2.0 Buggy Lab (Slope and Speed)

In this section, students connect the proportional relationship of constant speed with the slope of the line. They can use the slope of a line to create the equation for the graph of their real world data and then use slopes to graph other lines and begin to understand the story of the graph even without having to collect the data themselves. At this point, students will have an understanding of "m," the first part of the linear equation y=mx+b.

Instructional Goals:

- **6th Grade**: Solve unit rate problems including those involving unit pricing and constant speed.
- **7th Grade**: a.Decide whether two quantities are in a proportional relationship (e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin). b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn. d. Explain what a point (x, y) on the graph of a proportional relationship means in the situation, with special attention to the points (0, 0) and (1, r) where r is unit rate.
- **8th Grade**: Graph proportional relationships interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*

Section 2.0: Buggy Lab (Slope and Speed)

2.1 Proportion Problems Brainstorm
2.2 Accuracy with a Stopwatch
2.3 Buggy Lab: Collect Data
2.4 Buggy Lab: Create a Whiteboard
2.5 Buggy Lab: Discussion
2.6 Buggy Lab: Board Meeting
Suggested Assignment: Khan Academy Unit Rate

Suggested Lesson Breakdown

Buggy Lab Data Collection	Buggy Lab Discussion
2.1 Proportion Problems Brainstorm	2.5 Buggy Lab: Gallery walk
2.2 Accuracy with a Stopwatch	2.6 Buggy Lab: Board Meeting
2.3 Buggy Lab: Collect Data	Suggested Assignment: Khan Academy Unit Rate assignment
2.4 Buggy Lab: Create a Whiteboard	2.0 Full Packet of Student Assignments

Buggy Lab Data Collection

Lesson	Text	Teacher Directions	Digital Elements
Buggy Lab 2.1	2.1 Proportion Problems Brainstorm So far we have solved a painting problem with ratios and proportions. We wanted to keep the same color no matter what size batch we needed. Let's brainstorm types of problems we might solve using what we know about ratios and proportions.	Documentation: Try to document this discussion wherever you keep your class notes or on your class whiteboard. When the brainstorm is over tell students, “When we start our next activity, part of your job will be to prove to your classmates if the relationship we investigate is proportional or not.	

Buggy Lab 2.2	**2.2 Accuracy with a Stopwatch** We're going to play around with a stopwatch. You can also use a cellphone/clock for this activity. If you have access to a stopwatch/cellphone/clock with a second hand, have it available for timing in our next activity.	**Class activity:** Everyone starts and stops the stopwatch at the same time (about 10 seconds) , then we read off the times and make a simple frequency graph. You can make a horizontal bar chart type graph using a digital tool and projecting to the class) We should see almost no one get the same time. As a class, decide what is a reasonable time. We are not as accurate as we think we are. Remember, most of the math we are exploring was discovered before clocks were capable of such precise measurement. **In-person:** Have students conduct the experiment with stopwatches in the classroom or with their personal phones **Digital:** Have students conduct the experiment on their personal devices. You could also use an online stopwatch linked here.	Whiteboard option 1 - Jamboard Whiteboard option 2 - https://www.whiteboard.chat/ Whiteboard option 3 - Miro's Web White Board Digital graphing tool for linear equations 2.0_Digital tool for bar charts 2.0_Online stopwatch

Buggy Lab 2.3	**2.3 Buggy Lab: Collect Data** Question that we will explore: Is speed a proportional relationship? We will be collecting a series of ratios (different units) and comparing them and plotting them on a graph to see if there is a proportional relationship. We'll observe the moving object and see what we notice. What measurements should we take? ● What units will we use? ● Do we plan to collect more than one set of data? ● What procedures do we need to follow so that our data is as accurate and comparable as possible? **In-person Student Instructions:** 1. Release the buggy before the start line. Start the timer when it reaches the line. 2. One student calls out time every 5 seconds. Have another student put a piece of tape on the floor when the buggy is at each time.	**Common student misconception:** Fractions use the same units - parts of a whole. Ratios use different units - comparing two things. (Be careful about hammering this home too early. It makes it very clear speed is a ratio.) We want distance on the y-axis as our dependent variable, because we want the standard meters/second so we understand the speed. Where on the buggy do we record each second? When do we push start/stop? As students are working, plant the questions for discussion: What is speed? What's the relationship between position and time? You can use the slides to help guide the assignment. **In-person:** Follow the student instructions with a physical buggy. If	2.0_Buggy Lab Worksheet 2.0_Buggy YouTube Video_Option1 2.0_Buggy YouTube Video_Option2 2.0_Buggy lab instruction slides

	Only push stop on the clock at the end. 3. Measure the distance from the starting line to each tape marker on the floor. **Digital Student Instructions:** Pause the video every 5 seconds *after* the car passes the starting line and record the position of the car. - Buggy video coming soon	you are not able to obtain buggies, follow the digital instructions. **Digital:** Have students play then pause the video every 5 seconds *after the car passes the starting line and record the position of the car. (0 time when the car passes the line, 0 position is the starting line.) Record at least 5 coordinates for the graph. - Buggy video coming soon	

Buggy Lab 2.4	**2.4 Buggy Lab: Make a Whiteboard** As a group, create a whiteboard with as many representations of the data as you can show. Then, create a rule using words and an equation using the y = mx format and write it on your whiteboard The whiteboard should include: ● Data table - Time on x-axis and Position on y-axis ● Graph with units and labels ● The story of the car - What did you observe? How did it move? How do you know? ● Is this a proportional relationship? Be prepared to defend your thinking! ● A rule in words and numbers that describes this relationship Remember: this is real data. Your measurements are not perfect. What rule works "best" or makes the most sense.	Students collect data by recording the position of the car every five seconds. So the independent variable on the x-axis will be time, and the dependent variable on the y axis will be position*. **Common misconceptions:** Students can get confused about which axis shows distance. Some can imagine the car "driving" from left to right on their graph, and that is not what the graph is showing. It is an abstraction of speed. The speed is the ratio that occurs over and over again because there is constant velocity. We are drawing a "picture" of speed. ***Position vs. distance misconception.** Position is the location of an object relative to the origin. This will be more important once we go to section 3 of this curriculum and address data that doesn't begin at the origin and other quadrants of the graph. Distance is the total amount the object has moved and is	Whiteboard option 1 - Jamboard Whiteboard option 2 - https://www.whiteboard.chat/ Whiteboard option 3 - Miro's Web White Board Digital graphing tool for linear equations

		always a non-negative number. **Whiteboarding:** Encourage students to include multiple representations on their whiteboards: drawing/motion map, table, graph, words explaining their graph/motion. Etc., equation Students can add to their boards during a Whiteboard Meeting. All boards will look different. That's helpful for you as a teacher, because then there is something to discuss!	

Buggy Lab Discussion

Lesson	Text	Teacher Directions	Digital Elements
Buggy Lab 2.5	**2.6 Buggy Lab: Gallery walk** Look at the whiteboards of the other groups. Use Talk Moves to make helpful comments/questions.	Review **Talk Moves** with students to help them make constructive comments. **Discussion Questions to plant with students:** ● Every point on this line represents a ratio. What is a rule (equation) you can use to describe any point on this	Talk move student sample Talk moves teacher sample

	Make sure to think about how they have presented their information. You can also make comments about the following: 1. Every point on this line represents a ratio. What is the rate of change for the graph? Did the group create a rule (equation) you can use to describe any point on this line? 2. What does the rate of change on a graph mean? What does it mean specifically for this graph? What did we discover? 3. Is constant speed proportional? Explain your thinking. Do you agree with each board's rationale? Go back and look at the comments on your own whiteboard. Are there any changes you would like to make to your board before the whiteboard meeting?	line? ● Is constant speed proportional? Explain your thinking. Do you agree with each board's rationale? **Definition of rate**: When a ratio has different units it's called a rate - you can add this to another page of your Model-so-far vocabulary	
Buggy Lab 2.6	**2.6 Buggy Lab: Whiteboard Meeting** Think back to the notes you saw on your board or other boards you just observed. Did someone make a particularly good point you want to share? Did someone have a great way of explaining that helped you	**Guide the discussion to reach conclusions about vocab and add to the Model-so-far.**	Model-So-Far page

	understand? What did you discover from this activity? In the Board Meeting be prepared to discuss the following: ● Is constant speed proportional? ● What are we looking for to see if this relationship is proportional? ● What does the x represent in your Buggy Lab graph? What does the y represent in your graph? ● Why do we make graphs of data? ● Why do we write equations of lines? Then, we'll revisit the class definitions of Slope and Unit Rate in the **Vocabulary** page of **Model-So-Far**.	The commonly accepted definition of speed is position divided by time and the metric unit is the meters traveled by the object in 1 second (expressed with shorthand as m/s). Is every equation dealing with constant speed proportional? No, only graphs starting at the origin can be proportional. Describe the line using equations y=mx Slope = m = change in y/change in x Vocab: slope intercept form - y=mx+b in this case b will always be 0. How do you know you're looking at a proportional relationship? View the graph with the complete set of data points together. **Discussion goal:** We know this is a proportional relationship and a	

		series of ratios, but it's also a function. Some students think that all relationships that increase or decrease by a constant value are proportional. A proportional relationship is one kind of function. We will be learning about other kinds of functions next week.	
Suggested Assignment	**Khan Academy: Unit Rate Assignment** We now understand that we need a unit rate to make an equation for our data to make a graph. Complete Unit Rate Assignment using Khan academy to help you think about making equations. This will also give you the opportunity to give and receive help from students who are not in your class.	**Suggested help-giving activity:** if you are active on Khan Academy/have accounts, have your students comment on the Khan Academy video to either ask a question or answer somebody else's question.	2.0_Khan Academy - Graphing proportional relationships - unit rate 2.0_Unit Rate Assignment