emcsquared: What are m and b, and What do They do to a Line

Title:	**Grade:** 8	**BIG Idea:**
What are *m* and *b*, and What do They do to a Line? ***Geogebra applets created by Athena Matherly**	**Author**:Hope Phillips	The affect of slope and y-intercept on a line

Prior Knowledge Needed:

- Plot points on a coordinate plane
- Understand what it means if two lines are parallel
- Change a decimal to a fraction and vice versa
- Describe patterns in the graphs of proportional relationships (y = kx)
- Recognize a relation as a correspondence between varying quantities
- Analyze relationships in a graph

GPS Standards:	**Objectives:**
M8A4 Students will graph and analyze graphs of linear equations and inequalities **b.** Determine the meaning of the slope and y-intercept in a given situation. **M8G1a.** Investigate characteristics of parallel lines algebraically (This is not the complete element but includes only the part salient to this task.)	1. Using an online applet, students will determine the affect of the slope, or *m*, on the graph of a line. 2. Using an online applet, students will determine the affect of the y-intercept, or *b*, on the graph of a line. 3. Students will determine that the graphs of lines with the same slope are parallel.

Materials:

Computer and internet access -- either computer lab, laptops, or teacher projecting applet to entire class
Applet - see *Resources* section below
Graphing calculators (or use online graphing utilities listed in *Resources* section below)

Task:

Open the applet *Slope-Intercept Form* at

http://www.geogebra.org/en/upload/files/english/Athena_Matherly/Slope_Intercept_Form/slope_intercept_form.html

Observe what happens as you move the two sliders on the applet. Then answer the questions to the right of the applet.

1. Leave *m* as 1 and move *b*. Explain how the line is changing. Explain how the equation is changing.
2. Leave *b* as 1 and move *m*. Explain how the line is changing. Explain how the equation is changing.
3. Explain the direction of the line when m is positive or negative.
4. What type of line do you see when m=0?

5. What conclusions can you make about the variables *m* and *b*?

Questions developed by applet creator Athena Matherly.

(*In addition to the questions on the applet, you will want to use the more in-depth questions and comments found in the **Teacher Directions** below.)

Description and Teacher Directions:

Have a brief discussion about the graph of a direct variation, a concept they learned in seventh grade. Graph the line y=1x, y = -1x, y= 4x, and y = -4x. Use one of the online graphing utilities listed in the *Resources* section below if you do not have handheld graphing calculators. The following are discussion points to make:

- graph is a line
- graph goes through the origin
- the value "k" determines the steepness of the line
- lines may rise or fall from left to right on the coordinate plane

Tell students they will be learning about the equations and graphs of lines. They can think of the equation and graph of y=kx as a foundation on which they may add new information.

Open the first applet. Follow the instructions on the right, setting the *m* slider to 1. Although not specified in the applet's directions, set the *b* slider to 0.2. Begin slowly moving the *b* slider to the right, first, so that the y-intercept changes from one value to another. Take care to not move the slider too fast.

Ask students to think about how the line and equation are both changing after each movement of the *b* slider.

Ask questions like the following:

1. How would you describe the position of the line when *b* is 0? (answer: goes through the origin)

2. How would you describe the position of the line as we move the *b* slider to the right? (answer: the line moves up the y-axis)

3. What did you notice about the equation of the line as we moved slider *b* to the right? (answer: the value to the right of the addition sign was always positive and got larger)

Now move the *b* slider to the left. Ask questions like the following:

1. How would you describe the position of the line as we move the *b* slider to the left? (answer: the line moves down the y-axis)

2. What did you notice about the equation of the line as we moved slider *b* to the left? (answer: the value to the right of the addition sign was always negative; the absolute value of the number got larger)

3. When b = 1, where does the line cross the y-axis? answer: at the point (0,1)

4. When b = 2, where does the line cross the y-axis? answer: at the point (0,2)

Teacher Commentary:

5. When b = 0, where does the line cross the y-axis? (answer: at the origin)

Tell students that based on their observations of where the line crosses the y-axis it should be clear to them why the name of the ***b*** slider is the **y-intercept**. This numerical value is where the graph crosses/intersects the y-axis.

Now look at applet direction # 2. Leave slider ***b*** as 1 while moving slider ***m***. Repeat the same process as with slider ***b***, moving slider ***m*** slowly to the right, one value at a time. Start with m = 0.2. Re-name each value of ***m*** as a fraction to help students transition between this applet and the way they will use slope to graph lines in future lessons.

Ask students to think about how the line and equation are both changing after each movement of the ***m*** slider. Ask questions like the following (applet questions #3-5 are addressed in the content below):

1. As we move slider ***m*** to the right of zero, what do you notice about the line? (answer: it is getting steeper; it rises from the left part of the coordinate plane to the right; from the third quadrant to first quadrant)

2. As we move slider ***m*** to the right of zero, what do you notice about the equation? (answer: the coefficient of the x-variable is getting larger)

Position slider ***m*** at 0. Ask the students to describe the steepness of the line. They should notice that the line has absolutely no steepness because it is horizontal.

Now ask students to move slider ***m*** to the left of zero.

3. As we move slider ***m*** to the left of zero, what do you notice about the line? (answer: it falls from the left part of the coordinate plane to the right; from the second quadrant to the fourth quadrant; the absolute value of ***m*** gets larger, the line gets steeper)

4. Which way does the line slant when ***m*** is positive? Which way does the line slant when *m* is negative? Use words like "up, down, right, and left" to describe.

Tell students the name of the ***m*** slider is the **slope.** This value determines the steepness of the line.

Now set <u>both</u> sliders to 0. What do you notice about the position of the line and the equation? (answer: The line is on the x-axis. It has no steepness, or slope, and crosses the y-axis at the origin. For the equation there is no need to write y = 0x + 0.
y = 0 is sufficient.

Discuss with students the equations displayed in the applet. These equations are written in **slope-intercept form** where
y = mx + b. This designation should make sense to students as they have just analyzed both the slope and y-intercept.

Remind students about the equation/graph of a direct variation, y=kx. Ask them how this equation/graph reminds them of the equations/graphs they have seen using the applet. The following are points to make:

- All graphs of y=kx go through the origin. Only some of the graphs using the applet did. Graphs with a y-intercept of zero went through

origin. The other graphs went above or below the origin.

- The coefficient *k* in the direct variation equations and the *m* in the applet equations mean the same thing -- they determine the steepness of the line.
- y = kx is a special case of y = mx + b where b is equal to zero.
- Using an x-y table like the one below, examine the numerical differences of direct variation equations versus slope-intercept equations.

y = 3x

x	y
-1	-3
0	0
1	3

versus

y = 3x + 5

x	y
-1	2
0	5
1	8

In the graph of y = 3x, the point (0,0) indicates the graph goes through the origin. In the equation y = 3x +5, when "x" is zero, "y" is equal to 5, indicating that the graph crosses the y-axis *above* the origin at the point (0,5).

Each "y" value in the graph of y = 3x+ 5 is exactly five more than the corresponding "y" values in the equation y = 3x. This "five more" is the addition of "plus 5" to the equation y = 3x. The steepness of the graphs y = 3x + 5 and y = 3x are the same because the coefficients of the x-variables are the same (i.e. their slopes are the same).

Graph these lines. Ask students what they notice about the two lines. In both equations, the coefficients of the x-variable are the same. When these lines are graphed, they are **parallel**. They both have the same steepness, despite crossing the y-axis in different places.

Ask students to graph the equations below. Compare the x-y tables and graphs of equations such as:

y = x versus y = x + 10

y = 3/4x versus y = 3/4x + 3

y = -5x versus y = -5x + 1/2

*Note the use of fractional coefficients instead of decimal. Tell students that in the future they will use the fractional version of slope to help them graph lines.

Extension:

Try the applet that is linked to this one (as noted on the applet page in the bottom, right-hand corner). It address the point-slope form of a line. http://www.geogebra.org/en/upload/files/english/Athena_Matherly/Point_Slope_Form/point_slope_form_WS.html

From the point-slope applet, another applet is linked. This one addresses standard form of a line.

http://www.geogebra.org/en/upload/files/english/Athena_Matherly/Standard_Form/standard_form_WS.html

***Additional applets can be found by following the links on any applet page.**

Resources:

http://www.geogebra.org/en/upload/files/english/Athena_Matherly/Slope_Intercept_Form/slope_intercept_form.html

Applet to complete task -- affects of slope and y-intercept on a line

Three online graphing utilities from which to choose --

1.
http://www.geogebra.org
select "Download" and then select "applet start"

2.
http://www.shodor.org/interactivate/activities/Graphit/

3.
http://nces.ed.gov/nceskids/createagraph/default.aspx?ID=866715662b5b40f0aa60903fa64f9557