deeper understanding of the learning standards.

Of course, using balanced-cognitive-demand tasks becomes an important feature of the common assessment instruments for the end of the unit as well. Creating and using common assessment instruments with a balance of cognitive demand across tasks for each learning standard is the next high-leverage team action.

Visit [nctm.org](http://nctm.org), see appendix D (p. 187), or visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) for additional sources, resources, and examples of higher-level-cognitive-demand tasks for your grade level.

**Table 1.2: Before-the-Unit Status Check Tool for HLTA 2—Identifying Higher-Level-Cognitive-Demand Mathematical Tasks**

<b>Directions:</b> Discuss your perception of your team's progress on the second high-leverage team action—identifying higher-level-cognitive-demand mathematical tasks. Defend your reasoning.			
<b>Stage I: Pre-Initiating</b>	<b>Stage II: Initiating</b>	<b>Stage III: Developing</b>	<b>Stage IV: Sustaining</b>
We do not discuss or share our use of the mathematical tasks in each unit of the curriculum.	We discuss and share some mathematical tasks we will use during the unit.	We explore and practice together mathematical tasks we will use during the unit.	We reach agreement on a collection of mathematical tasks every team member will use.
We do not share our understanding of the difference between lower- and higher-level-cognitive-demand mathematical tasks.	We do not base our instructional decisions and mathematical task choices on the cognitive demand of the task.	We are able to compare and contrast higher- and lower-level-cognitive-demand mathematical tasks for each learning standard of the unit.	We reach agreement on both the solution pathways for each mathematical task and the management of those tasks in the classroom.
We do not discuss the cognitive demand of the tasks we use in class.	We have reached agreement on what differentiates a higher- from a lower-level-cognitive-demand mathematical task.	We connect the mathematical tasks to the essential learning standards, daily lesson learning objectives, and corresponding activities for each unit.	We choose mathematical tasks that represent a balance of lower- and higher-level cognitive demand for the learning standards of the unit.
We do not use higher-level-cognitive-demand mathematical tasks.	We use higher-level-cognitive-demand mathematical tasks if they are included in the lesson.	We create higher-level-cognitive-demand mathematical tasks from lower-level-cognitive-demand mathematical tasks individually.	We create higher-level-cognitive-demand mathematical tasks from lower-level-cognitive-demand mathematical tasks as a team.

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this table.

## HLTA 3: Developing Common Assessment Instruments

*One of the most powerful, higher-level leverage strategies for improving student learning is the creation of frequent, higher-level quality, common formative assessments.*


—Richard DuFour, Rebecca DuFour, Robert Eaker, and Tom Many

Just as the mathematical tasks you and your teacher team choose for your lessons help you to partially answer the second critical question of a PLC—How will we know if they know it?—so do the choices your team makes for the during-the-unit and end-of-unit common assessment instruments.

As your team makes sense of the essential learning standards for the unit and better understands how to choose, adapt, and create higher-level-cognitive-demand mathematical tasks and learning activities, your team will be ready to develop common assessment instruments to assess students' understanding of the essential learning standards for the unit.

High-Leverage Team Action	1. What do we want all students to know and be able to do?	2. How will we know if they know it?	3. How will we respond if they don't know it?	4. How will we respond if they do know it?
<b>Before-the-Unit Action</b>				
HLTA 4. Developing common assessment instruments				

 = Fully addressed with high-leverage team action

 = Partially addressed with high-leverage team action

### The What

Why is developing common assessment instruments an important before-the-unit high-leverage activity? The process of creating common assessment instruments for each unit of your course supports your team conversations about prerequisite concepts and skills, common student errors, and ways of assessing students' understanding of the essential learning standards. It allows you to design lessons backward as you move from the outcomes (student demonstrations of knowledge on essential learning standards) for the unit to the learning activities, tasks, and resources students use during the unit and need for success on the end-of-unit assessments. Developing the common assessment instruments will also help you to better prepare for using them for a formative process at the end of the unit (discussed in detail in chapter 3 with HLTA 9, page 143) in order to inform feedback to students and guide instructional decisions in accord with NCTM's assessment principle outlined in *Principles to Actions* (NCTM, 2014).

According to DuFour, DuFour, Eaker, and Many (2010):

One of the most powerful, high-leverage strategies for improving student learning available to schools is the creation of frequent, high-quality, common formative assessments by teachers who are working collaboratively to help a group of students acquire agreed-upon knowledge and skills. (p. 75)

There is an important distinction between formative assessment *processes* your team uses and the assessment *instruments* as part of those formative processes. W. James Popham (2011) provides an analogy to describe the difference between summative assessment instruments (such as your end-of-unit tests) and formative assessment processes (such as what you and your students *do* with those test results). He describes the difference between a surfboard and surfing.

While a surfboard represents an important tool in surfing, it is only that—a part of the surfing process. The entire process involves the surfer paddling out to an appropriate offshore location, selecting the right wave, choosing the most propitious moment to catch the chosen wave, standing upright on the surfboard, and staying upright while a curling wave rumbles toward shore. (p. 36)

The surfboard is a key component of the surfing process, but it is not the entire process.

Your team's assessment instruments are the tools it uses to collect data about student demonstrations of the learning standards. The assessment instruments subsequently will inform you and your students' ongoing decisions about learning. Assessment instruments vary and can include such tools as class assignments, exit slips, quizzes, or unit tests; however, to avoid inequities in the level of rigor provided to students, and to serve the formative learning process, these assessment instruments must be *in common* for every teacher on your grade-level team.

When your collaborative team creates and adapts unit-by-unit common assessment instruments together, you enhance the coherence, focus, and fidelity to student learning expectations across all middle school courses. The common assessment instruments also provide coherence by fostering mathematics content learning progression continuity for students.

You minimize the wide variance in student task-performance expectations from teacher to teacher (an inequity creator) when you work collaboratively with colleagues to design high-quality assessment instruments appropriate to the identified essential learning standards for the unit. The expectation to collaborate on the development and use of common formative assessments is so critical as a support for equitable instruction that it is specifically listed as one of the actions mathematics teachers pursue in effective learning communities under the professionalism principle in NCTM's (2014) *Principles to Actions*.

The first questions your team must ask are, "How do we know our end-of-unit assessments are of high quality? On what basis would we make these determinations?"

## The How

Collaborative teams consider the following when creating high-quality assessment instruments.

- What level of cognitive demand will we expect for each essential learning standard on the exam?
- What evidence of content knowledge will we assess for each essential learning standard?
- What evidence of student engagement in Mathematical Practices and processes will we assess for each essential learning standard?
- What types of question formats will we use to evaluate specific evidence of learning (such as multiple choice, short answer, multiple representations, explanation and justification, or technology)?

Once your team decides the types of questions or tasks you will use to understand student thinking, your team will need to develop high-quality common assessment instruments that reflect those decisions and support student use of the assessment instrument as a learning tool.

### *Evaluating the Quality of Your Current Assessment Instruments*

How do you decide if the unit-by-unit assessment instruments you design are of high quality? Figure 1.15 provides a during- or end-of-unit assessment instrument quality-evaluation tool that your collaborative team can use to evaluate the quality of your current unit assessment instruments, such as tests and quizzes, as well as to build new and revised assessment instruments for each unit of the course.

Your collaborative team should rate and evaluate the quality of one of your most recent end-of-unit or chapter assessment instruments (tests) using the evaluation tool (figure 1.15) and the high-quality assessment diagnostic and discussion tool (figure 1.16, pages 40–41). How does it score—12? 16? 22? How close does your assessment instrument (your surfboard, so to speak) come to scoring a 27 or higher out of the thirty-two points possible in the rubric? It should be your expectation to write common assessment instruments that would score 4s in all eight categories of the assessment evaluation rubric.

Your collaborative team could also create agreed-on criteria for assessment instrument quality using figure 1.15 as a starting point, based on your local vision for high-quality assessment. Adapt the tool to fit your vision for high-quality assessments.

The value of any collaborative team–driven assessment depends on the extent to which the assessment instrument:

- Reflects the essential learning standards and clearly indicates those standards on the assessment instrument in student-friendly “I can . . .” language
- Supports a student formative process after the assessment (see HLTA 9 in chapter 3, page 143)
- Provides valid evidence of student learning for each essential standard
- Results in a positive impact on student motivation and continued learning

For additional practice using the assessment instrument quality-evaluation tool from figure 1.15, visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) and see the end-of-unit sample assessments.

### *Designing a High-Quality Assessment Instrument*

Designing common assessment instruments before the unit provides a context for the discussion of prerequisite knowledge, which you may need to address during instruction while making sense of the essential learning standards. It also provides a context for discussing potential student errors or misconceptions.

Your team can use the questions in figure 1.17 (page 42) as a way to unpack an essential learning standard and prepare for tasks that will need to be on your next common end-of-unit assessment instrument.



Assessment Indicators	Description of Level 1	Requirements of the Indicator Are Not Present	Limited Requirements of This Indicator Are Present	Substantially Meets the Requirements of the Indicator	Fully Achieves the Requirements of the Indicator	Description of Level 4
Identification and emphasis on essential learning standards (specific feedback to students)	Learning standards are unclear and absent from the assessment instrument. Too much attention is given to one target.	1	2	3	4	Learning standards are clear, included on the assessment, and connected to the assessment questions.
Visual presentation	Assessment instrument is sloppy, disorganized, difficult to read, and offers no room for work.	1	2	3	4	Assessment is neat, organized, easy to read, and well-spaced, with room for teacher feedback.
Balance of higher- and lower-level-cognitive-demand tasks	Emphasis is on procedural knowledge with minimal higher-level-cognitive-demand tasks for demonstration of understanding.	1	2	3	4	Test is rigor balanced with higher-level and lower-level-cognitive-demand tasks present.
Clarity of directions	Directions are missing and unclear. Directions are confusing for students.	1	2	3	4	Directions are appropriate and clear.
Variety of assessment task formats	Assessment contains only one type of questioning strategy, and no multiple choice or evidence of the Mathematical Practices. Calculator usage not clear.	1	2	3	4	Assessment includes a blend of assessment types and assesses Mathematical Practices modeling or use of tools. Calculator expectations clear.
Tasks and vocabulary (attending to precision)	Wording is vague or misleading. Vocabulary and precision of language are a struggle for student understanding and access.	1	2	3	4	Vocabulary is direct, fair, accessible, and clearly understood by students, and they are expected to attend to precision in response.
Time allotment	Few students can complete the assessment in the time allowed.	1	2	3	4	Test can be successfully completed in the time allowed.
Appropriate scoring rubric (points)	Scoring rubric is not evident or is inappropriate for the assessment tasks presented.	1	2	3	4	Scoring rubric is clearly stated and appropriate for each task or problem.

Source: Adapted from Kanold, Kanold, & Larson, 2012, p. 94.

**Figure 1.15: Assessment instrument quality-evaluation tool.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

**Directions:** Examine your most recent end-of-unit test, and evaluate its quality against the following eight criteria described in figure 1.15 (page 39).

**1. Are the essential learning standards written on the test as student friendly and grade-appropriate “I can . . .” statements?**

Discuss: What do your students think about learning mathematics? Do your students think learning mathematics is about doing a bunch of math problems? Or, can they explain the essential learning standards and perform on any task that might reflect that standard?

Note: In order for students to respond to the end-of-unit assessment feedback when it is passed back (HLTA 9, in chapter 3), this is a necessary test feature.

**2. Does the visual presentation provide space for student work?**

Discuss: Do your students have plenty of space to write out solution pathways, show their work, and explain their thinking for each task on the assessment instrument?

Note: This criterion often is one of the reasons not to use the written tests that come with your textbook series. You can use questions from the test bank aligned to your instruction, but space problems as needed.

**3. Is there an appropriate balance of higher- and lower-level-cognitive-demand questions on the test?**

Discuss: What percentage of all tasks or problems on the assessment instrument are of lower-level cognitive demand? What percentage are of higher-level cognitive demand? Is there an appropriate balance? Unless this has been a major focus of your work, your current end-of-unit tests may not score very high in this criterion.

Note: Use figure 1.15 (page 39) as a tool to determine rigor. This will help you to better understand the level of cognitive demand. Also, see page 52 at the end of this section for more advice on this criterion. As a good rule of thumb, rigor-balance ratio should be about 30/70 (higher- to lower-level cognitive demand) on the assessment.

**4. Is there clarity with all directions?**

Discuss: What does clarity mean to each member of our team? Are any of the directions for the different test questions or tasks confusing to the student? Why?

Note: The verbs (actions words) used in the directions for each set of tasks or problems are very important to notice when discussing clarity.

**5. Is there variety in assessment formats?**

Discuss: Did our test use a blend of assessment formats or types? Did we include questions that allow for technology as a tool, such as graphing calculators? Did we balance the use of different question formats? If we used multiple choice, did we include items with multiple possible answers similar to those on the PARCC, SBAC, or other state assessments?

Note: Your end-of-unit assessments should not be of either extreme: all multiple-choice or all open-ended questions.

Discuss: Is the vocabulary for each task used on our end-of-unit assessment clear, accessible, and direct for students? Do we attend to the precision of language used during the unit, and do the students understand the language used on the assessment?

**7. Is enough time allotted for students to complete the assessment?**

Note: Each teacher on the team should complete a full solution key for the assessment as will be expected of students. For upper-level students, it works well to use a time ratio of 3:1 (or 4:1) for student to teacher completion time to estimate how long it will take students to complete an assessment. For elementary students, it may take much longer to complete the assessment. All teachers should use the agreed-upon time allotment.

Discuss: Are the scoring rubrics to be used for every task clearly stated on the test? Do our scoring rubrics (total points for the test) make sense based on the complexity of reasoning for the task? Are the scoring points assigned to each task appropriate and agreed upon by each teacher on the team?

Summary: Using your score from the figure 1.15 assessment tool (page 39), which specific aspects of your current unit assessment instruments need to be improved?

[illegible]

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

**Directions:** Choose an essential learning standard you are planning to assess in your next end-of-unit assessment, and answer the following questions. Be sure to look very carefully at the verbs that describe the essential standard. They will provide hints about the question or task types you will need for the test.

1. What prerequisite skills are necessary for this essential learning standard? How will you assess students' knowledge of these prerequisites?
2. What are common errors related to this essential learning standard? How will your instruction identify and resolve these errors before students take the common unit assessment?
3. How does your conversation around planning common assessment instruments influence your plans for instruction during the unit?
4. What mathematical tasks will you use during instruction for this essential learning standard, and what tasks will you reserve for the assessment of this standard?

**Figure 1.17: Tool for planning and preparing for common assessment instrument task development.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

Once you identify and explore prerequisites and common errors, your team is better prepared to find or develop the common assessment instrument tasks or questions. If this is a new activity for your collaborative team, it might make sense to start with an existing assessment instrument and then adapt it so that it addresses the learning standards comprehensively and provides a balance of higher- and lower-level-cognitive-demand tasks.

Perhaps the greatest challenge you face with creating high-quality unit exams is finding the right balance between procedural fluency (mostly lower-level cognitive demand) with student demonstrations of understanding (mostly higher-level-cognitive-demand tasks) on each unit exam. Cognitive-demand balance is the third criterion listed in figure 1.15 (page 39), the assessment instrument quality-evaluation tool. Did the end-of-unit assessment instrument you reviewed using figure 1.15 score well in terms of an expected balance for student reasoning? Was there a blend of higher- and lower-level-cognitive-demand tasks and questions?

Figure 1.18 (pages 44–45) shows first-attempt sample assessment questions for an end-of-unit assessment instrument being developed for the grade 7 content standard clusters (7.EE) from a unit on expressions: *Use properties of operations to generate equivalent expressions* and *Solve real-life and mathematical problems using numerical and algebraic expressions and equations* (NGA & CCSSO, 2010, p. 49).

The specific essential learning standards for this end-of-unit assessment are:

1. Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients. (7.EE.1)
  - *Learning objective:* “I can apply properties of operations as strategies to factor and expand linear expressions with rational coefficients to generate equivalent expressions.”
2. Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. (7.EE.2)
  - *Learning objective:* “I can rewrite expressions in different forms to show how quantities are related.”
3. Solve multistep real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (7.EE.3)
  - *Learning objective:* “I can solve real-life and mathematical problems using operations with rational numbers in any form.”
4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (7.EE.4)
  - *Learning objective:* “I can use variables to represent quantities in a real-world or mathematical problem, and construct simple equations to solve problems by reasoning about the quantities.”

As you examine this assessment instrument, you will notice that it is *not* balanced with regard to cognitive demand or assessment-task formats, which are two criteria on the quality-evaluation assessment instrument tool. It also lacks some of the other specific criteria of a high-quality assessment. But for now, focus your team’s discussion on the rigor-balance issue and the variety of task formats.

As you review this older version of an end-of-unit test, you will observe that students are being assessed on simplifying expressions using the distributive property and order of operations with integers. However, *simplify* is not part of the vocabulary within these standards. The intent of the seventh-grade standards 7.EE.1–4 is that students learn to *construct and use equivalent expressions* in both factored and expanded forms. This reality of the standards changes the nature of how you ask students questions on the assessment.

**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_ **Period:** \_\_\_\_\_**Grade 7 Unit 2 Sample Assessment**

Noncalculator

Use the distributive property to simplify the expressions.

1.  $4[10 - (1 + 7)]$

2.  $-2/5 (x + 25)$

3.  $11(s + 9)$

4.  $-21(x - 7)$

5.  $24y - 6(8 - 4y) + 52$

6.  $(4m + 9) - 3(2m - 5)$

Simplify each expression.

7.  $6y + (-13y)$

8. Subtract  $x$  from  $3x - 1$ .

9.  $4d - 5 - 9d + 17$

10.  $27 - 13x + 32 - 2x + 10x$

11.  $-4(5x + 7) - 3x + 13$

12.  $7x^2 + 7y + 4x^2 - 4y$

Evaluate the expression when  $x = 2$ .

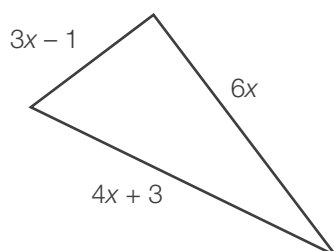
13.  $15 + 3x + 10 + 8x$

14. Kirsten and her friends are going to the movies. Each person buys a ticket for \$8, a medium drink for \$2.75, and a large popcorn for \$4.25.

a. Write an expression in simplest form that represents the amount of money each person spends at the movies. Use  $x$  to represent the total amount of people in the group.

continued →

15. Write and simplify an expression for the perimeter of the figure.



Solve each equation.

16.  $x + 5 = -7$

17.  $-10 = z - 12$

18.  $0 + (-21) = b$

19.  $f + (-8) = 6$

20.  $a + 5 + 8 = 20$

21.  $-4n = -8$

22.  $\frac{1}{3}x = 6$

23.  $16 = -2x$

24.  $3(x - 2) = -12$

25.  $13.49 = -8.56 + y$

26.  $30.2b = -75.5$

27.  $\frac{1}{2}x = -7.5$

Choose the letter of the term that best matches each statement.

a. Terms

b. Coefficient

c. Constant term

d. Like terms

e. Equation

\_\_\_\_\_ 28. Terms that have identical variable parts

\_\_\_\_\_ 29. The parts of an expression that are added together

\_\_\_\_\_ 30. This type of term has a number but no variable.

\_\_\_\_\_ 31. The number part of the term

**Figure 1.18: Sample assessment questions for end-of-unit test on expressions (lower-level cognitive demand only).**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

Students are also being assessed on solving simple equations. A common student error when distributing and simplifying is that students often get confused when using positive and negative numbers, so notice the presence and location of integers. Also, the last few tasks on this test address some of the key vocabulary and language issues for this unit.

Referencing the essential learning standards, you will notice there are tasks in this sample test using rational numbers in both expressions and equations (see 7.EE.1 and 7.EE.3, page 43), along with a real-life expressions example. However, since students are not required to explain their reasoning, what is not assessed is student thinking and understanding with respect to the essential standards of the unit. There are also no mathematical tasks on the test that expect students to explain the process or solution pathway used to arrive at an answer or identify common errors. On another note, there are no real-life models of simple equations as expected in the essential learning standard for the unit.

Use figure 1.19 to work with your collaborative team to rewrite some of the items on the end-of-unit assessment instrument shown in figure 1.18 (pages 44–45). Use the questions from figure 1.17 (page 42) and the checking for cognitive-demand balance tool in figure 1.19, as a general team discussion guide for creating an improved balance between higher- and lower-level-cognitive-demand tasks and student opportunities to identify common errors related to the essential learning standards.

**Directions:** With your collaborative team, answer the following questions to check the cognitive-demand balance of your common assessment instruments.

1. What does the current assessment instrument do well in terms of the nature of the cognitive demand of each mathematical task on the test?
2. How are prerequisite skills and common misconceptions regarding the learning standards addressed in this assessment instrument?
3. Which tasks on the assessment should remain lower-level-cognitive-demand tasks?
4. Which tasks are more easily adapted into higher-level-cognitive-demand tasks? And how might you adapt them toward a higher level of cognitive demand?

**Figure 1.19: Checking for cognitive-demand balance of common unit assessment instruments tool.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.



The revised end-of-unit assessment in figure 1.20 (pages 47–51) for the seventh-grade content standard clusters *Use properties of operations to generate equivalent expressions* and *Solve real-life and mathematical problems using numerical and algebraic expressions and equations* (7.EE) provides an example of assessment questions similar to those questions (tasks) in figure 1.18 (pages 44–45), but it provides more balance with respect to cognitive demand and question format.

Notice that, for the most part, the problems are similar. However, students are asked to explain their reasoning and to find other ways to demonstrate their thinking. When asked to use a procedure, there is an expectation that students will connect the procedure to a demonstration of reasoning.

How does the revised end-of-unit assessment in figure 1.20 compare to the adjustments you made with your collaborative team? Your version does not need to match this assessment. What is important is that the assessment measures student performance on the learning standards, identifies potential misconceptions, provides students with an opportunity to demonstrate their depth of understanding, and is appropriately balanced for cognitive demand.

<b>Name:</b> _____ <b>Date:</b> _____ <b>Period:</b> _____
<b>Grade 7:</b> Unit 2 Assessment <b>Time:</b> Fifty minutes <b>Tools allowed:</b> Pencil, no calculator
<b>Essential learning standard:</b> I can use properties of operations to generate equivalent expressions (1–7).
<ul style="list-style-type: none"> <li>• <b>7.EE.1</b>—I can apply properties of operations as strategies to factor and expand linear expressions with rational coefficients to generate equivalent expressions.</li> <li>• <b>7.EE.2</b>—I can rewrite expressions in different forms to show how quantities are related.</li> </ul>
Write an equivalent expression.
<div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">1. <math>11(s + 9)</math></div> <div style="text-align: center;">2. <math>-\frac{2}{5}(x + 25)</math></div> </div> <div style="margin-top: 40px;">         3. Which of the following expressions is equivalent to <math>24y - 6(8 - 4y) + 52</math>? Show all your work and justify your reasoning.         <ul style="list-style-type: none"> <li>a. <math>28y + 4</math></li> <li>b. <math>48y + 28</math></li> <li>c. <math>0y + 4</math> or 4</li> <li>d. <math>20y - 4</math></li> <li>e. <math>48y + 4</math></li> </ul> </div>

**Figure 1.20: Revised sample assessment questions for end-of-unit test on expressions.** continued →

4. Are the expressions  $8x^2 + 3(x^2 + y)$  and  $7x^2 + 7y + 4x^2 - 4y$  equivalent? Explain how you know.

5. A student solved the following problem incorrectly. Circle the mistake, explain what the student did wrong, and then solve the problem correctly. Remember to complete all the steps for full credit.

$$\begin{aligned}(4m + 9) - 3(2m - 5) \\&= 4m + 9 - 6m - 15 \\&= 4m - 6m + 9 - 15 \\&= -2m - 6\end{aligned}$$

6. In the expression  $-\frac{1}{4}x + 3$ ,

Gianna factored the expression and wrote:  $-(\frac{1}{4}x - 3)$

Hannah factored the expression and wrote:  $-1(\frac{1}{4}x - 3)$

Both Gianna and Hannah claim to be correct. Do you agree? Why or why not?

7. Which expression is not equivalent? Explain why.

- a. Subtract  $x$  from  $3x - 1$ .
- b.  $x$  more than  $3x - 1$
- c.  $3x - 1$  decreased by  $x$
- d. Difference between  $3x - 1$  and  $x$

**Essential learning standard:** I can solve real-life mathematical problems using numerical and algebraic expressions and equations.

**7.EE.3**—I can solve real-life and mathematical problems using operations with rational numbers in any form.

**7.EE.4**—I can use variables to represent quantities in a real-world or mathematical problem, and construct simple equations to solve problems by reasoning about the quantities.

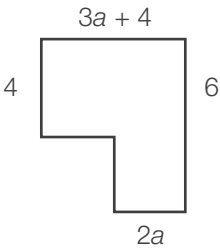
8. Photographers Ryan and Alex get paid per photography session. Ryan is paid a set-up fee of \$25 plus \$10 per hour. Alex is paid a set-up fee of \$20 plus \$11 per hour.

Write an expression for each photographer. Use  $h$  to represent hours worked.

Ryan: \_\_\_\_\_ Alex: \_\_\_\_\_

- a. Mr. Smith wants to have photos taken of his new baby boy. If the photo session will take 2 hours, who should he choose to take pictures? Explain your reasoning.
- b. If Mr. Smith wants to take pictures for 5 hours, whom should he choose as his photographer, Ryan or Alex? Explain your reasoning.
- c. If the photo session needed to go beyond 5 hours, would you change your answer from Part B? Explain why.
9. Kirsten and her friends are going to the movies. Each person buys a ticket for \$8, a medium drink for \$2.75, and a large popcorn for \$4.25.
- a. Write an expression in simplest form that represents the amount of money each person spends at the movies. Use  $x$  to represent the total amount of people in the group.
- b. If the total money spent was \$60, how many people went to the movies?

10. Use the picture to answer the following questions.



a. Write an expression, in simplest form, for the perimeter of the rectangle.

11. Javier's family decides to open a pizza place! The following chart shows the prices for a small cheese pizza plus additional toppings.

Toppings	Cost
Cheese	\$12.00
Extra cheese	\$1.00
Meat	\$0.75
Veggies	\$0.50

a. Write an expression to represent the cost of a cheese pizza with  $v$  for the veggie toppings. Then, identify how much a customer would spend on a veggie pizza.

b. Is it possible for someone to order a pizza for exactly \$15? Explain your answer.

12. Madison wants to earn \$350 for a new iPad mini. She already has \$175 saved and has come up with a plan to earn the remaining amount.
- How much more money does Madison need to buy her iPad mini? Explain how you figured this out.
  - Madison tells her parents that she will feed the dog two times each day for \$1 each time. She also tells them she will walk the dog every day after school for \$3. Write an expression to represent how much Madison will make each day.
  - How much money will Madison make if she feeds her dog two times each day and walks the dog every day of the school week (Monday through Friday)? Show your work.
  - How many school weeks must Madison do this to be able to earn the remaining amount? Show your work and explain how you arrived at your answer.
  - Madison's mom offers Madison a new plan: if Madison walks the dog every day after school and feeds the dog two times each day from now until winter break (5 weeks), she will give Madison \$200. Is this a better deal than what Madison offered? Explain your reasoning.

Solve each equation. Show all your work.

13.  $x + 5 = -7$

14.  $\frac{1}{3}x = 6$

15.  $3(x - 2) = -12$

*Source: Adapted with permission from Aptakisic Junior High School, Buffalo Grove, Illinois.*

*Source for standards: NGA & CCSSO, 2010, p. 49.*

**Figure 1.20: Revised sample assessment questions for end-of-unit test on expressions (continued).**

You do not need to design your assessments from scratch; you can use assessment instruments provided with your curriculum materials and adjust them to ensure that they identify the essential learning standards, uncover common misconceptions, are appropriately balanced with respect to cognitive demand, provide the necessary time and space, and use appropriate, clear language and vocabulary.

Your collaborative team could also create your own agreed-on criteria for assessment instrument quality using figure 1.18 (pages 44–45) as a starting point based on your team or district’s vision for higher-quality assessment. Use the tool in this handbook as a starting point, and adapt it to fit your vision for high-quality assessment instruments used in your mathematics program.

Your team will also need to consider the role of technology in your unit assessments. Since many state assessments are now administered in an online environment, it will be helpful if your students have some experience using technology as a tool during testing. Be sure to allow your students practice in the online format if those are expectations of your state assessment.

You should always look for resources that balance conceptual understanding, procedural fluency, and higher- and lower-level cognitive demand. Be sure that all materials you select support the mathematical understanding necessary to achieve the essential learning standards for the unit.

As resources to dig deeper into this issue, consult your state board of education website, NCTM ([www.nctm.org](http://www.nctm.org)), or the College Board ([www.collegeboard.com/testing](http://www.collegeboard.com/testing)), or use sample online tests at Smarter Balanced Assessment Consortium ([www.smarterbalanced.org](http://www.smarterbalanced.org)), Partnership for Assessment of Readiness for College and Careers (PARCC) ([www.parrconline.org](http://www.parrconline.org)), or the American College Testing Service ([www.actaspire.org](http://www.actaspire.org)).

## **Your Team’s Progress**

As you and your collaborative team focus on developing common assessment instruments, remember that you do not need to design your assessment instruments from scratch. You can use the instruments provided with your curriculum materials and adjust them to ensure they address and list the essential learning standards, uncover common misconceptions, balance cognitive demand, can be completed in the available time, integrate technology as appropriate, and use appropriate and clear vocabulary.

It is helpful to diagnose your team’s current reality and action prior to launching the unit. Ask each team member to individually assess your team on the third high-leverage team action using the status check tool in table 1.3. Discuss your perception of your team’s progress on developing common assessment instruments. It matters less which stage your team is at and more that you and your team members are committed to working together to focus on understanding the learning standards and the best activities and strategies for increasing student understanding and achievement as your team seeks stage IV—sustaining.

Once you have prepared your common unit assessment, your team efforts should turn to creating a scoring rubric for the test and developing expected proficiency expectations for students. Developing scoring rubrics and proficiency expectations for the common assessment instruments is the fourth high-leverage team action in the before-the-unit-begins planning process. The process of developing scoring rubrics requires your team to reflect and stay focused on the essential learning standards for the unit.

**Table 1.3: Before-the-Unit-Begins Status Check Tool for HLTA 3—Developing Common Assessment Instruments**

<b>Directions:</b> Discuss your perception of your team's progress on the third high-leverage team action—developing common assessment instruments. Defend your reasoning.			
<b>Stage I: Pre-Initiating</b>	<b>Stage II: Initiating</b>	<b>Stage III: Developing</b>	<b>Stage IV: Sustaining</b>
We do not develop or use common assessment instruments.	Some members of our team develop common assessment instruments.	We develop common assessment instruments as a team, but not before the unit begins.	We design and write common assessments as a team before the unit begins.
We do not know if the end-of-unit assessments given by each member of the team are balanced for cognitive demand, provide sufficient time, and use clear language and vocabulary.	We develop end-of-unit common assessments connected to the learning standards, but they are not checked for balance of cognitive demand or clarity.	We develop common end-of-unit assessment instruments connected to the learning standards. They are either balanced for cognitive demand or clear but not both.	We develop common end-of-unit assessments that are clear, balanced, and connected to all aspects of the learning standards for the essential unit.
We do not know if our assessments are aligned to our instructional practices and reflect the essential learning standards of the unit.	We develop common assessments as a team, but not all members use them to influence their instructional plans for the unit.	Our planning for common assessments influences our instructional plans for the unit.	Our common assessments are deeply aligned with our instructional discussions and practices.

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## HLTA 4: Developing Scoring Rubrics and Proficiency Expectations for the Common Assessment Instruments


*Do you trust me enough to allow me to grade your end-of-unit assessments?*

—Tim Kanold

Creating a team culture of collaborative scoring and assessment discussions is one of the most important tasks of your middle school grade-level or course-based team. It ensures a greater chance for fidelity and accuracy in scoring all assessment instruments, and it eliminates the potential inequity a wide scoring variance from teacher to teacher can cause.

Just as the mathematical tasks and common assessment instruments (tests and quizzes) help you partially answer the second critical question of a PLC—How will we know if they know it?—so do the choices your team makes for scoring the mathematical tasks on the common unit assessments. The purpose of this team action will be discussed further in chapter 3, HLTA 9 and 10 (see page 141).

High-Leverage Team Action	1. What do we want all students to know and be able to do?	2. How will we know if they know it?	3. How will we respond if they don't know it?	4. How will we respond if they do know it?
<b>Before-the-Unit Action</b>				
HLTA 4. Developing scoring rubrics and proficiency expectations for the common assessment instruments				

 = Partially addressed with high-leverage team action

### The What

Why is this an important before-the-unit-begins high-leverage team activity? HLTA 4 will improve insight into the way you provide instruction pathways for students during the unit. More importantly, it will support valid inferences that you and your team make every day about students' knowledge—especially as you dedicate more time to higher-level-cognitive-demand tasks, and the complex reasoning required by your students. It will also improve the accuracy of your feedback and grading practices at the end of the unit and helps create greater team equity in the interpretation of student scores.

By reaching team agreement on the rubric score for each item on the end-of-unit test, you increase the reliability that the feedback for proficiency on the essential learning standards for the unit is accurate, and you increase your ability to ensure students understand the expectations of a solution pathway required to receive full credit on each task. Without this agreement, you and your team members are not feeding accurate data back into the system that you can use to provide feedback to students, guide effective instructional decisions, and make program improvements—the essence of the assessment principle in *Principles to Actions* (NCTM, 2014).



More important, this team action becomes an *inequity eraser* for your students and increases the likelihood that your feedback on their performance will be consistent and accurate across all members of your team and that it can be leveraged to improve student learning.

Determining how to score the assessment instrument involves far more than linking point values to test questions and tasks. As you work on scoring rubrics for tasks in your collaborative team, your instruction during the unit will benefit from:

- Discussing the value of each task relative to the other tasks on the test
- Deciding how you will determine if students have provided a complete solution for full credit relative to the essential learning standard each assessment task (problem) represents
- Deciding what you will do when students' answers are incomplete or incorrect—how will their response be scored?

These decisions are typically easier to make and more straightforward with lower-level-cognitive-demand tasks (as may have been the case with your past assessment instruments) but not as clear for the higher-level-cognitive-demand tasks necessary to measure student understanding, reasoning, *and* procedural fluency.

## The How

A first step for your team is to examine a potential mathematical task (test question) and decide:

1. How many points to assign to the assessment task (the test question) to receive full credit
2. What level of student work or solution pathway would be required for the student to receive full credit
3. How to grade potential student solutions together in order to calibrate decisions for assigning points to the task

Closely examine the sample tasks shown in figures 1.21 and 1.22 (page 56). First, find a solution pathway that you would expect from a student in order to receive full credit. Assign a total number of points to the task, and be ready to explain your decisions. Then, calibrate your scoring rubric choice for the task by discussing solution pathways with your colleagues.

**Directions:** Find a solution pathway and decide how many points you would assign to this mathematical task for a student to receive full credit on the test. Justify your reasoning.

Jamal is filling bags with sand. All of the bags are the same size. Each bag must weigh less than 50 pounds. One sand bag weighs 57 pounds, and another sand bag weighs 41 pounds. Explain whether Jamal can put sand from one bag into the other so that the weight of each bag is less than 50 pounds.

*Source: Reprinted from Smarter Balanced Assessment Consortium, n.d. Used with permission.*

**Figure 1.21: Sample grade 6 task.**

**Directions:** Find a solution pathway and decide how many points you would assign to this mathematical task for a student to receive full credit on the test. Justify your reasoning.

Mr. Ruiz is starting a marching band at this school. He first does research and finds the following data about other local marching bands.

	Band 1	Band 2	Band 3
<b>Number of Brass Instrument Players</b>	123	42	150
<b>Number of Percussion Instrument Players</b>	41	14	50

**Part A**

Type your answer in the box. Backspace to erase.

Mr. Ruiz realizes that there are  brass instrument player(s) per percussion player.

**Part B**

Mr. Ruiz has 210 students who are interested in joining the marching band. He decides to have 80% of the band be made up of percussion and brass instruments. Use the unit rate you found in Part A to determine how many students should play brass instruments.

Show or explain all your steps.

*Source: Partnership for Assessment of Readiness for College and Careers (PARCC), 2013.*

**Figure 1.22: Sample grade 6 task.**

Use figure 1.24 (page 58) to work with your collaborative team to examine the photography task shown in figure 1.23.

7. Photographers Ryan and Alex get paid per photography session. Ryan is paid a set-up fee of \$25 plus \$10 per hour. Alex is paid a set-up fee of \$20 plus \$11 per hour.

a. Write an expression for each photographer. Use  $h$  to represent hours worked.

Ryan:  $\$25 + \$10h$

Alex:  $\$20 + \$11(h)$

- b. Mr. Herrera wants to take pictures of his new baby boy. If the photo session will take 2 hours, who should he choose to take pictures? Explain your reasoning.

$$\begin{array}{r} 25 + 10(2) \\ \$45 \end{array}$$

$$\begin{array}{r} 20 + 11(2) \\ \$42 \end{array}$$

=

Alex because it costs less money.  
The flat fee is less and the per hour is only a dollar more.

- c. If Mr. Herrera wants to take pictures for 5 hours, should he choose Ryan or Alex as his photographer? Explain your reasoning.

$$\begin{array}{r} 25 \\ + 50 \\ \hline 75 \end{array}$$

$$\begin{array}{r} 25 + 10(5) \\ \$75 \end{array}$$

$$\begin{array}{r} 20 + 11(5) \\ \$75 \end{array}$$

$$\begin{array}{r} 11 \\ \times 5 \\ \hline 55 \\ + 20 \\ \hline 75 \end{array}$$

Either photographer  
because both have the  
same price for 5 hrs.

Source: Adapted with permission from Aptakisic Junior High School, Buffalo Grove, Illinois.

**Figure 1.23: Sample student response for photography task.**

Now consider the photography task and the student sample work shown in the photography task in figure 1.23. How would you score, based on the complexity of reasoning required by the student, this mathematics task if it was on your test? Is it worth two points? Four points? Six points? Once that is decided, then how many points could the student receive for his or her response: 3 out of 4? 4 out of 6? 5 out of 6? Depending on your response, the student will receive a very different grade on this assessment task. Remember, accuracy of scoring is the goal. Begin by making sure your team agrees on the scoring value of the task, and then discuss the nature of the work students are expected to show to receive full credit for the task.

**Directions:** With your collaborative team, examine the following questions for the photography task shown in figure 1.23 (page 57).

1. How would you assign the points for different parts of the solution?
2. If the point value for the task is greater than one, how could a student get partial credit?
3. What evidence of student learning would receive full credit?
4. How will the team ensure the scoring of the task will be consistent between all team members?
5. How is the expected scoring rubric for the assessment task articulated to students?
6. Now score the student sample to determine consistency, and then share your score.

**Figure 1.24: Collaborative team task scoring discussion prompts.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

How did your team determine scoring? Did students receive one point for their reasoning and one point for the correct answer, or no credit if the answer is incorrect? Is each part of the question worth one point, two points, or four points? If your collaborative team does not have conversations about scoring, inequities will persist across the team, and grades will not be accurate from teacher to teacher and class to class. Your team needs to articulate scoring for all exam tasks before giving the assessment instrument to students at the end of the unit.

Linking scoring points to each end-of-unit assessment task provides a means for unpacking the intent of each task to determine representations of good student work. If possible, it is important for this activity to occur before the unit begins, as the discussions will likely influence how you teach the mathematics content for the unit.

As an example, consider figure 1.25 (pages 59–63), a sample end-of-unit assessment for a possible unit on functions in grade 8.

Name: \_\_\_\_\_

Period: \_\_\_\_\_

Date: \_\_\_\_\_

Unit 2: Grade 8 Functions Assessment

Time: Sixty minutes

Tools allowed: Pencil and calculator

Content standard cluster: Define, evaluate, and compare functions.

• 8.F.1: I can identify a relation as a function (algebraically, graphically, numerically, and verbally).

• 8.F.2: I can compare and analyze two functions represented in different ways (algebraically, graphically, numerically, and verbally) and provide support.

1. Use the pizza menus given to answer the following questions.

Chicago Pizza Restaurant

Thin Crust	Individual 9"	Small 12"	Medium 14"
Plain Cheese	\$7.25	\$10.25	\$12.25
Extra Ingredients	\$1.00	\$1.25	\$1.50

Italian Pizza Restaurant

Plain Cheese Pizza. . . . . \$10.50 each

Vegetable Topping . . . . . \$1.00 each

Meat Topping . . . . . \$2.00 each

a. Complete the table with the number of toppings (x) and corresponding pizza cost (y) for 0–4 toppings. You may pick which size pizza to use.

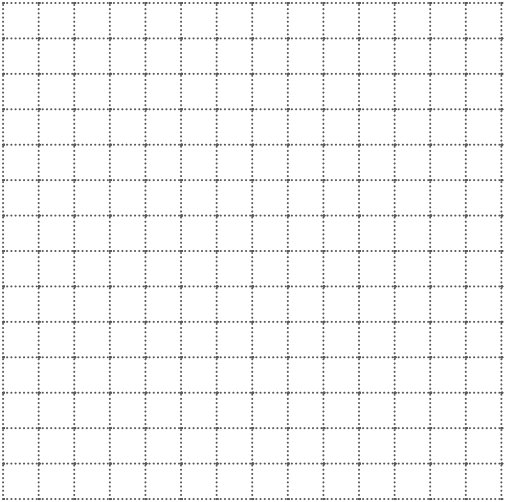
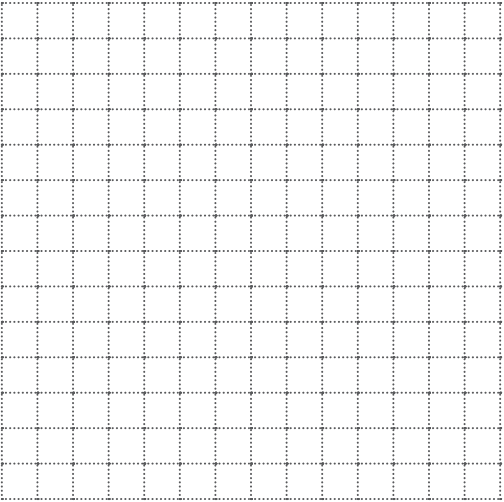
Number of Toppings (x)	Cost (y)

a. Complete a table with the number of toppings (x) and corresponding pizza cost (y) for 5 toppings.

Number of Toppings (x)	Cost (y)
0 Toppings	
1 Vegetable topping	
1 Meat topping	
2 Vegetable toppings	
2 Meat toppings	

Figure 1.25: Sample grade 8 functions unit exam.

continued →

<p>b. Graph the number of toppings (<math>x</math>) and corresponding cost (<math>y</math>) on the graph below. Be sure to label your axes.</p> 	<p>b. Graph the number of toppings (<math>x</math>) and corresponding cost (<math>y</math>) on the graph below. Be sure to label your axes.</p> 
<p>2a. Do the Chicago Pizza Restaurant data represent a function? Y or N (Circle one.)</p> <p>b. Explain how you know the Chicago Pizza Restaurant does or does not represent a function based on the table.</p> <p>c. Explain how you know the Chicago Pizza Restaurant does or does not represent a function based on the graph.</p> <p>3a. Does the Italian Pizza Restaurant represent a function? Y or N (Circle one.)</p> <p>b. Explain how you know the Italian Pizza Restaurant does or does not represent a function based on the table.</p> <p>c. Explain how you know the Italian Pizza Restaurant does or does not represent a function based on the graph.</p> <p>4. Build a function rule for the restaurant or restaurants that is a function.</p>	

5. Use the pizza menus to answer the following questions.

**Rosenak’s Rockin’ Pizza**

	Cost
Cheese pizza	\$5.00
Additional toppings	\$1.00

**Giuliano’s Gooey Pizza**

	Cost
Cheese pizza	\$3.50
Additional toppings	\$1.50

- a. Based on the data, complete the tables with the number of toppings ( $x$ ) and corresponding pizza cost ( $y$ ) for 0–4 toppings. Be sure to label each column.

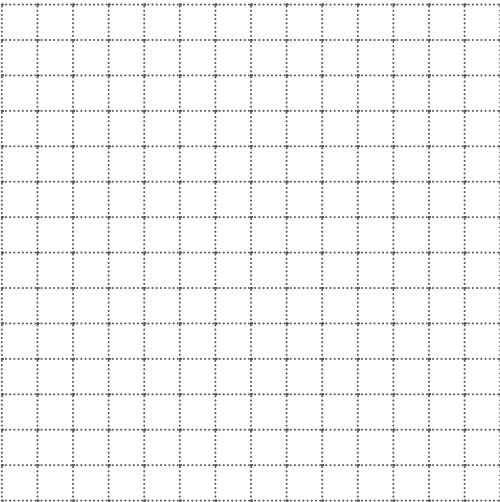
**Rosenak’s Rockin’ Pizza**

x	y

**Giuliano’s Gooey Pizza**

x	y

- b. Graph the data from both pizza restaurants on the same graph. Use one color for Rosenak’s Rockin’ Pizza and a different color for Giuliano’s Gooey Pizza. Identify which color you chose for each. Be sure to label your axes.



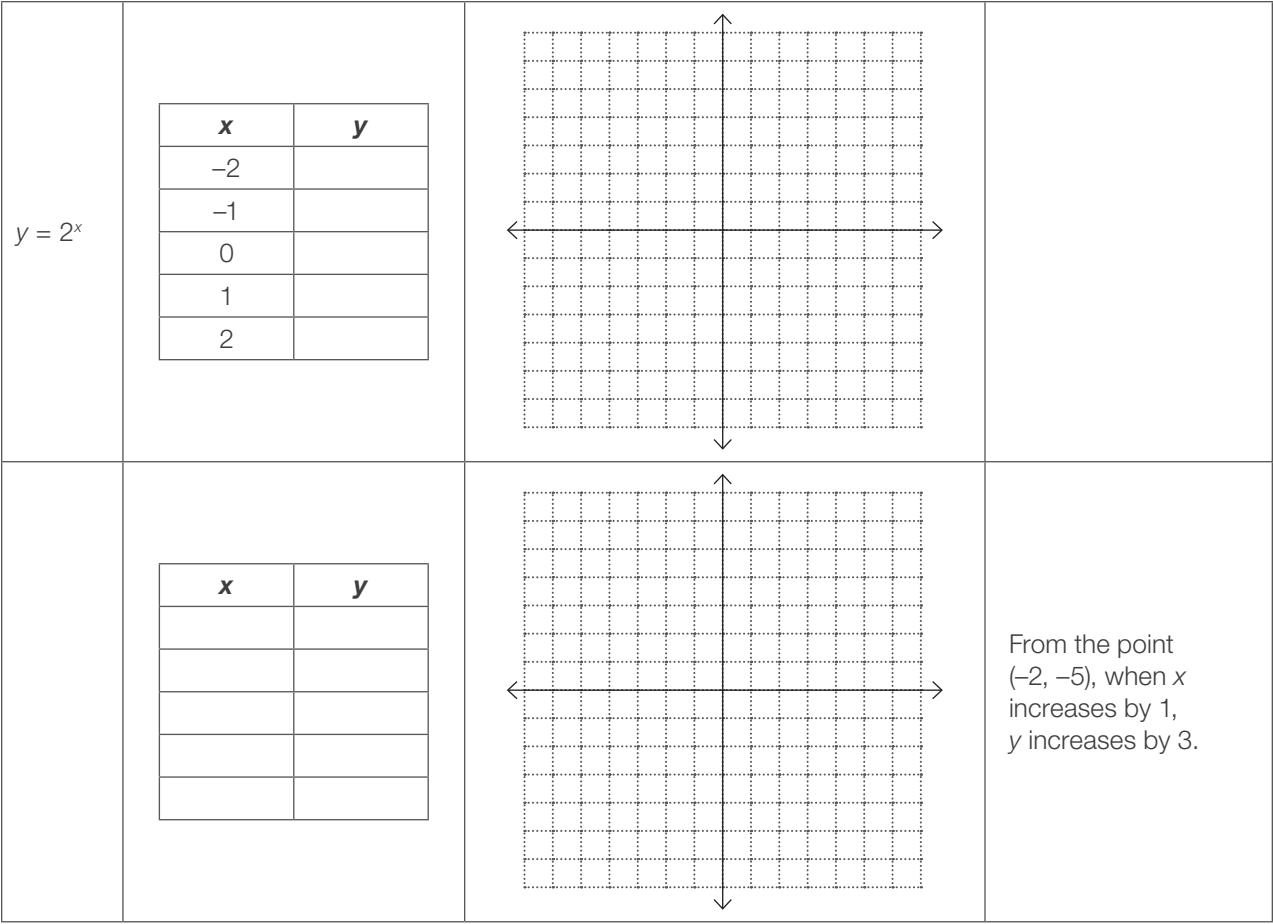
- c. Determine the coordinates of the point of intersection for these two graphs. Explain what this coordinate represents in terms of both pizza restaurants.

- d. If you want to spend the least amount of money, what number of toppings would make it best to order from Rosenak's Rockin' Pizza, and when would it be best to order from Giuliano's Gooey Pizza?
- e. Why are there only positive x values?
- f. Why are there only positive y values?

Complete each row by using the given information to complete the missing three parts. For example, in the first row, you are given a graph and will need to complete the rule, table, and verbal parts.

Rule	Table	Graph	Verbal												
	<table><tr><th><i>x</i></th><th><i>y</i></th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>	<i>x</i>	<i>y</i>												
<i>x</i>	<i>y</i>														
	<table><tr><th><i>x</i></th><th><i>y</i></th></tr><tr><td>-2</td><td>4</td></tr><tr><td>-1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>4</td></tr></table>	<i>x</i>	<i>y</i>	-2	4	-1	1	0	0	1	1	2	4		
<i>x</i>	<i>y</i>														
-2	4														
-1	1														
0	0														
1	1														
2	4														





Source: Adapted with permission from Aptakisic Junior High School, Buffalo Grove, Illinois.

**Figure 1.25: Sample grade 8 functions unit exam (continued).**

Visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

**Creating the Scoring Rubric**

Work with your collaborative team to assign a scoring guide of points for the end-of-unit assessment in figure 1.25. Use the assessment instrument alignment and scoring rubric tool in figure 1.26 (page 64) to answer questions for each test task.

Once you have completed the questions in figure 1.26, visit [go.solution-tree.com/mathematicsatwork](https://go.solution-tree.com/mathematicsatwork) and download the actual scoring guide provided by the middle school teacher team using this assessment. The teacher team decided on eighty-five points total for the test. Does this surprise you? Did you score the test for more total points or less?

There isn't one right way to determine the points for scoring exams. What is important is that your team members use the same scoring scale and base the scoring rubrics for each task on a decided standard (such as the complexity of reasoning required by the assessment task or a proficiency scale based on lower- or higher-level cognitive demand). Each team member must also honor the agreed-on scoring scale in order to ensure grades are accurate and equitable across team members and sections of the course. This is discussed in more detail with HLTA 9 in chapter 3 (page 143).

**Directions:** Within your collaborative team, answer each of the following questions in relation to the assessment in figure 1.25 (pages 59–63).

1. Which essential learning standard does each task address, and how do you know that the task is aligned to the essential learning standard?
2. What work do you expect students to demonstrate in order to successfully respond to and receive full credit for each task on the assessment?
3. How will you assign partial credit for each task?
4. Which Mathematical Practices or processes does the task develop? Describe why or why not.
5. What scoring value or point value would you assign to each task?
6. Based on your scoring assignment for each task, how many total points should be assigned to this end-of-unit assessment?
7. Are there any questions on the test you would want to ask differently? If so, how would that affect the point value assigned to the test question or task?
8. How many points correct would a student need for each essential learning standard in order to be considered proficient for that standard (the proficiency target)?

**Figure 1.26: Assessment instrument alignment and scoring rubric tool.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.

## Setting Proficiency Targets

Notice the last question in figure 1.26: How many points correct would a student need for each essential learning standard in order to be considered proficient for that standard (the proficiency target)?

Your grade-level team should decide what level of student performance will be required to be considered proficient in each of the essential learning standards for the end-of-unit assessment. Your team should know the learning score target you will expect each student to obtain for each learning standard represented on the end-of-unit test to be considered proficient for that essential learning standard. You can use the scoring rubric at [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) or your own rubric you developed for the test in figure 1.25 to practice setting your own proficiency targets. Your team's response to students who do or do not achieve the learning proficiency target is discussed further in chapter 3 as part of HLTA 9.

Also note that there is a type of standards-based grading practice gaining popularity in grades K–8 across the United States (Reeves, 2008). It involves measuring students' proficiency on well-defined course learning standards (Marzano, 2009). Although many districts adopt standards-based grading *in addition* to traditional grades, standards-based grading can replace traditional point-based grades. If this is the case at your school, and you want more information on standards-based grading, you can go to [www.marzanoresearch.com](http://www.marzanoresearch.com) to review Robert Marzano's (2009) *Formative Assessment and Standards-Based Grading* or *A School Leader's Guide to Standards-Based Grading* (Heflebower, Hoegh, & Warrick, 2014) and learn more about the use of proficiency scales to score student work and measure student progress.

## Your Team's Progress

It is helpful to diagnose your team's current reality and action prior to launching the unit. Ask each team member to individually assess your team on the fourth high-leverage team action using the status check tool in table 1.4 (page 66). Discuss your perception of your team's progress on developing scoring rubrics and proficiency expectations for the common assessment instruments. It matters less which stage your team is at and more that you and your team members are committed to working together and understanding the various student pathways for demonstrating solutions to the mathematical tasks on your common assessments as your team seeks stage IV—sustaining.

These first four high-leverage team actions give you and your team:

- A direct focus on your unit-by-unit understanding of and decisions regarding the essential learning standards
- Insight into the mathematical tasks and activities that support your work during the unit
- Understanding of common assessments you can use to determine whether or not students have attained the content and process knowledge of the essential learning standards
- Guidelines for how to score student work and set proficiency expectations for each essential learning standard of the unit

There is one major high-leverage, equity-based team action left to complete before you launch into the unit and your instruction: planning for and using common homework assignments.

**Table 1.4: Before-the-Unit-Begins Status Check Tool for HTLA 4—Developing Scoring Rubrics and Proficiency Expectations for the Common Assessment Instruments**

<b>Directions:</b> Discuss your perception of your team's progress on the fourth high-leverage team action—developing scoring rubrics and proficiency expectations for the common assessment instruments. Defend your reasoning.			
Stage I: Pre-Initiating	Stage II: Initiating	Stage III: Developing	Stage IV: Sustaining
We do not use common scoring rubrics on our assessments.	We discuss our scoring and grading practices collaboratively.	We create scoring rubrics for our common unit assessments collaboratively.	We create dependable scoring rubrics for all tasks on the common unit assessments as a collaborative team.
Each teacher establishes his or her own scoring system for their independent assessments.	We have not yet reached agreement on how to score the tasks on our common assessments.	We discuss and reach agreement on a student's complete response to receive full credit on each task for our common assessments.	We design assessment rubrics to align with students' reasoning about the mathematics for each essential learning standard of the unit.
We do not know the scoring and grading practices other members of our team use.	We use scoring rubrics independently, and do not discuss our use of scoring rubrics with other members of the team.	We use the common end-of-unit assessment scoring rubrics for measuring student proficiency on each learning standard but don't discuss them as a team.	We use the common end-of-unit assessment scoring rubrics for measuring student proficiency on each learning standard and discuss them as a team.
We do not set student proficiency targets for each essential learning standard of the unit.	We set student proficiency targets independently, but do not know the proficiency targets other members of our team use for each essential learning standard of the unit.	We collaboratively set student proficiency target performances on the end-of-unit assessment for some, but not all, of the essential learning standards of the unit.	We collaboratively set student proficiency target performances on the end-of-unit assessment for each essential learning standard of the unit.

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this table.

## HLTA 5: Planning and Using Common Homework Assignments





*Assign work that is worthy of their best effort (problem solving and reasoning).*


—Linda Darling-Hammond


*By using homework for practice in self-assessment and complex thinking skills, we can put students in charge of the learning process.*

—Cathy Vatterott

Planning common homework assignments is another way your team reaches agreement on the second critical question of a PLC, How will we know if they know it?

High-Leverage Team Action	1. What do we want all students to know and be able to do?	2. How will we know if they know it?	3. How will we respond if they don't know it?	4. How will we respond if they do know it?
<b>Before-the-Unit Action</b>				
HLTA 5. Planning and using common homework assignments				

 = Fully addressed with high-leverage team action

 = Partially addressed with high-leverage team action

### The What

The mathematical tasks and problems you assign as homework should help your students accurately answer the question, How will I know if I am understanding the daily learning objectives from the lesson? Although not always interpreted this way, when implemented effectively, homework can become one of the most effective daily formative assessment tools available to your team as you work to continually “elicit and use evidence of student thinking”—one of the eight research-informed instructional practices outlined by NCTM (2014) in *Principles to Actions*. Thus, your grade-level or course-based team needs to reach agreement on the purpose, coherence, rigor, and length of homework assignments for every unit throughout the year. In addition, your team needs to agree on how the homework will be used and communicated to students, parents, and support staff.

Why is this an important before-the-unit-begins high-leverage team action? Once again, your team’s work to develop common homework assignments for the unit before it begins becomes a potential inequity eraser for you and your students. Also, mathematics homework in middle school is often an area that lacks clarity and purpose for students, parents, intervention support personnel, and most importantly, you. Your team asks, “Why do we give students homework? What is the purpose of homework? Why won’t students do their homework? How is homework assigned for a grade?” The very idea of mathematics homework in middle school, and what to do with it, is often a conundrum.

Is homework really an essential element to the process of student learning? The short answer is yes, but the best protocols to follow for homework are not quite as clear. What is clear is that:

1. The assignment of independent practice or homework cannot be a superficial exercise for you or your team.
2. Anyone who is an expert at anything devotes significant time to practice (Gladwell, 2008).
3. If we deny students an opportunity for independent practice, we deny them the very thing they need to develop real competence (Anderson, Reder, & Simon, 1995).

The homework you assign, as well as the way you think about homework as a class activity—the way you use it as a formative task to guide instruction—needs to be a carefully thought out and planned for team discussion, agreement, and activity *before* the unit begins.

Although research on homework does not indicate a specific set of common implementation protocols for all grades and all subjects (Cooper, 2008a, 2008b), the issue of homework becomes more complicated as your attention turns to implementing mathematics standards that focus on understanding (and thus using higher-level-cognitive-demand practice problems).

Although there are several schools of thought about the role homework should play and the extent of its use, research does indicate that homework can be helpful in improving student achievement if implemented correctly (Cooper, 2008b). A key finding from the research is that homework is most effective when teachers provide feedback to students' homework on a daily basis and give students written descriptive feedback that goes beyond simply marking student work as correct or incorrect (Davies, 2007; Marzano, 2007; Shuhua, 2004).

Practice is important but not without first developing student understanding. Practice without understanding may be detrimental to students' development of fluency, and in many cases, avoiding this danger means that instruction should place greater emphasis on guided practice—practice that is supported by monitoring and feedback—prior to independent practice (Larson, 2011). Marzano (2007) finds that to have a positive effect, homework should also have a clear purpose that you communicate to students: to deepen students' conceptual understanding, enhance their procedural fluency, or allow them the opportunity for independent formative practice around higher-level-cognitive-demand tasks. You should intentionally consider and carefully choose each homework problem or mathematical task based on the essential learning standards of the lesson and unit.

Research also supports the idea of *spaced* (sometimes called *distributed* or *spiral*) versus *massed* homework practice during the unit of study (Hattie, 2012; Pashler, Rohrer, Cepeda, & Carpenter, 2007) as having a significant impact on student learning. That is, provide homework assignment (practice) tasks that are spaced throughout the unit, allowing your students to cycle back and perform distributed practice on prior learning standards, including those learned earlier in the unit, previous units, or possibly in a previous course.

As each teacher on your team begins to honor high-leverage team actions 1 to 4 (teaching to the same set of essential learning standards and designing high-quality common assessments) for your course, then, it is a natural outcome that the nature of practice for student learning *outside of class* (homework) would be designed from the same core set of problems for each student, no matter the assignment of teacher for the course.

## The How

Your collaborative team discussion regarding the role of homework and the selection of homework problems can be a powerful professional growth experience and should be an embedded part of your team's work throughout the year.

### *Understanding the Purpose of Homework*

Understanding the purpose of mathematics homework on a daily basis during each unit is your first step to significantly improving current homework practice. Use the questions in the discussion tool in figure 1.27 (page 70) to help you and your team develop a better understanding of the purpose, content, and expected protocols for the unit's homework assignments. You can also use the prompts for team discussion with vertical course-based teams as you examine mathematics homework protocols and progressions across all courses in your department.

Your answers to the questions in figure 1.27 will likely vary a bit for each of your collaborative teams. It is the expectation, however, that your collaborative team will reach full agreement on your responses to the questions in figure 1.27 as you work together (before the unit begins) to select appropriate independent practice tasks (homework problems) for students to do outside of the classroom.

Your responses as individuals and as a team to these questions will reveal some of your current beliefs about assigning mathematics homework. In response to question one in figure 1.27—Why do we assign homework for each unit's lessons? What is the purpose of homework?—it is important to note that the primary purpose of homework is not summative; you should rarely assign homework to students in order to assign a grade. In fact, homework should generally not count for more than 5 to 10 percent of the total student grade. Because homework is a *formative learning* activity—an opportunity for students to obtain independent feedback and improve learning without you guiding them—it should not constitute so much of a student's grade that it is not reflective of actual student performance and achievement.

Thus, the primary purpose of mathematics homework for middle school students is to create a formative feedback process as part of *independent practice*.

More importantly, *successful* independent practice. That is, students must understand and use homework as an opportunity for a self-guided formative assessment learning process—while you are not in the room (Hattie, 2012). Independent practice can be with other students, with other adults, or with help from YouTube or other social media resources. However, your students, while outside of class and away from you as their authority for guided practice, must practice mathematics problems and connect those problems to the essential learning standards.

Students should not view homework as something to do to receive a grade or because you, as their teacher, will go over the problems in class the next day (which makes homework no longer an independent practice exercise) or because they are being punished; rather, they should view homework as important. They should view it as a type of formative assessment for successful practice critical to the learning process and to help them retain content knowledge in their long-term memory. In class, students need your modeling and a lot of peer-to-peer guided practice (see chapter 2, HLTA 7, page 99, for more details). Then, outside of class, and in a timely fashion, they need to participate in accurate independent practice with feedback (self-feedback and action or with feedback with peers)—well before they return to your class the next day.

**Directions:** Use the following prompts to guide discussion of the unit's homework assignments.

**Purpose of homework:**

1. Why do we assign homework for each unit's lessons? What is the purpose of homework?

**Nature of homework:**

2. What is the proper number of mathematical tasks for daily homework assigned during the unit? In other words, how much time should students spend on homework?
3. What is the proper rigor (cognitive-demand expectations) of the mathematical tasks for homework assigned during the unit?
4. What is the proper distribution of tasks for homework to ensure spaced practice (cyclical review) for our students?
5. How do our daily homework assignments align to the learning standard expectations for the unit?
6. How will we reach consensus on unit homework assignments in order to ensure coherence to the student learning and practice expectations?

**Use of homework:**

7. How should we grade or score homework assignments?
8. What will we do if students do not complete their homework assignments?
9. How will we go over the homework in class?
10. How will we communicate the common unit homework assignments to students, parents, and support staff?

**Figure 1.27: Collaborative homework assignment protocol discussion tool.**

Visit [go.solution-tree.com/mathematicsatwork](http://go.solution-tree.com/mathematicsatwork) to download a reproducible version of this figure.



Perhaps the homework paradigm shift for you and your colleagues is to stop calling homework *homework*. Certainly, students can do *independent practice* at the coffee shop or after school in a classroom, on the bus, in a hallway, in the car on the way to practice or a game, or with friends at the library. Independent mathematics practice does not have to be done at home.

Ultimately, the work of your collaborative team is to decide the role homework plays as part of your classroom activities and learning process. As you work to review and develop your team's homework protocols, consider the following guidelines.

- **Homework purpose:** The primary purpose of homework should be to allow the student the opportunity for *independent practice* on learning standards mastered in class during guided practice and small-group discourse. Homework can also provide a chance for the student to practice mathematical tasks that relate to previous learning standards or tasks that reflect prerequisite learning standards for the next unit. Homework that provides review of previous work and helps to prepare students for future work leads to improved student achievement (Cooper, 2008a).
- **Homework length:** How much time should daily homework take students to complete? How many problems should it entail? Homework should not be lengthy (Cooper, 2008b), so teachers should take care about what they assign—no more than eight to ten carefully chosen problems per day. Take into account the cognitive demand of the tasks or problems you assign. Homework tasks as a general rule should not take more than thirty to thirty-five minutes (per course) of time outside of class.
- **Homework task selection:** The homework your school curriculum or textbook includes is not necessarily appropriate for your students without some adjustments with which your team agrees. Make sure that all tasks are necessary as part of independent practice, have *spaced* practice and not *massed* practice, and align to the stated learning standards of the unit.
- **Homework answers:** There are many advantages to providing students with homework answers before the unit of instruction begins. When you provide students with answers to the homework problems, they can check their solutions against the answers, and if their end results do not match the provided answers, they can rework the problem to find their errors. In other words, students receive immediate and formative self-assessed feedback of their work—like when playing an electronic game. Moreover, a compelling reason to provide students with the answers to the homework in advance of the assignment is to save time during the class period the next day. *No time* should be spent going over the answers or the actual homework problems. Remember, homework is *independent* practice, not *in-class* practice. Since the students know exactly what they know and what they do not understand, any in-class discussion time on homework can be limited to a brief few minutes and becomes more meaningful for the students.
- **Homework focus in class:** Once your collaborative team determines homework, focus on how to address homework in class, the type of feedback that teachers will give students, and what will occur if students do not complete the homework. If you spend most of the class time going over homework, you lose the impact of successful independent practice on student learning. Your students may be choosing to wait to do homework problems because they know they can write down the work when you go over the problems the next day. Since the purpose of homework is independent practice, limit the amount of time in class to grade, score, or go over the practice problems. If you spend most of the class time going over homework, your team must revisit the amount and content of what you assign. It could be that your team assigned too much homework or that students did not achieve an appropriate level of mastery prior to practice of the learning standard.

These daily and unit processes and procedures should be agreed on and consistent from teacher to teacher within your grade-level or course-based collaborative team.

### ***Using Effective Homework Protocols***

From a rigor and coherence point of view, the homework you assign for a unit of study must be the same for all students in your course. Give all team-developed homework assignments to your students and parents in advance of teaching the unit with the understanding that your team can and will modify the assignments during the unit as necessary to address specific student learning needs. Use the diagnostic tool in figure 1.28 to check how your team is doing with respect to using high-quality mathematics homework protocols and procedures.

Figure 1.29 (page 74) is a sample unit homework assignment sheet from the Algebra 1 Team at Aptakisic Junior High in Buffalo Grove, Illinois. Students receive the homework assignment sheet at the beginning of a unit, and it's also available online as a Google Doc. The team blends a use of the textbook with its own extensive worksheets for each homework assignment and posts them online as well, as the teachers do not rely on the textbook only for all assignments. You can use elements of the diagnostic tool from figure 1.28 to score the quality of the sample homework shown in figure 1.29. Note that the homework assignment sheet lists the unit's essential learning standards and that the problems assigned illustrate spaced practice that is focused. In general, these teachers spend no more than five minutes of class time going over the homework in class the next day since they view homework as independent practice for their students.

High-Quality Homework Indicators	Description of Level 1	Requirements of the Indicator Are Not Present	Limited Requirements of This Indicator Are Present	Substantially Meets the Requirements of the Indicator	Fully Achieves the Requirements of the Indicator	Description of Level 4
The primary purpose of homework is independent practice.	Homework is primarily assigned to give a student a grade. Homework counts more than 10 percent of a student's total grade.	1	2	3	4	Homework is understood as primarily for independent practice and a formative assessment learning loop for students. Homework counts no more than 10 percent of a student's grade.
Homework assignments are the same for every teacher on the course team.	Each teacher on the team creates his or her own homework assignments and does not share with others.	1	2	3	4	Common homework assignments are developed collaboratively by the team and are the same for all students in the grade level or course.
All homework assignments for the unit are given to the students before the unit begins.	Students find out homework assignments each day or each week as the unit progresses.	1	2	3	4	Students are provided all unit homework assignments—electronically or with a handout—as the unit begins.
Homework assignments for the unit are appropriately balanced for cognitive demand.	Homework practice problems are not balanced for rigor. Emphasis is on lower-cognitive-demand tasks.	1	2	3	4	Homework practice is appropriately balanced with higher- and lower-cognitive-demand tasks.
All practice problem answers are given to the students in advance of the homework assignments.	Students must wait until the next day to receive answers or solutions to homework practice problems.	1	2	3	4	Students are able to check their solutions during independent practice and are expected to rework the problems if not correct the first time.
Homework assignments for each unit exhibit spaced and massed practice.	The homework assignments represent superficial thought as to the problems chosen and consist of massed practice.	1	2	3	4	The homework assignments represent carefully chosen problems or tasks. Spaced practice from several lessons of the unit or previous units is included in addition to massed practice.
Daily homework is aligned to the essential learning standards of the unit.	Students are not able to make connections between the daily homework practice problems and the learning standards of the unit.	1	2	3	4	Students connect the homework practice as essential to helping them demonstrate knowledge of the essential learning standards of the unit.
Limited time is spent going over homework in class.	Students and teacher spend fifteen to twenty-five minutes (or more) in class going over the homework answers and solutions. The teacher does most of the work as the students watch.	1	2	3	4	At most, five to seven minutes of class time are used discussing the homework. It is primarily a peer-to-peer class activity facilitated by the teacher.

**Figure 1.28: Homework quality diagnostic tool.**

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Grade 8 Algebra 1—Assignment Guide Unit 1		
1. Write out the original problem. 2. Show all steps needed to solve the problem. 3. Write and box your answer. 4. Check and self-correct your answers. Use the solution key posted online as needed to check your answers.		
Lesson	Assignment	Score
Lesson One: Solving Problems by Creating Equations in One Variable (A-CED.1)	Homework worksheet one	
Lesson Two: Solving Problems by Creating Equations in One Variable (A-CED.1)	Homework worksheet two	
Lesson Three: Solving Problems by Creating Equations in One Variable (A-CED.1)	Homework worksheet three (Include a review from worksheets one and two.)	
Lesson Four: Solving Problems by Creating Equations in One Variable (A-CED.1) and Introduction to the Graphing Calculator	Homework worksheet four	
Quiz One on A-CED.1		
Lesson Five: Introduction to Functions (F-IF.1–2)	Pages 259–261 (1, 3, 13, 23, 38, 40–42)	
Lesson Six: Evaluating Functions (F-IF.1–2)	Homework worksheet five	
Lesson Seven: Operations With Functions (F-IF.1–2)	Page 260 (27, 43), page 267 (5, 29), page 271 (4, 19, 30)	
Quiz Two on F-IF.1-2		
Lesson Eight: Solving by Creating Equations in Two Variables (A-CED.2)	Homework worksheet six	
Lesson Nine: Solving by Creating Equations in Two Variables (A-CED.2)	Homework worksheet seven	
Lesson Ten: Solving by Creating Equations in Two Variables (A-CED.2)	Homework worksheet eight	
Review	Review project for the unit.	
Unit 1 Test on A-CED.1–2 and F-IF.1–2		

Source: Adapted with permission from Aptakisic-Tripp CCSD 102, Buffalo Grove, Illinois.

Source for standards: NGA & CCSSO, 2010, pp. 65, 69.

**Figure 1.29: Sample unit homework assignment sheet: Algebra 1 Team, Aptakisic Junior High.**

Take some time to examine your current homework assignments and practices. Use the homework quality diagnostic tool from figure 1.28 (page 73) to evaluate your current homework practices and make decisions about how your team can improve in this critical formative assessment process for students.

## Your Team's Progress

It is helpful to diagnose your team's current reality and action prior to launching the unit or chapter. Ask each team member to individually assess your team on the fifth high-leverage team action using the status check tool in table 1.5. Discuss perceptions of your team's progress on planning and using common

homework assignments. It matters less what stage your team is at and more that you and your team members are committed to collaboratively defining the purpose of homework, using the same common homework assignments and protocols, and communicating those assignments to students, parents, and colleagues as your team seeks stage IV—sustaining.

**Table 1.5: Before-the-Unit-Begins Status Check Tool for HLTA 5—Planning and Using Common Homework Assignments**

<b>Directions:</b> Discuss your perception of your team's progress on the fifth high-leverage team action—planning and using common homework assignments. Defend your reasoning.			
Stage I: Pre-Initiating	Stage II: Initiating	Stage III: Developing	Stage IV: Sustaining
We do not have a clear purpose for why we assign homework.	We have <i>established</i> a clear purpose for homework, but it is not independent and formative student practice.	We have <i>developed</i> the shared purpose of using homework as independent formative student practice.	We have <i>implemented</i> the shared purpose of homework as independent formative student practice.
We do not plan or use common homework assignments and do not know the homework assignments given by other members of our team.	We discuss homework assignments and have not yet reached collaborative agreement on the nature of those assignments for each unit.	We collaboratively <i>plan</i> and develop common homework assignments for each unit.	We collaboratively <i>use</i> common homework assignments for each unit.
We do not know the nature of the homework protocols used for the assignments given by other members of our team.	We discuss the nature of the homework protocols used for the assignments given by other members of our team, but do not agree on those protocols.	We have team agreement on developed homework protocols including limited number of tasks, spaced practice, balance of cognitive demand, and alignment to the essential learning standards.	We have complete team agreement on homework protocols including limited number of tasks, spaced practice, balance of cognitive demand, and alignment to the essential learning standards, and we use those protocols with our students.
We do not know how other members of our team go over homework in class.	We discuss how we go over homework in class but do not agree on what we should do.	We discuss how we go over homework in class and agree on what we should do with homework during class.	We discuss how we go over homework in class, agree on what we should do, and implement that agreement.
We do not know how other members of our team count homework as a percent of the student's total grade.	We know how others count homework for a grade, but we each do it our own way.	We grade homework the same each day, but we count it differently from other team members as a percent of the total student grade.	We have complete team agreement on how homework should be used and accounted for as part of the student's total grade.

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As your team seeks the sustaining stage, you will increase the rigor, coherence, and fidelity of the independent practice (homework) all students are expected to do during the unit for your course.

## Setting Your Before-the-Unit Priorities for Team Action

When your school functions within a PLC culture, your grade-level team makes a commitment to reach agreement on the five before-the-unit-begins high-leverage team actions outlined in this chapter.

- HLTA 1. Making sense of the agreed-on essential learning standards (content and practices) and pacing
- HLTA 2. Identifying higher-level-cognitive-demand mathematical tasks
- HLTA 3. Developing common assessment instruments
- HLTA 4. Developing scoring rubrics and proficiency expectations for the common assessment instruments
- HLTA 5. Planning and using common homework assignments

As a team, reflect together on the stage you identified with for each of these five team actions. Based on the results, what should be your team's priority? Use figure 1.30 to focus your time and energy on actions that are most urgent in your team's preparation for the next unit. You and your team cannot focus on everything. Focus on fewer things, and make those things matter at a deep level of implementation.

The five high-leverage team actions in this chapter combine to form step one of the teaching-assessing-learning cycle (see figure 1.1, page 8) and will help you prepare for the rigors and challenges of teaching and learning during the unit. They are also linked to teacher actions that will significantly impact student learning in your class.

In chapter 2, we turn our attention to steps two and three of the teaching-assessing-learning cycle, which focus on implementing formative assessment classroom strategies and students taking action on in-class formative assessment feedback. We also focus on supporting student engagement in the Mathematical Practices to promote deeper understanding of mathematical content through the use of higher-level-cognitive-demand tasks. The CCSS Mathematical Practices lesson-planning tool provides one avenue for organizing your collaborative team's work for collective lesson inquiry.

<b>Directions:</b> Identify the stage you rated your team for each of the five high-leverage team actions, and provide a brief rationale. When you are ready, discuss your ratings as a team.				
1. Making sense of the agreed-on essential learning standards (content and practices) and pacing Stage I: Pre-Initiating      Stage II: Initiating      Stage III: Developing      Stage IV: Sustaining Reason: _____ _____ _____				
2. Identifying higher-level-cognitive-demand mathematical tasks Stage I: Pre-Initiating      Stage II: Initiating      Stage III: Developing      Stage IV: Sustaining Reason: _____ _____ _____				
3. Developing common assessment instruments Stage I: Pre-Initiating      Stage II: Initiating      Stage III: Developing      Stage IV: Sustaining Reason: _____ _____ _____				
4. Developing scoring rubrics and proficiency expectations for the common assessment instruments Stage I: Pre-Initiating      Stage II: Initiating      Stage III: Developing      Stage IV: Sustaining Reason: _____ _____ _____				
5. Planning and using common homework assignments Stage I: Pre-Initiating      Stage II: Initiating      Stage III: Developing      Stage IV: Sustaining Reason: _____ _____ _____				
With your collaborative team, respond to the red light, yellow light, and green light prompts for the high-leverage team actions that you and your team believe are most urgent.  <b>Red light:</b> Indicate one activity you will stop doing that limits effective implementation of each high-leverage team action.  <b>Yellow light:</b> Indicate one activity you will continue to do to be effective with each high-leverage team action.  <b>Green light:</b> Indicate one activity you will begin to do immediately to become more effective with each high-leverage team action.				

**Figure 1.30: Setting your collaborative team's before-the-unit priorities.**

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