Lesson Title: Reflections of Functions 2 **Date:_____**

Subject: Algebra I, Geometry, Algebra II or Pre-Calculus
Topic: Function Representation of Horizontal & Vertical Reflections on Coordinate Plane
Grade: Secondary **Designer:** Paul Gibbins

Stage 1 – Desired Results

Lesson Overview: In this lesson students will observe the relationship between the graph of a function and its corresponding function notation, f(-x) and –f(x), as effected by reflections over the x-axis or the y-axis. Emphasis will be on the horizontal and vertical changes to the graph, and whether the negation in function notation is inside or outside the function.

Standards Addressed:
CCSS 8.F.2: Define, evaluate, and compare functions
2) Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *Function notation is not required in 8th grade.

CCSS F-BF.3: Build new functions from existing functions
3) Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them*.

Enduring Understanding:
Graphs Reflected Over the Y-Axis:
- Horizontal change to the graph
- Represented as f(–x)

Graphs Reflected Over the X-Axis:
- Vertical change to the graph
- Represented as –f(x)

Essential Questions:
- What type of reflection results when graphing f(–x)?
  - What is the axis of symmetry?
- What type of reflection results when graphing –f(x)?
  - What is the axis of symmetry?

Students will need to:
- Understand function notation
- Understand the concept of lines of symmetry

Students will be able to:
- Identify reflections as negation either inside or outside of the function.
- Draw the reflections of a functions over the x-axis or the y-axis

Stage 2 – Assessment Evidence

Performance Tasks:
In this activity students will be asked to:
- Predict what will happen to a new graph based upon prior experience.
- Predict the changes to the coordinates of points when the graph is reflected over either the x or y-axis
- Create written reflections comparing their answers to the correct solution

Other Evidence:
- To be decided by the teacher.

<table>
<tr><th colspan="2">Stage 3 – Learning Plan</th></tr>
<tr><td>Lesson Procedure:
This lesson could be used as an introduction to the concept of reflections or for a lesson introducing the concept of reflections or a means of reinforcement of prior learning.

The student portion of the lesson will require approximately 20 minutes. Additional time will be needed for follow-up based upon the needs of the class as determined by the teacher.

The student responses on page 4 and page 6 would be artifacts that demonstrate their understanding of the main concepts as stated in the discussion questions below. Printing page 4 would have the advantage of including the graphs created by the students. These printed responses could be included in the student's math journal or used as evidence of learning for homework.</td><td>Required Materials:
Computer for each student.

(Optional) A printer to document student responses to open response questions, their prediction graphs, and/or concept overview pages.

(Optional) Math journal to record answers to some open response questions, such as page 4 and 6. Some teachers may consider this an appropriate place to keep a record of the students work in case they are needed for review, etc.</td></tr>
<tr><td>Possible Discussion Questions for Students:
1. How would you describe reflecting a graph over the x-axis?
2. How would you describe reflecting a graph over the y-axis?
3. A graph containing the points A(3, -2) & B(-1, -5) is reflected over the x-axis. What are the coordinates of corresponding points on the graph of the reflection?
4. A graph containing the points L(2, 3) & M(-4, -6) is reflected over the y-axis. What are the coordinates of the corresponding points on the graph of the reflection?</td><td>Sample Answers to Discussion Questions:
1. Reflecting over the x-axis is a horizontal change to the graph with the x-axis serving as a line of symmetry. The y-coordinates of the points reflected are the opposite while the x-coordinates are unchanged.
2. Reflecting over the y-axis is a vertical change to the graph with the y-axis serving as a line of symmetry. The x-coordinates of the points reflected are the opposite while the y-coordinates are unchanged.
3. A'(3, 2) & B'(-1, 5)
4. L'(-2, 3) & M'(4, -5)</td></tr>
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