**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**. |
| **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 . * Translate the function 2 places to the right and 7 units up. * The function 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 )*   + *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 . 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 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 .   + 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 transform the graph? What does the 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:**   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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |