**Using Transformations to Graph Linear Functions**

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| ***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**.
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| **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.
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| **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
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| **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)
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| **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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| **Using Transformations to Graph Linear Functions** |
| **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.
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| **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?
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| **Informal Assessment** (5 minutes) |
| **Exit Ticket:** 1. 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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |