

8th Grade Math Lesson: Comparing Functions

This should take place after a good amount of exploration of the multiple representations of functions (graphs, tables, rules, explicit & recursive sentences) but before the abstraction of writing an algebraic linear rule has been mastered. Students should be familiar with comparing growth rates (including increasing and decreasing trends) as well as initial values of different linear functions. If students are new to the Function Builder sim, the lesson plan step labeled Individual Function Builder Exploration (Step 1) should be done in an earlier lesson to allow enough time for students to experience and manipulate the sim before attempting Step 2 and Step 3.

Content Objectives:

1. Students will use a table or graph to construct an equivalent function rule.
2. Students will be able to compare two functions represented graphically and numerically in tables.
3. Students will use their own words to complete the sentence frames (below) to describe the growth of two functions:

Recursive: To find the next output, use the output before and _____.

Explicit: To find each output, use the input and _____.

Common Core Standards:

Define, evaluate, and compare functions. (CCSS: 8.F):

- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).(CCSS: 8.F.2)

Use functions to model relationships between quantities. (CCSS: 8.F):

- Construct a function to model a linear relationship between two quantities. (CCSS: 8.F.4)

CCSS Math Practices:

MP1: Make sense of problems and persevere in solving them.

MP4: Model with mathematics.

MP6: Attend to precision.

MP8: Look for and make use of structure.

Materials:

- Chromebooks (class set) -- *Please note that provided directions for the activity are written for chromebooks (will need to be modified if you are using other devices)*
- Access to [PhET Function Builder](#) Simulation
- Access to Google Classroom & [Partner Challenge: Comparing Functions](#) Assignment
- [Sample Student Work](#) for Partner Challenge: Comparing Functions

The Plan (90 minute lesson):

Time	Activity	Notes
0:00-0:15	Warm-up	Students should work for 5 minutes silently and independently. They should talk to their table partner for 3 minutes. Then, use equity cards (or other randomization technique) to choose students to show/discuss their solutions with the whole class. Have students show how to check the correctness of the solution sentences by plugging in sample (x,y) points from the trends.
0:15-0:25	Individual Function Builder	Have each student pick up their assigned chromebooks.

	Exploration (Step 1)	<p>Guide students through Step 1 of the Instructions to Project below. Students should explore the Numbers mode during this time. Once students have logged in and have explored for a couple of minutes, project the sim on the front screen, and briefly guide the class in a discussion about the bolded vocabulary terms in the instructions: <i>What do you think we mean by “Operations”, “Function Tube”, etc. Where are they on the screen? What kinds of “Operations” are available to use? (emphasize adding, subtracting, multiplying and dividing as 4 options)</i></p> <p>Other guiding questions to ask: <i>What happens when you swap the order of your “Operations” in the “Function Tube?” Is it the same function? What happens when you drop an Output into your Function Tube? What happens in your Table when you drop in Input values that are out of order (ex. 1, then 3, then 2)?</i></p> <p>Students should continue exploring for the remainder of the 10 minutes.</p>
0:25-0:45	Partner Challenge: Creation (Step 2)	<p>Guide students through Step 2 of the Instructions to Project below. Emphasize that there should be 1 Google Doc per team of partners (they need to SHARE so both can edit the document).</p> <p><i>What patterns are you noticing in your input-output table? How are these related to the operations you used in your rule? What happens when you check the “Simplify” box? What do you think makes the new function rule “simpler”? Which format for the function rule seems easier to read? Why? Does the “simplified” rule still show 2 operations? (If not, guide the students to use 2 non-inverse operations in their rule).</i></p>
0:45-1:10	Partner Challenge: Function Sleuthing (Step 3)	<p>Guide students through Step 3 of the Instructions to Project below. Emphasize that now all 4 students in both teams should be shared on the Google doc (to edit). The Function Sleuths ONLY complete sections in BLUE on the Google doc (first by typing their names at top).</p> <p>With 5 minutes remaining, remind students to write their recursive or explicit sentences even if they haven’t found the missing representations of the function.</p> <p>Depending on the Function that was created, often one of the sentences (either recursive or explicit) is significantly easier to find and write:</p> <p><i>What patterns are you noticing in the outputs in your table? (recursive)</i> <i>How would you fill in any of the missing inputs (and matching outputs) in your table? (recursive) How did you find this? How fast is the pattern changing?</i> <i>What is the relationship between the inputs and their outputs in the table? (explicit)</i></p>

		<i>Are the outputs always bigger than/smaller than/the same sign as/the opposite sign as the inputs? What kinds of operations might these clues suggest? (explicit)</i>
1:10-1:20	Comparing Functions	<p>Guide students through Step 4 of the Instructions to Project below. They should use the comment feature to respond to their Sleuths' work, and they should ONLY type in the red areas of the Function Comparison question response box on the document.</p> <p><i>Where do you see the initial values in the table? On the graph? How are they the same or different?</i></p> <p><i>How can you tell the rate of change for each function in the table? On the graph?</i></p> <p><i>Are they increasing/decreasing? How do you know from the table? The graph? The rule?</i></p> <p><i>Is one increasing/decreasing faster/slower than the other? How can you tell in the table? On the graph? In the rule?</i></p>
1:20-1:30	<p>Learning Logs & Clean-up:</p> <p>Where are you seeing the details from your Function Sleuth's sentences appearing...</p> <p>...in the table?</p> <p>...in the graph?</p> <p>... in the function rule?</p>	Make sure students carefully place chromebooks in the correct slots in the cart -- and plug in to charge!

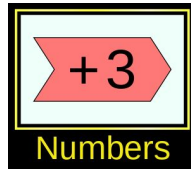
Follow-up:

After the lesson, student responses in the "Comparison" step can be used to guide a discussion about key features of linear trends (rate of change, initial value) and how they appear in the various representations (graphs, tables, rules). This could lead to a discussion about how to more efficiently "solve" the mystery of finding unknown functions for a given data set or graph, and it could lead to a "gallery walk" or even a "give one, get one" type activity in which students practice comparing functions represented in different ways (including function rules that are not yet simplified). See more possible follow-up lesson ideas in the [Sample Student Work](#).

Instructions to Project:



Step 1: Explore Function Builder

Click on the Function Builder link on the class website.



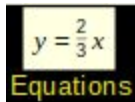
Choose the Numbers screen:


Experiment with:

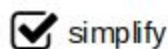
- ★ Dropping different **Operations** in the **Function tube**
- ★ Sending different **Input values** through the Function tube
- ★ Reversing your function by sending **Output values** back through!
- ★ **Hide** your Operations or **Reveal Results** from each step
- ★ **Erasing** and **Resetting** your Function tube
- ★  and 

Step 2: Function Challenge Creation

With your table partner(s):



1. Choose the Equations screen:
2. Choose 1 partner to open the **Partner Challenge: Comparing Functions** assignment in our Google Classroom.  so your partner **CAN EDIT**.
3. Create your function with **at least 2 operations** from the menu below.
4. **Type your input-output values** into the **Function 1 Table** on your Google doc.
Double check these for accuracy!
5. Create a second (different) function with **at least 2 operations**.
6. **Screenshot simplified y= rule** into the **Function 2 y= Function Rule**.

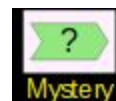


Ctrl + Shift + , then click and drag.

Click **Copy to clipboard**

then  to **PASTE**

Done early? Try the Mystery mode to test your smarts:



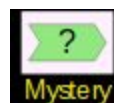
Step 3: Function Sleuthing



your Google doc with your assigned Function Sleuths so they **CAN EDIT**. Then, both partners should open the **Partner Challenge: Comparing Functions** Google doc that has been shared with you (either from your **email** or **Google Drive**).

1. Work together to **re-create the functions** your Challengers have created (you can ask for a hint about the *number of operations* if you're feeling stuck).
2. For Function 1: Screenshot the **Graph** and the **y= Function Rule** & paste into the Google doc in the appropriate boxes.
3. For Function 2: Type at least 5 input-output pairs into the **Table** on the doc. Screenshot the **y= Function Rule** & paste into the Google doc.
4. For both Function 1 and 2, write a **precise Recursive and/or Explicit sentence** to describe the trends you are exploring.

[**Level 1:** one sentence or **Level 2:** both sentences]



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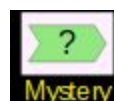
Step 4: Comparing Functions

Check the work that your Function Sleuths have completed in your Google doc.

Add at least 2  to give positive or constructive feedback.

Then, complete the **Function Comparison** questions (about the Function 1 and Function 2 **that you created!**) with your partner. Remember to use full sentences!

When you are done, be sure to  your **Partner Challenge** Assignment.



Done early? Try the Mystery mode to test your smarts:

