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| **GRADE: 9** | | |
| **Unit Title: Interpreting Functions (F-IF)**  **Lesson Title: Justifying Functions and Slopes**  **Estimated Duration:4 to 6 hrs** | | **Real-World Purpose:**  **A large part of the world around us runs by mathematical rules. Functions are the heart of many mathematics courses, starting with the Algebra I course and moving forward. Functions are important because they are the mathematical building blocks for designing buildings *(architectural work and solar energy)* finding cures for diseases, forecasting world disasters, understanding global economics, and manufacturing consumer products, just to name a few.** |
| ***I Can***  **F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).**  **F-IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of context.**  **F-IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the**  **function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an**  **appropriate domain for the function.\***  **F-IF.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.**  **Estimate the rate of change from a graph.** | | |
| **Performance objectives (Evidence of Learning)**   1. **Given a set of ordered pairs, the student will be able to determine if a relation is a function with 90% accuracy.** 2. **Given graphs of relations, the student will be able to determine if a relation is a function by seeing how many times a vertical line touches a function. This will be done with 100% accuracy** 3. **Given a set of ordered pairs, the student will be able to determine the domain and range on a worksheet with a 100% accuracy.** 4. **Given a linear or quadratic equation, the students will be able to evaluate a function at a given point from a PowerPoint with 80% accuracy.** | | |
| **Prerequisite Skills:**   * **Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. (8.EE.5)** * **Solve linear equations in one variable. B. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. (8.EE.7b)** | | |
| **Materials/Resources:**  **Whiteboard**  **Expo markers**  **Promethean**  **Algebra tiles**  **Handouts**  **Worksheets**  **Math websites** | | **Key Vocabulary:**  **Function**  **Relation**  **Domain**  **Average rate of change**  **Vertical line test**  **Range**  **Output**  **Input**  **Function notation**  I |
| **Elements of Rigor:**   * **Conceptual understanding of key concepts** * **Procedural skill and fluency** * **Rigorous application of mathematics in real-world contexts** | | |
| **Lesson Introduction** | | |
| **How will you introduce the lesson?**  **Student Exploration Activity**  **Introduction: Today we will be learning about relations and functions. You can think of relations as a vending machine. I put in $.75 and out came a pack of gum. I will then pull the pack of gum out of the machine. If I put in $1.00, out comes a Hershey’s bar. I will then pull out the Hershey’s bar out of the machine. What I get depends on how much I put into the vending machine.**  **Relations and functions show how variables interact, are displayed, and applied in our world.**  **Which variable has to be the same in order for a set of ordered pairs to have no slope? (x value)**  **What number in the ordered pairs makes a function not be a relation? (x value)** | | |
| **Lesson Activities** | | |
| 1. **Activity #1: 8.F-1 and F-IF.1**  **Relation: a set of ordered pairs**  **Domain: the set of input values (*x*) in a relation; *x* is also called the independent variable**  **Range: The set of output values (*y*) in a relation; *y* is also called the dependent variable**  **Independent variable: the variable in a relation with a value that is subject to choice**  **Dependent variable: the variable in a relation with a value that depends on the value of the independent variable**  **2. Activity #2: F-IF.1**  **Determining Domain and Range of a Relation, Teacher Guided Instruction, and Student Pair and Share (30 minutes estimated)**  **Question: State the domain and range of the following relations. List them from least to greatest using set notation.**  **a. {(9, 3), (-1, 4), (0, 5), (-6, -3), (10, 12)}**  **b. {(7, 0), (2, -8), (-11, 3), (2, 8), (1, -6)}**  **c. {(0, 1), (-3, 6), (3, 5), (-13, 14), (7, 9)}**  **Solutions**  **a. Domain { -6, -1, 0, 9, 10 } Range { -3, 3, 4, 5, 12 }**  **b. Domain { -11, 1, 2, 5, 7 } Range { -8, -6, 0, 3, 8 }**  **c. Domain { -13, -3, 0, 3, 7 } Range { 1, 5, 6, 9, 14 }**  3. **Activity #3: F-IF.1**  **Determining if a Relation is a Function, Teacher Guided Instruction and Student Pair and Share** (50 minutes estimated)  **A function is a special type of relation in which each input has exactly one output. Functions can be represented by the following: ordered pairs, table of values, mapping diagrams, graphs (vertical line test), and function notation. Students will display these representations in a bubble map using the Bubble Map Template (Attachment #5).**  **Ordered Pairs**  **A given relation is a function if each input (x value) is paired with exactly one output (y value). The x values should not repeat.**  **Question: Is either relation below a function? Explain why or why not. If the relations is a function, state the domain and range.**  **A. {(2, 4), (-5, 7), (3, 6), (-5, 3), (0, -2)} B. {(6, -1), (-3, 5), (2, 4), (9, 0), (-7, 1)}**  **Solutions:**  **A. {(2, 4), (-5, 7), (3, 6), (-5, 3), (0, -2)} is not a function because the input -5 has two output values.**  **B. {(6, -1), (-3, 5), (2, 4), (9, 0), (-7, 1)} is a function because each input has exactly one output.**  **Domain {-7, -3, 2, 6, 9} Range {-1, 0, 1, 4, 5}**  **Table of Values**  **A given table of values is a function if each input (x value) is paired with exactly one output (y value). The x values should not repeat.**  **Question: Which input-output table below represents a function? Explain why or why not. If the relations is a function, state the domain and range.**    **Solutions:**  **Table A is not a function because the input value 0 has two output values.**  **Table B is a function because each input value has exactly one output value.**  **Domain {-2, 1, 6, 7, 15} Range {-3, 0, 2, 8}** | | |
| **Lesson Closure** | | |
| **Review the vocabulary words essential to the unit: relation, function, equation, input, output, *x* values, *y* values, domain, range, independent, dependent, *f(x)*, restriction, and slope.**  **3. Review the use of function notation such as *f(5)* and *f(x) + g(x).*** | | **Essential Questions:**  **What are the different ways to determine if a relation is a function?**  • **What makes a function different and/or better than a relation?**  **• When do domains have to be restricted for functions?**  **• How do you restrict domains?**  **• What is the domain for linear functions and why?**  **• What does it mean for a function to have a restriction?**  **• How do you find the slope of a function and what does the slope mean in context of a real world situation?** |
| **Standards for Mathematical Practice**(select all that apply) | | |
| * Make sense of problems and persevere in solving them. * Reason abstractly and quantitatively. * Construct viable arguments and critique the reasoning of others. * Model with mathematics. * Use appropriate tools strategically. * Attend to precision. * Look for and make use of structure. * Look for and express regularity in repeated reasoning. | | |
| **Supplemental Activities** | | |
| **Intervention**  **8.EE.6: Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.**  **Use x-y coordinate geoboards to graph the functions below. The large bands can be used to represent the function and the small bands can be used to make similar triangles. This exercise will reinforce slope between two points, the slope formula, similar triangles, the y-intercept, and creating function/equations from a graph. If x-y coordinate geoboards are not available, this activity can use mini-white boards with x-y coordinate planes. Students would draw the similar triangles with Expo markers.**  **f(x) = 2x – 5 f(x) = -x + 1**  **• 8.EE.7b: Solve linear equations in one variable.**  **b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.**  **Use algebra tiles to reinforce expanding expressions using the distributive property. Students may not see that right.** | | **Enrichment**  • **F-IF.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.\*** |
| **Performance Based Assessment Task** | | |
| **Math Task**  **Create and graph a linear function with a real-world context starting from a set of ordered pairs.**  **a. Write a relation containing six ordered pairs and prove that the**  **relation is a function.**  **b. Graph the ordered pairs and write the linear function.**  **c. Create a real-world situation for the linear function.**  **d. Graph the linear function in context, restricting the domain and**  **labeling the axes.**  **e. Evaluate a function using a number for a given variable** | **Rubric/ Plausible Student Response(s)**  **a. Write a relation containing six ordered pairs and prove that the**  **relation is a function.**  **Relation of six ordered pairs written in set notation 10 pts**  **Justification that relation is function 10 pts**  **b. Graph the ordered pairs and write the linear function.**  **Graph of six ordered pairs with axes labeled 10 pts**  **Use of graph to find slope and y-intercept 10 pts**  **Linear equation written in function notation 10 pts**  **c. Create a real-world situation for the linear function.**  **Real-world situation explained with details and reasoning 20 pts**  **d. Graph the linear function in context, restricting the domain and**  **labeling the axes.**  **Graph of linear function in context with axes labeled 20 pts**  **e. Evaluating a function for a given variable. 10 pts**  **Total 100 pts** | |