Go the Distance! By Mary Burr

Overview

Prerequisite Skills:

- Use Pythagorean Theorem to calculate hypotenuse or missing legs of a right triangle.
- Calculate slope of a line (slope between two points) using rise, run, and slope formula.

Learning Goals:

- Determine the distance between two points (hypotenuse of a right triangle) on a coordinate plane.
- Explain the relationship between the slope formula, Pythagorean Theorem, and distance formula.

Create a formula for determining the distance between two ordered pairs (without a graph).

Common Core Standards:

CCSS.MATH.CONTENT.8.G.B.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

CCSS.MATH.CONTENT.8.G.B.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

CCSS.MATH.CONTENT.8.EE.B.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; 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.

Mathematical Practices:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.
5. Use appropriate tools strategically.

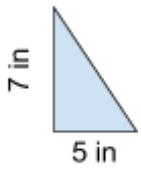
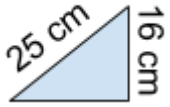
Materials:

- PhET *Graphing Lines* simulation: http://phet.colorado.edu/sims/html/graphing-lines/latest/graphing-lines_en.html
- Computers/tablets for each student or pair of students
- Go the Distance! Activity Sheet (1 per student)

Estimated Time: Approximately 50 minutes

Distance Formula

Warm Up	**5 minutes**
Teacher will… • Display warm up problems to review the Pythagorean Theorem. (Include diagrams) • Call on students to share answers and review. Find the missing side length in each triangle below.	*Students will…* • Complete warm up. • Share answers when requested, ask for help if needed.

 	
Simulation Introduction and Open Play	**5 minutes**
Teacher will…	*Students will…*
● Encourage students to take a few minutes to explore the Graphing Lines simulation, letting them know they will be looking at the slope for today's activity. ● Distribute the activity sheet as students begin open play. ● **Circulate the room** and ask students: 1. What happens when you move the dots? 2. What do the blue lines represent? 3. What does it make you think of? 4. How does the formula in the top right relate to the image on the graph? 5. Does this look like anything we have worked on before? 6. What other words did we use to describe the vertical change and the horizontal change when we were talking about slope?	● Explore the simulation, graphing whatever points and lines they choose. ● Respond to teachers' informal questioning. ● Jot down discoveries as #1 on the activity worksheet.
Guided Exploration & Discussion Part 1	**15-20 minutes**
Teacher will…	*Students will…*
● Encourage students to begin working on #2-7 in pairs. Try to give them at least 5 minutes where **the teacher is silent** before probing/aiding. Let students know they can and should **discuss their answers with a partner.** ● After most students complete 2 -7**, facilitate a class checkup** around the following questions: 1. Which part of the graph could replace a? Does it matter which leg is a and which leg is b? 2. What part of the graph is considered the hypotenuse? Why can we not just count the blocks there? 3. Uncheck the slope, check the "Hide Grid" box. How can we calculate the rise and the run now?	● Complete #2-7 on the activity sheet. ● Respond to teacher questions. ● Ask questions or ask for help as needed. ● Revise or add detail to answers to activity sheet as desired during discussion.

4. After I square a and b in the Pythagorean theorem and add them, how do I find just the hypotenuse and not c squared? (take the square root of the whole equation) 5. If we uncheck the slope lines, is there a way to figure out the rise and the run without counting blocks? 6. What types of formulas did you come up with? 7. Do you think your formula will always work with any two points on a line? Optional: reveal distance formula	
Guided Exploration & Discussion Part 2	**15-20 minutes**
Teacher will…	*Students will…*
● Encourage students to begin working on #9-12 in pairs. Try to give them at least 5 minutes where **the teacher is silent** before probing/aiding. ● After most students have finished #9-12, **facilitate a class discussion** around the following questions: 1. Review answers to see if students were able to accurately calculate the distance; if time permits, have students share their work on the whiteboard or document camera. 2. How are the distance formula and the Pythagorean Theorem linked? 3. When would it be better to use the distance formula? When would it be better to use the Pythagorean Theorem?	● Complete the activity sheet. ● Respond to teacher questions. ● Ask questions or ask for help as needed. ● Revise or add detail to answers to activity sheet as desired during discussion. ● Answer questions and question answers: students should be able to determine if they agree/disagree with others' claims and justify their own responses.
Going forward…	
● Students practice calculating the distance between two points on a coordinate plane. ● Students work on verbally explaining how to derive the distance formula from the Pythagorean Theorem. ● Teacher reflects upon and revises lesson as needed.	

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Learning Goals:

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- Explain the relationship between the slope formula, Pythagorean Theorem, and distance formula.
- Create a formula for determining the distance between two ordered pairs (without a graph).

1. **Explore** the Graphing Lines simulation for a few minutes, graphing whatever points or lines you choose. Write down 1-3 observations you have about graphing lines.

2. **Talk** with a partner: How does this relate to the Pythagorean Theorem? **Record** your thoughts below.

We think this is similar to the Pythagorean Theorem because:

_____

_____

We think this is different than the Pythagorean Theorem because:

_____

_____

3. Draw a line to match the corresponding parts.

Pythagorean Theorem	**Graphing Lines Simulation**
Leg a	line segment
Leg b	run
Hypotenuse c	rise

4. **Graph** any two points. Sketch a **diagram** (or insert a screenshot) of your graph, including the **ordered pairs** for your points below.

5. **Calculate** the length of the hypotenuse of the triangle formed in number 4, using what you know about the Pythagorean Theorem.

6. **Rewrite** the Pythagorean Theorem, **substituting** in the matched words above.

$a^2 + b^2 = c^2$

$\_\_\_\_\_^2 + \_\_\_\_\_^2 = \_\_\_\_\_^2$

7. **Rewrite** the above formula, **substituting** in parts of the slope formula to help calculate the missing values for the legs. Since you cannot accurately count the length of the line segment, leave that as a variable.

$\_\_\_\_\_^2 + \_\_\_\_\_^2 = \_\_\_\_\_^2$

8. What would you do to the left side of the equation above if you were trying to isolate the variable on the right (How do you get rid of the exponent?)? Hint: It's the last step when solving for the hypotenuse in the Pythagorean Theorem. Rewrite the formula with the variable isolated.

9. Using the formula you created in number 8, calculate the distance of the hypotenuse using the ordered pairs from # 4.

10. **Graph** the ordered pairs (6, 4) and (-4, 1).

11. Using the formula you created in number 8, calculate the distance of the hypotenuse. (Check your work with the original Pythagorean Theorem, if necessary).

12. Using the formula you created in number 8, calculate the distance between the ordered pairs (15, 11) and (20, 18).