Activity Name: Absolutely Understanding Absolute Value Functions

Objective:

Students will demonstrate the ability to explore the properties of an absolute value function and a linear function. Students will graph an absolute value function as well as a linear function and determine some similarities and differences between their graphs and equations.

Getting Started:

Within any introduction to functions, linear functions are often represented by patterns. Students identify the next three numbers in a sequence and if there is a constant rate of change, the next step is being able to create an equation that models that situation. It is extremely important for students to see the relationship between a series of data points, an equation, and its graph. That's why creating a solid understanding of linear functions is extremely important to any further discussion of functions.

When absolute value functions are introduced, some students find difficulty with it not only in the shape of its graph, but also in the series of coordinate points created from that function. Perhaps the confusion comes from an understanding of exactly what absolute value is as opposed to just "taking away the negative sign". This activity, which uses Casio's fx-9860, is designed to help increase the student's understanding of absolute value and linear functions and how they interact with each other.

Important: It is important for students to know how to create a series of coordinate points before simply inputting the function into the graphing calculator. By doing this, it will increase understanding and comprehension of the material.

Activity:

In this activity, we will explore the similarities and differences between a linear function and an absolute value function. Using a sheet of graph paper, plot the points for the function $y = 2x$. Once you have created a set of ordered pairs and correctly placed them on the coordinate plane, connect the points to form a straight line. Use the fx-9860 to check work and validate the correct placement of points. You can also use the table application to check your points as well.

Next, plot the points for the function, $y = \text{abs}(2x)$. Once you have generated these ordered pairs and plotted them on the coordinate plane, examine the graphs and begin to make some mental observations about these two functions.

Remember that both of these equations represent functions because they pass the vertical line test. However, they are two different types of functions. The first function is a linear function and the second function is an absolute value function. What characteristics of these functions are similar and what are different?

Calculator Notes:

- Turn on the fx-9860.
- Press "MENU".
- Press "5" for Graph.
- Make sure that there are no graphs contained within the Graph Editor window so you can get a clear, visual representation of your graphs.

- In Y1, enter 2x. (You are entering the function y = 2x.)
- In Y2, enter abs (2x). (You are entering the function y = abs (2x).)
- Note: To enter an absolute value command, press “OPTN”, followed by F5 for “NUM”, and finally, F1 for “Abs”.
- Change the font for the graph of Y2. To do this, press F4 for Style and select any font that is different than the default in F1.
- Set the View Window to a Standard View Window by pressing “F3” within the View Window application.
- Press “EXIT” to return to the Graph Editor Window
- Press “F6” to Draw the graphs.

Sample Problems:

1. Based on the graphs, is there a point of intersection between the graphs of y = 2x and y = abs (2x)? If there is, state the point of intersection(s). If not, state why there is no point of intersection.
2. Use the fx-9860 to graph the following functions:
   - Y = abs x + 2
   - Y = abs (x + 2)

   What does the use of parentheses do to the function? How is this important to the understanding of the absolute value function?
3. Use the fx-9860 to graph the following functions:
   - Y = abs x – 2
   - Y = abs (x – 2)

   What does the use of parentheses do to the function? How is this important to the understanding of the absolute value function?
4. Use the fx-9860 to graph the following functions:
   - Y = abs x
   - Y = abs –x

   How does the use of the negative sign in front of the x-variable affect the graph of the function?
5. Use the fx-9860 to graph the following functions:
   - Y = abs x
   - Y = abs 2x
   - Y = abs 4x

   How does increasing the x-coefficient affect the graph of the absolute value function?
6. Use the fx-9860 to graph the following functions:
   - Y = 2x
   - Y = abs (2x)

   Use the G-Solve application (F5) to find the intersection of the two functions. What is the intersection of these two functions?
7. Refer to question 6. Change the linear function to be Y = 2x – 3. Graph that function along with the function Y = abs (2x). Now, determine the point(s) of intersection.

8. Refer to question 6. Change the absolute value function to be Y = abs (2x) – 3. Graph that function along with the linear function, Y = 2X. Now, determine the points of intersection.

Answers:

1. Yes, the origin (0,0) is the point of intersection of the two functions.
2. Comparing the graphs of the functions: y = abs x + 2 and y = abs (x + 2), we can see that the vertex of the first function is moved two units up on the y-axis while the vertex of the second function is moved two units to the left of the origin. The parentheses group the expression (x + 2) as opposed to taking the absolute value of x and then moving it up two units.
3. Comparing the graphs of the functions: y = abs x - 2 and y = abs (x - 2), we can see that the vertex of the first function is moved two units down on the y-axis while the vertex of the second function is moved two units to the right of the origin. The parentheses group the expression (x - 2) as opposed to taking the absolute value of x and then moving it down two units.
4. These two functions are graphed identically. This is because the second function is taking the absolute value of the opposite of x. However, you should note that if the function were to read y = - abs x, then the graph would be the exact opposite, thus appearing in the third and fourth quadrants as if it were reflected at the origin.
5. By increasing the coefficient of the x-variable within these functions, the graph gets narrower as if it were closing in on the y-axis.
6. There are many points of intersection between these two graphs because the graphs are identical in the first quadrant. By using the G-Solve function and finding the points of intersection, you can continually tap the right arrow on the Replay pad to see the many points of intersection.
7. There are no points of intersection between these two functions.
8. There are many points of intersection between these two functions as these graphs are identical from the vertex of the first function at (0, -2) and increasing from that point through the first quadrant.

Extension:

Use the Casio fx-9860 to create the following absolute value functions:

- An absolute value function where its vertex is located on the y-axis above the origin.
- An absolute value function where its vertex is located on the y-axis below the origin.
- An absolute value function where its vertex is located on the x-axis to the left of the origin.
- An absolute value function where its vertex is located on the x-axis to the right of the origin.
- An absolute value function where its vertex is located in the first quadrant.
- An absolute value function where its vertex is located in the second quadrant.

- An absolute value function where its vertex is located in the third quadrant.
- An absolute value function where its vertex is located in the fourth quadrant.

Extension Answers:

Answer to the Extension problems may vary but one possible solution is included in parentheses after the problem.

- An absolute value function where its vertex is located on the y-axis above the origin. (Y = abs x + 2)
- An absolute value function where its vertex is located on the y-axis below the origin. (Y = abs x – 2)
- An absolute value function where its vertex is located on the x-axis to the left of the origin. (Y = abs (x + 2))
- An absolute value function where its vertex is located on the x-axis to the right of the origin. (Y = abs (x – 2))
- An absolute value function where its vertex is located in the first quadrant. (Y = abs (x – 2) + 3)
- An absolute value function where its vertex is located in the second quadrant. (Y = abs (x + 2) + 3)
- An absolute value function where its vertex is located in the third quadrant. (Y = abs (x + 2) – 3)
- An absolute value function where its vertex is located in the fourth quadrant. (Y = abs (x – 2) – 3)