Using Transformations to Graph Linear Functions

Overview

Students will expand their understanding of the slope-intercept form of a line to understand visually how a line will change when either the slope and/or the intercept is altered.

Prerequisite Skills:

- Identify *m* and *b* in slope-intercept form
- Graph a linear function in slope-intercept form from **m** and **b**.

Learning Goals:

- Identify and use a vertical stretch or compression to graph a linear function.
- Identify and use a vertical shift to graph a linear function.
- Combine transformations to graph a linear function.

Standards:

- **F.BF.3** Identify the effect on the graph of replacing f(x) by f(x)+k, kf(x), f(kx), and f(x+k) for specific values of k (both positive and negative)....
- **F. IF.7a** Graph linear and quadratic functions and show intercepts, maxima, and minima

Materials:

- PhET *Graphing Slope-Intercept* simulation:
- https://phet.colorado.edu/sims/html/graphing-slope-intercept/latest/graphing-slope-intercept_en.html?screens=1
- Computers/tablets for each student or pair of students
- Using Transformations Activity Sheet (1 per student)

Estimated Time:
Approximately 45 minutes

Students already know how to graph a line in slope intercept form. This lesson is designed to emphasize that just like with transformations in geometry, we can move and resize the graphs of functions. Transformations can be a powerful understanding of what functions do. Function transformations are math operations that cause the shape of a function's graph to change *(i.e if you change the function's equation, you change the shape of the graph).*

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Warm Up (5 min)

- Graph $y = 2x - 5$.
- Translate the function 2 places to the right and 7 units up.
- The function $y = 2x - 5$ translated two places to the right and 7 units up becomes _y_____.

Students will be able to understand that you can move the graph of a linear function around the coordinate plane using transformations. There are three basic transformations: translation, reflection, and stretching. Teacher and students can further discuss what a translation is, reflection, stretch, etc.

Simulation Introduction (5- 7 minutes)

- Distribute student activity sheet.

- Students will explore the simulation and write down observations/and or questions under #1 on their activity sheet.
- Teacher will circulate the room and observe students.
    - *What does the purple dot represent? What happens when you move the blue dot?*
    - *What does the equation look like when you make a horizontal line? Vertical line?*
    - *How do you make a line steep? What do you notice about the slope?*
    - *How do you make a line less steep? What do you notice about the slope?*
    - *What can you do with the boxes with the question marks? What do they show?*
- Ask students to briefly share what they wrote down for #1 on the activity sheet and discuss any of the questions above.

Guided Exploration (15 minutes)

- Tell students to begin working on #2. *Observe students and encourage them to talk about the slope and y-intercept of the parent function.*
- Tell students to work on # #3-8 in pairs.
- **Circulate the room** to be available for questions and ask probing/pushing questions, such as:
    - *How do you know by looking at the graph and equation if a vertical shift was applied to the parent?*
    - *How can you tell by looking at the graph if the line gets more steep or less steep?*
    - *How can you tell by looking at the equation if the line gets more steep or less steep?*
    - *What is being transformed each time? (in this case, the parent function $y = x$)*
    - *How can you tell if the transformation was a reflection?*

If pairs finish early, students can create lines for their partner and have their partner guess what transformations were applied. For example, a student could have the line $y = -\frac{3}{4}x - 2$. Their partner could ask questions like, was the line reflected? Did the line get more steep or less steep? Shift up or down?

Discussion and Summary (10 minutes)

- Facilitate a class discussion starting with #7. Ask students how many lines they graphed. If students only graph one line, ask them if they could graph 2 lines. Why might we graph 2 lines? *Show students that each line represents a transformation.* Have students think and discuss: *Do you have to graph the line $y = \frac{1}{2}x$ first and then shift it down 3? Or can you shift the parent function down 3 first and then use slope to go up one over two? Is there a pattern to the order and if so, what is that pattern similar to (order of operations)?*

- Go over #8. *Discuss the vocabulary.*

The graph gets **less steep** when the slope is between _0___ and __1__. This is called a **vertical compression** of the parent function. The graph gets **more steep** when the slope is _greater__ than 1. This is called a **vertical stretch** of the parent function. **Reflections** happen when the slope is __negative___. **Vertical shifts** happen when the y-intercept is not equal to ___0__.

- Consider the function $y = -\frac{3}{4}x - 4$.
    - What transformations are applied to the parent function?
    - How does the negative in front of the slope affect the graph? How does a slope of $\frac{3}{4}$ transform the graph? What does the -4 do to the graph?

- Does knowing how **m** and **b** transform a graph change the way you would graph a line in slope intercept form?

Informal Assessment (5 minutes)

Exit Ticket:

A. Explain and demonstrate how to make transformations of linear functions in slope-intercept form. Include a basic explanation of how changing each part of the equation will change the graph as a whole.

B. Graph a line that is more steep and shifted down from the parent function.

Write your equation here: _____