Prior-Knowledge Warm-Up Activities

Study findings suggest that learning of new content is supported by activating a conceptually relevant prior-knowledge sequence that helps connect the prior knowledge with the new knowledge.

—Pooja G. Sidney and Martha W. Alibali

Your mathematics lesson should always begin with a connection to prior knowledge. Your connection to each student's prior knowledge as they enter into the lesson for the day significantly influences what students learn in the specific situation presented by the mathematical tasks you ask students to pursue. Mathematical tasks can include activities, examples, or problems that your students are to complete as a whole class, in small groups, or individually.

Why should you ensure every mathematics lesson begins with a warm-up prior-knowledge problem or task? The simple answer: *student perseverance.* When you monitor students' initial response to entry concepts into the lesson, they are more likely to persevere longer as the lesson begins (Hattie & Yates, 2014).

Moreover, since the prior-knowledge task is generally a review, it allows you to gather evidence of overall student readiness to begin the lesson. And, finally, it allows you to establish context (or purpose) to the lesson, and, as previously mentioned, it provides an excellent opportunity to draw on multiple resources of knowledge in order to make instruction more meaningful to students (Aguir, et al., 2013).

You can use the prior-knowledge task to create the much-needed context for the *why* of the lesson. You can explain to students about standards they learned in the past and make connections from today's lesson to that prior knowledge. Your "creating context" discussion can come from the prior-knowledge problem and prepares students for the lesson you are about to begin. These types of questions will help you determine how the lesson's learning target fits within the mathematics learning progression of the unit and indicate you are using mathematics outcomes to focus students' learning (NCTM, 2014).

In this chapter, you will learn how to develop this element of your mathematics lesson design. In part 2, chapter 8 of this book (page 67), you will examine *how* to use this essential element of instruction for an effective teacher response to the evidence of learning you collect.

Choosing Prior-Knowledge Warm-Up Activities

You need to be mindful of time as you choose your prior-knowledge warm-up activities. In mathematics lessons, most warm-up activities that activate prior knowledge are generated either by a mathematical task or a discussion prompt you provide for the students as class begins.

A warm-up activity should not take up a lot of class time; no more than five to ten minutes is appropriate. If the warm-up activity is more of an exploration prior-knowledge task (a mathematical task involving investigation rather than questions to answer), then more time might be necessary to allow students to persevere and engage in learning the content in the lesson for the day. In the following personal story, Sarah Schuhl references a conversation with a team about the amount of time spent on a prior-knowledge warm-up task while also discussing the nature or intended purpose of the task.

Personal Story SARAH SCHUHL

I worked with a third-grade team to collaboratively plan a mathematics lesson related to areas of shapes composed of rectangles. When I asked how the lesson would begin with students, the team indicated it always started every lesson with a worksheet from a program that asked students ten random mathematics questions. We examined the questions. The questions for the area lesson ranged from elapsed time to addition with an algorithm to fraction equivalence to pattern recognition. I asked how much of the one-hour lesson was devoted to this warm-up each day. The answers ranged from fifteen to twenty-five minutes. Several teachers explained that students did not know the concepts, and so they retaught the ten problems before starting the lesson. They further explained that the area lesson would be difficult and they wished they had more time.

After much discussion, the teachers finally agreed to write their own warm-up activity. They wrote one question asking students to find the perimeter and area of a rectangle with only two sides labeled so students would practice area of a rectangle as well as be reminded that they can find missing side lengths when they are not included in the diagram. The teachers wrote a second question giving students the area of a rectangle with its base and asking students for the height, again reinforcing the idea that missing side lengths can be determined. They agreed to give students five minutes to work on the problems in their groups and then have two groups share their solutions before launching the lesson with a shape composed of two rectangles and asking students to find its area in their groups.

After the lesson, the teachers were excited with the evidence of student learning in the lesson. They felt the warm-up was quick and activated the knowledge needed to maximize the time spent practicing areas of complex shapes. While spiraled review is important, they decided they will create the warm-ups to prepare students for the learning of the day and might occasionally include one spiral review question, if needed. The team decided it would also work to include the spiral review questions in their homework assignments.

When you are selecting prior-knowledge tasks to support essential learning standards for a lesson, it can be helpful to reference the prior standards as well. These could be standards from a prior grade (or course) to see the level of depth explored the year before. Alternatively, these could be standards from a prior unit. Either way, the goal is to help students connect to the content of the lesson in order to help them make meaning. This helps to clarify where your instruction needs to start and the prior learning you want to connect with through the warm-up activity.

Figure 2.1, figure 2.2, figure 2.3 (page 22), and figure 2.4 (page 23) provide examples of prior-knowledge warm-up mathematics tasks for grades 2, 5, 7, and an algebra 1 high school course. They are based on a standard from the prior grade level. However, keep in mind that sometimes the prior-knowledge mathematical task is from a previous unit or lesson and may not be from a prior grade level, course, or unit. As you choose your warm-up task, make sure the task reflects knowledge most connected to the essential learning standard for the mathematics unit, and the daily learning target to teach those standards you are about to ask students to engage in learning for the day.

Take some time to closely examine the prior-knowledge task most appropriate for your grade level.

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard From Prior Grade, Course, or Unit
Grade 2	**Formal unit standard:** Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions. **Essential learning standard:** I can use addition and subtraction within 100 to solve one- and two-step word problems. **Daily learning target:** Students will be able to use addition and subtraction to solve one-step word problems involving adding to and putting together.	**Grade 1:** Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions.
Prior-knowledge task sequence: 1. Pat has eight red flowers and two yellow flowers in a vase. How many flowers are in the vase altogether? Show how you know. 2. There are twelve flowers in a vase. Five are white, and some are purple. How many are purple? Show how you know.		
Explanation of task: By starting with tasks that include numbers under 20, teachers can learn whether or not students understand one- and two-step problems and the strategies that go along with solving them. These prior-knowledge examples specifically focus on putting together and taking apart. Teachers have the opportunity to see how students show their work, especially for question number two. Do students use addition, subtraction, or do they add on?		

Figure 2.1: Grade 2 prior-knowledge mathematics task sample.

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard From Prior Grade, Course, or Unit
Grade 5	**Formal unit standard:** Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models. **Essential learning standard:** I can find whole-number quotients of whole numbers using multiple strategies. **Daily learning target:** Students will be able to find whole-number quotients of three-digit dividends and two-digit divisors using multiple strategies and explain the calculation using an area model or rectangular array.	**Grade 4:** Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

Figure 2.2: Grade 5 prior-knowledge mathematics task sample.

continued →

Prior-knowledge task sequence:

1. Gabriella makes 7 waffles for breakfast. She has 42 berries to put on top of her waffles. She will put an equal number of berries on each waffle. How many berries will Gabriella put on each waffle? Show your work and write the equation.
2. Now suppose Gabriella has 52 berries. What will happen? How many will she put on each waffle and why?
3. Solve 3,476 ÷ 7. Show your work.

Explanation of task:

For the first day of grade 5 instruction on division, knowing the grade 4 standard is four-digit dividend and one-digit divisor, it would be beneficial to start with a task that the majority of grade 5 students will be able to connect to without getting too caught up in errors. This will still give the teacher good insight into student misconceptions and their overall understanding of division. Before asking a rote division question, it helps for you to know if your students can pick up division in context of a word problem.

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard from Prior Grade, Course, or Unit
Grade 7	**Formal unit standard:** Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. **Essential learning standard:** I can compute unit rates associated with ratios of fractions. **Daily learning target:** Students will be able to compute unit rates associated with ratios of fractions.	**Grade 6:** Understand the concept of a unit rate $\frac{a}{b}$ associated with a ratio $a : b$ with $b \neq 0$, and use rate language in the context of a ratio relationship.

Prior-knowledge task sequence:

What is a unit rate? Describe or provide an example. Share your example with your shoulder partner and be ready to share with the class.

Note: If it seems that the class is struggling to come to consensus on the definition of a unit rate, it may be helpful to have an example ready to help support students' thinking. It would provide an opportunity to have a discussion within a specific context, which can help students who are struggling. For example, Pizza Joint is running a special on pizzas this month: $125 for 10 pizzas. Write a unit rate to express the price for each pizza.

Explanation of task:

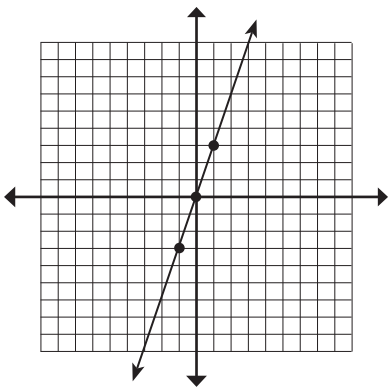
Before diving into the grade 7 standard about computing unit rates, it could be helpful to know what students remember about unit rates from grade 6. The question being asked is challenging because students have to recall the information and create their own example, which requires them to work backward and requires them to create. As students are working, the conversations they will be having with their peers should reveal their understanding of the topic. If students struggle through this warm-up, even with a numeric example, then the teacher knows students need to start at the grade 6 level before they can jump into the expectation of the grade 7 standard. If students demonstrate an understanding of unit rates, then the teacher knows to start with more challenging tasks for the lesson.

Figure 2.3: Grade 7 prior-knowledge mathematics task sample.

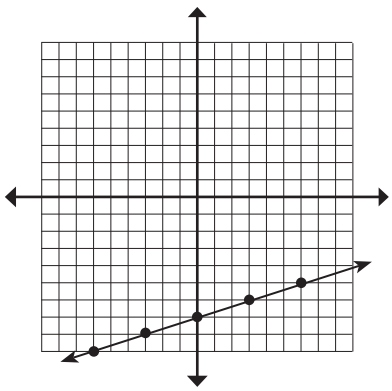
Grade or Course	Grade-Level Standard	Prior-Knowledge Standard From Prior Grade, Course, or Unit
Algebra 1	**Formal unit standard:** • Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). • Graph linear functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **Essential learning standard:** I can graph linear and nonlinear functions. **Daily learning target:** • Students will be able to graph different functions by hand. • Students will be able to distinguish between linear and nonlinear functions.	**Grade 8:** • Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. • Derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

Prior-knowledge task sequence:

1. Write the equation for the line graphed below.

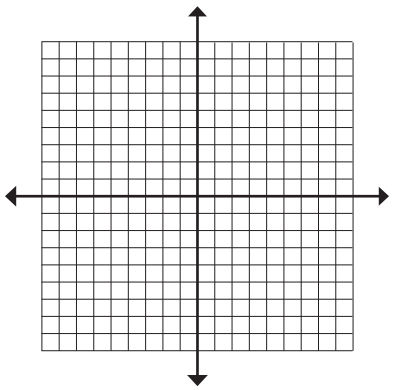


2. Write the equation for the line graphed below.



3. What is different about these two graphs? What do you notice about the intercepts and the slopes?

4. Graph an example of a nonlinear function. Be prepared to share with a neighbor.



Explanation of task:
The algebra 1 high school standards for this lesson relate to graphing. Given the knowledge students will have based on grade 8 standards, this warm-up starts with the basics of graphing and the vocabulary tied to graphing in order to determine what students remember and can apply. Sample vocabulary might consist of constant rate of change (slope), intercepts, domain, and range. The vocabulary word *function* is new to the high school standards.

Figure 2.4: Algebra 1 high school prior-knowledge mathematics task sample.

In the grade-level examples provided in figures 2.1, 2.2, 2.3, and 2.4, you will notice the use of a sequence of questions to gather evidence of prior knowledge. However, it is also possible that the warm-up is an exploration-type question that students work on together and investigate, based on prior knowledge, without having to answer a series of questions. These types of warm-up problems can help students establish a *why* for the day's learning targets as well.

For example, in a grade 3 lesson introducing division, you might start with some multiplication problems that ask students to think about the number of groups and the number of objects within the group. You could ask students to create a word problem context for the product of 4×6 or 9×7. They could draw or write out verbal examples. Then as you introduce the concept of division, you can tie in the same language used in the warm-up activity to help students make the connection between division and multiplication.

In an algebra 1 course, as the warm-up mathematical task you might ask students to solve a system of equations written in standard form, knowing the only strategy they currently can use for solving a system is graphing. This type of task might seem long and tedious to the students, but it builds an efficiency *reason* to learn and identify a more effective strategy like substitution or elimination. It starts to build the representation context for why you would choose between graphing, substitution, or elimination methods as a solution pathway.

Reflecting on Practice

Now, take a few moments to consider the teacher reflection for the warm-up activities you choose for your lessons and how you determine which tasks and problems to use.

TEACHER *Reflection*

What is the best strategy you currently use to determine the prior-knowledge warm-up activities to use before your lessons? Do you prefer to use mathematical tasks for your warm-ups, discussion prompts, or both?

As a team, identify an essential learning standard in your next unit of study. Use figure 2.5, the Prior-Knowledge Task-Planning Tool, to identify either the prior grade or unit essential standard you might need to reference, and choose either a mathematical task or discussion prompt that ties into the prior-knowledge skills that will help students access the essential learning standard for the lesson. In the explanation section, make some notes about why you chose the specific prior-knowledge task or tasks.

At first, it is helpful to write an explanation, but as you progress you may find it is just as beneficial to verbally discuss the reasoning.

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard From Prior Grade, Course, or Unit
	Formal unit standard: **Essential learning standard:** **Daily learning target:**	
Prior-knowledge task sequence:		
Explanation of task:		

Figure 2.5: Prior-knowledge task-planning tool.

*Visit **go.SolutionTree.com/MathematicsatWork** for a free reproducible version of this figure.*

As you and your team consider the prior-knowledge activities, it's important to remember that the mathematical tasks you choose and the discussion prompts you provide need to connect to the conceptual understanding you are trying to build. This is why it is so important to reference prior standards that align to the same strand in the same grade or from a previous grade. This helps you and your students understand and observe the vertical connections and progressions between the various units of content across grades and courses.

TEAM RECOMMENDATION

Use Prior-Knowledge Warm-Up Activities

- When planning prior-knowledge warm-up activities, be sure to choose mathematical tasks and discussion prompts that connect to the conceptual understanding you are trying to develop for the essential learning standard and learning target that day.
- Use prior-knowledge activities to help connect to the *why* of the lesson, paint a picture of where students are headed in the lesson, and develop student perseverance during the lesson (by reminding them throughout the lesson how chosen activities connect to the learning standard).

Thus, lesson design begins by identifying the essential learning standards for the unit and how the learning target for each day connects to that standard. The next step is identifying a prior-knowledge warm-up task connecting the mathematical task to the *why* of the lesson. These first two essential lesson-design elements establish the relevance for learning the mathematics of the day and address the first critical question of a PLC (DuFour et al., 2016): What do we want all students to know and be able to do?

So what is next? As the mathematics lesson unfolds, you cannot forget about the importance of the academic language vocabulary you will incorporate into your lesson and unit planning and the potential barriers to learning students can face if you fail to address vocabulary as part of the lesson design.