UNIT 1: LESSON 3

Area and Perimeter with Formulas

OVERVIEW	
Unit Title: Exploring the Area Model with Floor Plans	**Length of Lesson in # of Hours:** 3 **# of Classes:** 1
How does this lesson connect to previous or future work as exemplified by the Standards in your scope and sequence? This lesson revisits the ideas of area and perimeter and both contextualizes and formalizes them. This lesson builds on work with expressions and the distributive property by having students construct formulas for area and perimeter.	

LESSON OBJECTIVES

At the end of this lesson, students will be able to:

- create simple equations related to perimeter and area
- compare different strategies for finding the perimeter of a rectangle
- use simple symbols to create equations

STANDARDS

Citation	
3.MD.8	Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
4.MD.3	Apply the area and perimeter formulas for rectangles in real world and mathematical problems. [Students should be able to do this once they have derived the formulas themselves.]
5.OA.1	Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.
5.OA.2	Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers. [Only with whole numbers and simple one- and two-step expressions.]

1 - 3 MATHEMATICAL PRACTICE(S) ADDRESSED IN THIS LESSON	ELEMENTS OF RIGOR
MP 4: Model with mathematics. MP 7: Look for and make use of structure. MP.8: Look for and express regularity in repeated reasoning.	*Which aspect(s) of Rigor do the targeted Standard(s) require?* ☒ Conceptual understanding of key concepts ☐ Procedural skill and fluency ☐ Rigorous application of mathematics in real-world contexts

ESSENTIAL QUESTIONS

How can I represent different strategies for finding perimeter?

What is a formula?

EVIDENCE OF LEARNING

Ways I and my students will know the extent to which the objectives have been met.

Students will be able to write questions that describe the perimeter and area of a rectangle.

LEARNING PLAN - Vocabulary

square foot

formula

LEARNING PLAN - Introduction	MATERIALS	TIME
1. Remind students of the work they did in Lesson 1 with the area and perimeter of rectangles using tiles and grid paper. Ask them to recall what units they used to measure area. (In other words, if the area of a rectangle is 24, what is it 24 *of*?) [In Lesson 1, they used square inches and square centimeters]. Ask them to recall what units they used to measure perimeter. [In Lesson 1, they used inches and centimeters.]		
2. Ask students about how long a foot is and how they know. Ask them to estimate the length of something in the room in feet and then check with a ruler or tape measure.	Ruler marked in inches	

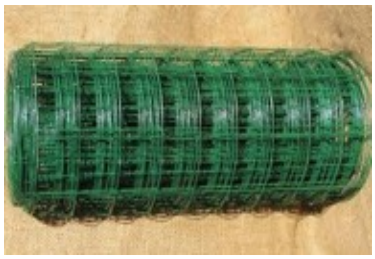
3. Invite a student to come to the board and use a ruler to draw a square that is one foot on each side. Say that this can also be used as a unit of area for measuring larger areas. Ask students to guess what it is called. [It's called a **square foot.**]		
4. Ask students to look around the classroom and find something with an area (might be the floor or ceiling, a tabletop, the board, a notebook) and explain where they see area and whether they might measure it in square centimeters, square inches, square feet, or some other unit.		
5. Ask students to look around the classroom and find something with a perimeter and explain where they see area and whether they might measure it in centimeters, inches, feet, or some other unit.		
LEARNING PLAN – Body of the Lesson	**MATERIALS**	**TIME**
1. Distribute the handout *Garden Fence Challenge* and set up the situation: Students have 100 feet of fencing to enclose a rectangular garden. They must use all of the fencing (no overlapping or gates). What will be the size of their garden? Encourage students to use the string, 1" square tiles, graph paper, and/or rulers to show how they will use all 100 feet of fencing. ***Note to teacher:*** *There are many answers to this question, but that probably won't be obvious to students. Let them explore and discover for themselves. When they find one solution, ask them to see if it is possible to make another size.*	*Garden Fence Challenge* handout U1.L3 String cut in 50-inch lengths 1" square tiles Graph paper Colored pencils Rulers	
Finding perimeter		
2. Have students share their various size rectangles. At the same time, capture on the board the various ways that they checked to ensure that the perimeter totaled 100 units. 3. Ask students to compare the various strategies that they used by asking them to check to see if they all total 100 units. Simply introduce parentheses to illustrate how to order what gets done first. For example, if a student says he added 30 + 30 and then 20 + 20 and writes it as 30 + 30 + 20 + 20, ask if he knows how to show that he first added the two separate sets of addition. If no one can answer, illustrate by showing that 30 + 30 + 20 + 20 can be rewritten as (30 + 30) + (20 + 20). Then suggest other ways to use the parentheses to represent different orders, such as [30 + (30 + 20) + 20, or 30 + (30 + 20 + 20)].		

4. Then ask: *What did each of you do to find the perimeter?* They should be clear that they added the lengths and widths (or doubled the length and width). Explain that, whenever there is a rule that always works, in this case, finding the perimeter, the rule can be written as an equation or formula. Then introduce the variable to replace the numbers that students used in their examples. Use the newly written examples to illustrate the distributive property. ***Note to teacher:*** *Even though students will use actual lengths, look for examples where they do the following: L + L + W + W. You can use this later to rewrite as 2L + 2W or L + W + L + W (the equivalence of these two expressions illustrates the distributive property which you will want to informally recognize through students' own work.) In turn, you can later rewrite these two expressions as 2(L + W).* 5. Use students' strategies to also introduce simple equations by building on their expressions. For example, if a student said his strategy was the following: 20 + 20 + 30 + 30, illustrate how you can add an equal sign and 100 to show equality: 20 + 20 + 30 + 30 = 100. Be sure to stress the meaning of the equal sign. (Many students think the equal sign means to put the result of a calculation. In fact, it indicates that the things on each side have the same value. One way to emphasize this is to write the equation in the other direction: 100 = 20 + 20 + 30 + 30.)		
6. Ask students to sketch a rectangular garden that has a length of 40 units and a total perimeter of 120 units. Ask them to figure out what the missing width is. Once everyone has had a chance to figure out the missing dimension, ask the class to describe what they would do to figure out the missing dimension. Then ask volunteers create a simple equation to show how they could figure out the unknown. ***Note to teacher:*** *Accept responses when the student writes something like, 2(40) + 2w = 120. Even though the variable is not isolated on its own on one side of the equation, that is a fine starting place. Nudge students by asking, "What would you do to figure out what w represents? Is there another way to write that equation based on what you just told me?" This is not the place to establish rules for solving equations. Allow students to reason in ways that make sense to them and, if necessary, help them use symbolic notation to represent their reasoning.*	*Finding Perimete*r handout U1.L3	
7. Distribute the handout *Finding Perimete*r and encourage students to first try the problems on their own, then share their thinking with a partner. ***Note to teacher:*** *If students have difficulty with composite shapes, you may want to spend class time on EMPower Over, Around, and Within: Geometry and Measurement, Lesson 6 (Teacher Book, pp. 69-73) which focuses on students creating composite shapes. If not, you may want to assign the student pages from that lesson for homework.*		

Deriving a formula for area of a rectangle		
8. Return to students' original rectangular garden shape. Ask students to share their strategies for finding the area. Then ask them to derive a simple rule, or formula, for finding the area of a rectangle.		
LEARNING PLAN – Closure / Conclusion	**MATERIALS**	**TIME**
Formative Assessment: 1. Have each student take a piece of graph paper and draw one garden that they worked with during the lesson. They should write equations to give the perimeter and the area of the garden. Have the students line up in order of the areas of their gardens, from smallest to largest and hold up their drawings so everyone can see them. Ask what they notice and what they wonder. 2. Check to make sure all the perimeters are 100 ft and that the areas are reasonable. If students stuck to whole numbers, the areas should be between 49 sq. ft. (for a 1' by 49' garden) and 625 sq. ft. (for a 25' by 25' garden) 3. Students might notice that longer and skinnier gardens have smaller areas and gardens that are closer to square have larger areas. They might wonder whether it is possible to make a garden with an even smaller area than the smallest one in the class or an even bigger area than the biggest one in the class.	Graph paper	
ADDITIONAL PRACTICE	**MATERIALS**	
For further practice with the relationship between area and perimeter	*EMPower Over, Around, and Within: Geometry and Measurement*, Practice page 64 [Area of 24 Sq. Cm] (SB)	

Garden Fence Challenge
U1.L3

I have 100 feet of fencing.



I want to make a rectangular garden that has a fence all the way around it.

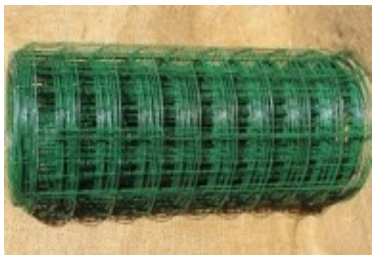
What size will the garden be?

Show how you know you will use all 100 feet of fencing.

Extra: How much space will I have in my garden?

Garden Fence Challenge (Answer Key)
U1.L3

I have 100 feet of fencing.



I want to make a rectangular garden that has a fence all the way around it.

What size will the garden be?

Show how you know you will use all 100 feet of fencing.

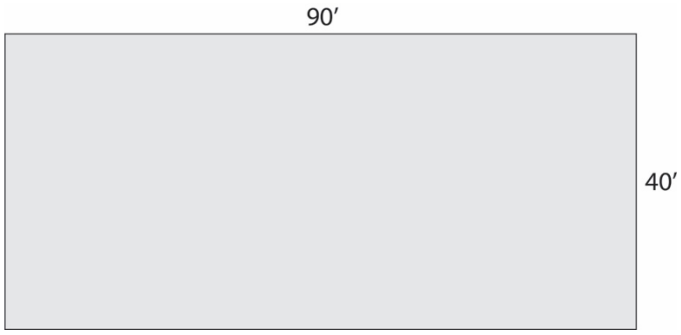
Student responses to the dimensions will vary but all rectangles should have a total perimeter of 100' (with two sides always totaling 50' since it's half of the fence). Obviously, there are many answers to this question, but it probably won't be obvious to students. Let them explore and discover for themselves. When they find one solution, ask them to see if it is possible to make another size.

Extra: How much space will I have in my garden?

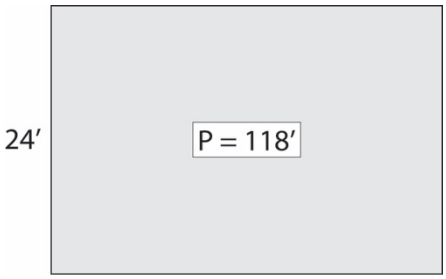
Student responses to the dimensions will vary based on the dimensions used to create the rectangle. For example, dimensions of 2' x 48' yield an area of 96 sq. ft. Yet, dimensions of 7' x 43' produce an area of 301 sq. ft. Encourage students to visualize why this works by demonstrating with the string or drawings a variety of dimensions.

Finding Perimeter
U1.L3

1. Determine the amount of fencing needed to surround the garden and show two ways to solve this.



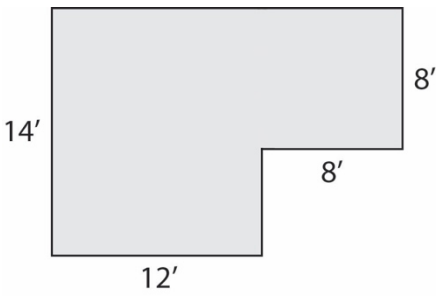
2. Given the length of the garden below, write an equation to show how to figure out the missing (width) dimension.



3. Jake wants to fence it the yard around his property. Assuming that the gates are part of the fencing, how much fencing would he need if his property is 100 feet by 80 feet? Write an equation to show to figure the amount of fencing needed.

4. Demetria wants to trim a tablecloth. She has 80 feet of lace trim. She knows her tablecloth is 6’ x 8’. Does she have enough trim? How do you know?

5. Based on the dimensions below, what is the perimeter of the shape?



6. Mary Jane decided to create an herb garden that was 4 feet on each side. What are some ways you could figure out the perimeter of her garden?