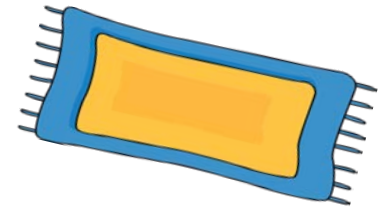| Task: "Coordinating" with the Rug	6th Grade

Your mom bought a new rug for your 12-foot by 14-foot living room, and she needs to get a rug pad to go under it. She doesn't have a tape measure long enough to measure the rug, but she knows that there are 2 feet of uncovered floor remaining on each side of the rug. What are the dimensions of the rug?

Teacher Notes:

Students may not use solution paths 2 and 3, but whole group discussion should include these solution paths in order to meet the standard.

Tennessee State Standards for Mathematical Content	Tennessee State Standards for Mathematical Practice
6.NS.C.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of absolute value to find distances between points with the same first coordinate or second coordinate.	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.

Essential Understandings:

- Many real-world problems can be expressed using pictures.
- Distances can be found by assigning coordinates and using the distance formula, $d = |x_2 - x_1|$ when the *y*-values are the same and $d = |y_2 - y_1|$ when the *x*-values are the same.
- Absolute value represents the distance that a number is from zero, regardless of whether the number is positive or negative.

Explore Phase

Possible Solution Paths	Assessing and Advancing Questions
Path 1: Students may draw a picture, such as the one below.	**Assessing Questions:** - How did you decide how to draw the picture? - Can you explain the calculations that you did to get your answers? **Advancing Questions:** - Can you think of a way to do this problem using distances between points? - How could a room and rug be plotted on a coordinate plane?
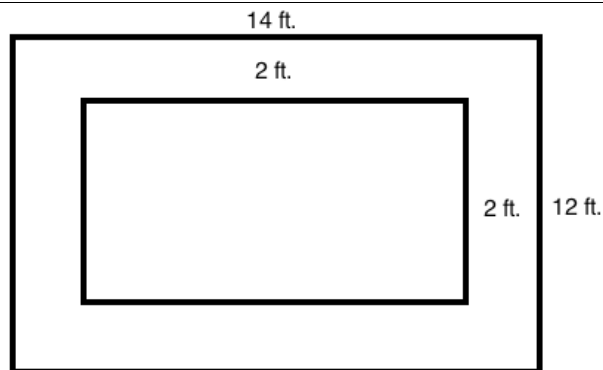
From this picture, they can see that the width of the rug (inner rectangle) is $12-2-2=12-4=8$ feet, and the length of the rug is $14-2-2=14-4=10$ feet.

Path 2: Students may use a coordinate plane to find the length and width of the rug. They may do this in different ways, but one way is to put the origin at one of the vertices of the larger rectangle (corner of the room). If they do this, then the dimensions of the rug could be found by any of the following methods:

1. The student could count the number of units between the corners of the rug to get 8 feet by 10 feet.

2. If the rug is positioned horizontally, the student should recognize that the vertices of the rug are at the points $(2,2)$, $(2,12)$, $(10,12)$, and $(10,2)$ and use the distance formula to get
$$|y_2-y_1|=|12-2|=|2-12|=10 \text{ feet and}$$
$$|x_2-x_1|=|10-2|=|2-10|=8 \text{feet.}$$

3. If the rug is positioned vertically, the student should recognize that the vertices of the rug are at the points $(2,2)$, $(2,12)$, $(10,12)$, and $(10,2)$ and use the distance formula to get
$$|y_2-y_1|=|10-2|=|2-10|=8 \text{ feet and}$$
$$|x_2-x_1|=|12-2|=|2-12|=10 \text{feet.}$$

Assessing Questions:
- How did you decide where to position the room and rug on the coordinate plane?
- How did you know that you could use the distance formula to find the width and length of the rug?
- Why did you subtract the numbers in the order that you did?
- How did the absolute value change your answer from what it would have been if you had not taken the absolute value?

Advancing Questions:
- Would you get the same answer if you'd placed the rug in a different position on the graph?
- Is the answer the same whether you subtract 12 from 2 as if you subtract 2 from 12?
- What does this tell you about absolute value?

Path 3: Students may use a coordinate plane to find the dimensions of the rug by putting the origin at the center of the rug. If they do this,

Assessing Questions:
- How did you decide where to position the room and rug on the

then the dimensions of the rug could be found by any of the following methods:

1. The student could count the number of units between the corners of the rug to get 8 feet by 10 feet.

2. If the rug is positioned horizontally, the student should recognize that the vertices of the rug are at the points $(-5,4)$, $(5,4)$, $(5,-4)$, and $(-5,-4)$ and use the distance formula to get
$$|y_2 - y_1| = |4-(-4)| = |-4-4| = 8 \text{ feet and}$$
$$|x_2 - x_1| = |5-(-5)| = |-5-5| = 10 \text{feet.}$$

3. If the rug is positioned vertically, the student should recognize that the vertices of the rug are at the points $(-4,5)$, $(4,5)$, $(4,-5)$, and $(-4,-5)$ and use the distance formula to get
$$|y_2 - y_1| = |5-(-5)| = |-5-5| = 10 \text{ feet and}$$
$$|x_2 - x_1| = |4-(-4)| = |-4-4| = 8 \text{feet.}$$

coordinate plane?
- How did you know that you could use the distance formula to find the width and length of the rug?
- Why did you subtract the numbers in the order that you did?
- How did the absolute value change your answer from what it would have been if you had not taken the absolute value?

Advancing Questions:
- Would you get the same answer if you'd placed the rug in a different position on the graph?
- Is the answer the same whether you subtract 12 from 2 as if you subtract 2 from 12?
- What does this tell you about absolute value?

Possible Student Misconceptions	Assessing and Advancing Questions
Students could have difficulty drawing the room and rug.	• Can you draw the room and put the dimensions on your picture? • How is the rug related to the room?
Students could have trouble putting the rug on the coordinate plane.	• How long is the room? • How long is the rug? • Can you draw the rug and room and then put the coordinate axes in?
Students could struggle with the absolute value part of the distance equation, and think that you can only subtract the smaller value from the larger value, which is more difficult to conceptualize when one of the values is negative.	• What is the absolute value of 8? Negative 8? Ten? Negative 10? • If we put these values on the number line, can you tell how their absolute values the same? • Why do we use absolute value to find distances?

Entry/Extensions	Assessing and Advancing Questions
If students can't get started….	• Can you draw a picture of the situation described in the problem? • What math concept that we've discussed recently could help you determine the length and width of the rug?
If students finish early….	• If the recommended width of the rug pad is 4 inches less than the rug on all sides, how large should the rug pad be?

	• Can you represent this situation using a coordinate plane and the distance formula?
	• When can the distance formula be used? Graph some points on a number line and determine their distances from one another using the distance formula. Collaborate with your group and be prepared to share with the class.

Discuss/Analyze

Whole Group Questions

Write the key understandings that students should come to in the discussion of this task and questions you can ask in the whole group setting to support arrival at these key understandings

Representing Problems with Pictures
- Who drew a picture to start this problem?
- Who solved it without a picture?
- Now that you've seen how a picture could be used, do you think it is an easier way to solve the problem?

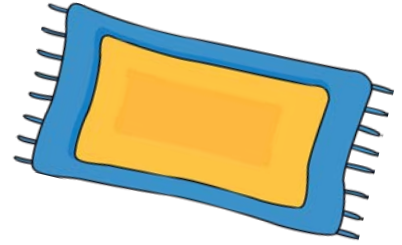**Using a Coordinate Plane to Solve a Problem**
- Who can tell me how they used a coordinate plane to represent the problem?
- What were the coordinates of the corners of the room and the rug?
- Did anyone do this differently?
- Why do you get the same answer regardless of where the rectangles are positioned?
- What types of drawings can be put on a coordinate plane?
- What types of things could not be represented this way?

The Distance Formula and Absolute Value
- Once you graphed the room and the rug, how did you determine the width and length of the rug?
- Is there another way besides counting?
- When can the distance formula be used?
- Can you describe why the number line works using examples on a number line?
- What does this tell us about absolute value?

"Coordinating" with the Rug

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