New York State Next Generation Mathematics Learning Standards Unpacking Document (DRAFT)

GRADE: 8	DOMAIN: Functions

CLUSTER: Define, evaluate and compare functions.

Students learn the concept of a function, with a function being defined as an assignment of each input, to exactly one output. Students learn that the assignment of some functions can be described by a mathematical rule or formula. Students will see that functions may be represented algebraically, graphically, numerically in tables, or using verbal descriptions. Students will apply their prior knowledge of linear equations and their graphs to the graphs of linear functions. Students inspect the rate of change of linear functions and conclude that the rate of change is the slope of the graph of a line. They learn to interpret the equation $y = mx + b$ as defining a linear function whose graph is a line. Students also gain some experience with non-linear functions, specifically by compiling and graphing a set of ordered pairs and then by identifying the graph as something other than a straight line. Students understand that non-linear functions do not have a constant rate of change. Once students understand the graph of a function, they begin comparing two functions represented in different ways.

Grade Level Standard:

NY-8. F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line. Recognize examples of functions that are linear and non-linear.

Note: Function notation is not required in grade 8.

PERFORMANCE/KNOWLEDGE TARGETS
(measurable and observable)

- Describe the proportionality that exists within linear functions.
- Identify linear functions as having graphs that are straight lines.
- Identify a linear function as y=mx + b.
- Identify linear functions in tables.
- Graph a linear function.
- Identify functions that are not linear from equations tables, and graphs.
- Utilizing a table of values, graph a non-linear function.
- Compare/contrast linear vs. non-linear functions represented as equations, tables, and graphs.

ASPECTS OF RIGOR

Procedural Conceptual Application

MATHEMATICAL PRACTICES	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
FOUNDATIONAL UNDERSTANDING	**NY-6.EE.2c** Evaluate expressions given specific values for their variables. Include expressions that arise from formulas in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order (Order of Operations). **NY-7.EE.4a** Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. **NY-8.EE.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. **NY-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 = *m*x for a line through the origin and the equation y = *m*x + *b* for a line intercepting the vertical axis at *b*.

The following pages contain EXAMPLES to support current instruction of the content standard and may be used at the discretion of the teacher and adapted to best serve the needs of the learners in the classroom.

Students are investigating which real-world contexts may or may not be modeled as a linear function by revisiting constant rate as it applies to the concept of linear functions and proportionality.

Example 1:
Describe why each situation could be "Linear" or "Non-linear":

- Student height over five years
- Amount of water drank each hour of the day
- Energy used by fan running all night long
- Snowfall on a county over a month

Example 2:
The costs to purchase school spirit posters are as follows: two posters for $5, four posters for $9, six posters for $13, eight posters for $17, and so on. Is this scenario best described as linear or non-linear? Defend your answer.

Example 3:
Which phrase describes a non-linear function?

A. The area of a circle as a function of the radius
B. The perimeter of a square as a function of the side length
C. The cost of gasoline as a function of the number of gallons purchased
D. The distance traveled by a car moving at constant speed as a function of time

Example 4:
Which set of ordered pairs (x,y) could represent a linear function of x?

A. {(-2,8), (0,4), (2,3), (4,2)}
B. {(1,2), (1,3), (1,4) (1,5)}
C. {(-2,7), (0,12), (2,17), (4,22)}
D. {(3,5), (4,7), (3,9), (5,11)}

Example 5:
A function is said to be linear if the rule defining the function can be described by a linear equation.
Functions 1, 2, and 3 have table-values as shown. Which of these functions appear to be linear? Justify your answers.

Input	Output
2	5
4	7
5	8
8	11

Input	Output
2	4
3	9
4	16
5	25

Input	Output
0	-3
1	1
2	6
3	9

Students need to connect the rate of change of a linear function to the graph of the linear function. When graphing a straight line, the rate of change is the same between all points along the line and is said to be constant. Students conclude that the rate of change is the slope of the graph, solidifying that $y=mx+b$ defines a linear function whose graph is a straight line. In non-linear cases, the rate of change will not be a constant and will change based upon the location of the two points being used.

The following pages contain EXAMPLES to support current instruction of the content standard and may be used at the discretion of the teacher and adapted to best serve the needs of the learners in the classroom.

Example 6:

Decide which of the following points are on the graph of the function y=2x+1: (0,1), (2,5), $(\frac{1}{2},2)$, (2, −1), (−1, −1), (0.5,1)

Find 3 more points on the graph of the function. Graph the function.

Find several points that are on the graph of the function $y=2x^2+1$.
Plot the points in the coordinate plane. Is this a linear function?
Support your conclusion.

Examining the graphs of both functions, list as many differences between the two functions as you can. Are there similarities?

Example 7:

The following is taken from EngageNY Grade 8 Module 5, lesson 8 with edits.

In the following exercises, an equation describing a rule for a function is given, and a question is asked about it. If necessary, use a table or a coordinate plane to help answer the question.

a. What shape do you expect the graph of the function described by y= 3x to take? Is it a linear or non-linear function?
b. Does the function $y = 2x^2 - x$ have a constant rate of change? Is it a linear or non-linear function?
c. Is 2x + 4y = 8 a linear or non-linear function? Justify your answer.
d. Is the function $y=2^x$ a linear or non-linear function? Justify your answer.

Consider the function that assigns to each number x the value x^3.
a. Do you think the function is linear or non-linear? Explain.
b. Develop a list of inputs and outputs for this function.
Organize your work using the table.

Input (x)	Output (x^3)
-2.5	
-2	
-1.5	
-1	
-0.5	
0	
0.5	
1	
1.5	
2	
2.5	

c. Plot the inputs and outputs as order pairs defining points on the coordinate plane.
d. What shape does the graph of the points appear to take?
e. Find the rate of change using rows 2 and 3 from the table above.
f. Find the rate of change using rows 3 and 4 from the table above.
g. Find the rate of change using rows 8 and 9 from the table above.
h. Return to your claim about the function. Is it linear or non-linear? Justify your answer with as many pieces of evidence as possible.

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Example 8:

Write an equation of a linear function________________

Write an equation of a non-linear function______________

Compare your two equations. Explain how you know the first equation is linear and the second is non-linear.

Explanations can include, but are not limited to: using coordinates, tables, graphs, rates of change, exponents.

Work with this standard connects to the following other grade-level standards:

NY.8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways

NY.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 the equation and $y = mx + b$ for a line intercepting the vertical axis at b.

NY.8. F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

NY.8. F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).