Introduction to Functions

9th Grade Algebra Unit

by Rachel McGuire

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Context Analysis

Community Factors

Milan High School is located in Milan, Michigan and part of the Milan Area Schools district. The building houses ninth through twelfth grade students. Milan is a small community with a population of about 14,253 people and is located about 15 miles south of the Ypsilanti/Ann Arbor area. Most of the area consists of farms and many students work on their parents land. Only 14.6% of adult men over 25 and 18.5% of women went on to college after high school. Of those percentages, only about half of them graduated with a bachelor's degree. The median household income is about $82,000 and the average family size is 3. A majority of students come from two parent households and 92% of the student body (out of about 600 students) is Caucasian.

Classroom Factors

In my classroom we have 36 individual student desks. Most of the classes are relatively full, with only 1 or 2 desks left empty. In my class I like to promote cooperative learning. Most days the desks are arranged into groups of 4 in order to do so. Unfortunately we have very limited technology available to us. We are limited to a classroom set of TI-84 calculators. Every day in class the agenda is written on a side whiteboard and materials for the day are on the front board typically accompanied by a "do-now" startup problem. The students know to come in, pick up any handouts, a calculator, and their binder that they are allowed to keep in the classroom.

Student Characteristics

A majority of my algebra classes are freshman students. Many of them are still getting used to high school and can tend to be lacking in maturity levels. This being the case, I have to keep the class as structured as possible and I can't put too much responsibility on the students. I also have a high number of students on IEP plans and another portion of students are retaking the class. For many students, algebra is a new concept and students do not have very much prior knowledge relevant to the class material. A lot of these characteristics will play a significant role when it comes to planning my unit.

Implications for Instruction

Due to the high level of IEPs and students retaking algebra, my unit will need to move at a slower pace. Most of this material is brand new and I will have to demonstrate a lot of the concepts. Unfortunately this will limit the opportunities for inductive and cooperative lessons. Also due to the characteristics of the class, I believe cooperative group work may be difficult for some students. Many students tend to have issues focusing and staying on task when they are permitted to work in a group. I will need to make sure I give very clear directions and explain what my expectations are for the class periods when we are working in groups.

Rationale

Students:

Have you ever wondered how much it would cost you for every minute you talk on the phone? How about how long it will take to fill up that pool you've been thinking about all summer? In this unit we will discover how we can model real life problems with linear relationships. We will also learn how to graph these functions in order to visualize the relationship. Several of the problems we encounter on a daily basis can be modeled using a linear function and we don't even realize we are doing it.

Teachers:

This unit covers all of the material pertaining to the introduction of linear functions including domain and range, function notation, graphing, and transformations. The unit directly reflects several of the High School Functions Common Core State Standards and aligns with the school district's benchmarks. The material is presented in a variety of ways including group work, hands-on activities, and individual work to monitor personal progress and to prepare students for the summative assessment.

Content Analysis

Common Core State Standards

HSF-IF.A.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)*.

HSF-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

HSF-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.

HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

HSF-IF-LE.A.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

HSF-IF-LE.A.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

HSF-BF.1a Write a function that describes a relationship between two quantities.

HSF-BF.B.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.

Generalizations

- We can model real world situations with linear functions.
  Focus Question: Can you think of any problems that have a linear relationship?

- A linear function has two variables and has a constant rate of change.
  Focus Question: How can I determine if two objects will have a linear relationship?

- Function Notation can be used as another way to write a function to easily represent the input and output.

Focus Question: How can I represent an application problem using function notation?

- Graphs help to visualize information and allows us to easily read facts from the graph
  Focus Question: In what type of problems will it help me to visualize the information?

Concepts

- Functions
- Domain and Range
- Linear functions
- Standard form of equations
- Slope-Intercept form
- Graphing
- Slope
- Linear transformations
- Application

Facts

- Ordered pairs, graphs, mapping diagrams, and tables are representations of functions.
- The domain is a list of the inputs of a function and the range is a list of the outputs.
- A linear function has a constant rate of change.
- A linear function has two variables.
- The standard form of a linear equation is Ax + By = C.
- The y-intercept of a function is where it crosses the y-axis on a graph and when x = 0.
- The x-intercept of a function is where it crosses the x-axis and when y = 0.
- The slope-intercept form of a linear equation is y = mx + b.
- In the slope-intercept form, m represents the slope and b is the y-intercept.
- The slope of a line is rise over run and represents the rate of change.
- The linear equation y = x (or $f(x) = x$) is the parent function for all linear equations.
- A series of transformations can be performed on y = x to obtain every other linear function.
- Many real world problems can be modeled by linear functions.

Content Outline

I. **Relations**
   a. Pairs inputs with outputs
      i. A function pairs an input with only one output
         1. Vertical line test
      ii. The domain is the set of the input values
      iii. The range is the set of the output values
   b. Can be represented multiple ways
      i. Ordered Pairs
      ii. Input/Output Tables
      iii. Coordinate Planes (Graphs)
      iv. Mapping Diagrams

II. **Linear Functions**
   a. Two variables and a constant rate of change
      i. X and Y
      ii. Slope
   b. Tables
      i. Follow an addition or subtraction pattern
   c. Graphs
      i. Graph is a straight line
   d. Equations
      i. Can be written in the form y = mx + b.

III. **Function Notation**
   a. Another way to name an equation
      i. Replaces *y* with *f*(x) in an equation
      ii. Can use any letter, most commonly f.
   b. Can easily visualize the input and output
      i. Example: *f*(2) = 1
         1. 2 represents the input, 1 is the output

IV. **Graphing**
   a. Standard Form – Ax + By = C
      i. Find the x-intercept by plugging 0 in for y. (x, 0)
      ii. Find the y-intercept by plugging 0 in for x. (0, y)
      iii. Graph both intercepts on the same coordinate plane
      iv. Connect the points with a line
   b. Slope-Intercept Form – y = mx + b
      i. M is the slope typically represented as a fraction (rise / run)
         1. Rise – how many units to go up or down
         2. Run – how many units to go left or right
      ii. B is the y-intercept
         1. A point on the y-axis
      iii. Graph the y-intercept (0, b)
      iv. "Do" the slope starting at the y-intercept in both directions

        1. If positive, go up and right, and go down and left

        2. If negative, go up and left, and go down and right

     v. Connect the three points with a line

V.   **Transformations**

    a. The parent function of all linear functions is $f(x) = x$ or $y = x$

    b. Perform transformations on the parent function to obtain new lines

       i. Translations

          1. Move up or down: $g(x) = f(x) + k$

          2. Move left or right: $g(x) = f(x+k)$

      ii. Shrinks and Stretches

          1. A shrink makes the slope of a line smaller or shallower.

            a. $g(x) = f(ax)$

            b. $0 < a < 1$

          2. A stretch makes the slope larger or steeper

            a. $g(x) = f(ax)$

            b. $a > 1$

     iii. Reflections

          1. Flips the graph over an axis

            a. Y-axis: $g(x) = f(-x)$

            b. X-axis: $g(x) = -f(x)$

VI.   **Applications**

    a. Model real-world problems with linear functions.

    b. Interpret what a linear equation in a contextual problem means.

Concept Map

INTRODUCTION TO FUNCTIONS

Relations: pairs inputs with outputs

Domain: set of the inputs

Range: set of the outputs

Functions

Pairs one input with exactly one output

Graph passes a vertical line test

Ordered Pairs

Input / Output Tables

Coordinate Plane (Graph)

Mapping Diagrams

Represented in multiple ways

Applications

Model real-world problems with linear functions

Interpret contextual problems

Transformations

Parent Function: y = x or f(x) = x

Translations: up or down g(x) = f(x) + k left or right g(x) = f(x + k)

Shrink or Stretch: changes slope to steeper or shallower g(x) = f(ax) shrink: 0 < a < 1 Stretch: a > 1

Reflection: flips over an axis y-axis: g(x) = f(-x) x-axis: g(x) = - f(x)

Linear Functions

typically represented with x and y

Have two variables and a constant rate of change

rate of change is the slope (rise over run)

Tables: follow an addition/subtract pattern

Graphs: form a straight line

Equations: can be written in the form y = mx + b

Graphing

Standard Form Ax + By = C

Find x-intercept: Plug in 0 for y (x, 0)

Find y-intercept: Plug in 0 for x (0, y)

1. Plot both points on coordinate plane
2. Connect points with line

Slope-Intercept Form y = mx + b

m is the slope Rise / Run Rise: up or down Run: right or left

b is the y-intercept (0, y)

Positive: up and right OR down and left

Negative: down and right OR up and left

graph this point

"Do" the slope in both directions

Connect the three points

Function Notation

Another way to name a function.

Allows us to easily see the input and output

Replaces y with f(x) or any letter

Example: f(2) = 1 2 is the input 1 is the output

Common Core State Standards	Unit Outcomes: (SWBAT)
*HSF-IF.A.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).*	• Identify a function as a relation that pairs one input to exactly one output • List the set of the domain and range for a function represented multiple ways
HSF-IF-LE.A.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.	• Identify a function as linear based on the rate of change • Create a table of values that represents a linear function and a nonlinear function
HSF-IF.A.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)*	• Find the output, y, when given the input, x, and vice versa when given a graph or a set of ordered pairs
*HSF-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	• Write equations using function notation. • Evaluate functions for the input or output when given the equation of the function • Interpret the meaning of an input or output relevant to the context of a problem

Common Core State Standards	Unit Outcomes: (SWBAT)
***HSF-IF.C.7a** Graph linear and quadratic functions and show intercepts, maxima, and minima.	• Graph a line when given the x- and y- intercepts • Graph the standard form (Ax + By = C) of a linear equation using the x- and y- intercepts
HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	• Graph linear equations in standard form (Ax + By = C) on a coordinate plane
HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	• Write the equation of a line when given the graph using the y-intercept and slope • Graph a line when given the slope and y-intercept
HSF-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.	• Graph a linear equation in slope-intercept form (y = mx + b) • Identify the slope and y-intercept of a line when given the equation y = mx + b
HSF-IF-LE.A.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).	• Write the linear equation of a line in the slope-intercept form when given a graph of the line
HSF-BF.1a Write a function that describes a relationship between two quantities.	• Write the equation of a line in standard form when given the x- and y- intercepts

Common Core State Standards	**Unit Outcomes: (SWBAT)**
HSF-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.	• Graph lines when given the equation in function notation or given a table of values • Identify the slope and y-intercept from the graph of the line
HSF-BF.B.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.	• Identify transformations on f(x) as either a translation, shrink, stretch, or reflection • Identify a vertical translation as f(x) + k • Identify a shrink as f(kx) when 0 < k < 1 • Identify a stretch as f(kx) when 0 < k • Identify a reflection over the y-axis as f(-x) • Interpret the transformations from one equation to another and graph the functions on the same coordinate plane

Algebra 1 Pre-test　　　　　Answers in Red　　　　　NAME_____KEY_____

Unit 3: Introduction to Functions　　　　　　　　　　　　　　　　Block_____

1. Determine if each relation is a function:

a) {(–5, 3), (–2, 1), (1, –1), (4, –3)}　　　b)
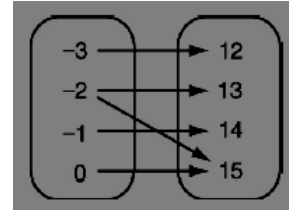
Yes　　　　　　　　　　　　　　　　No

c)
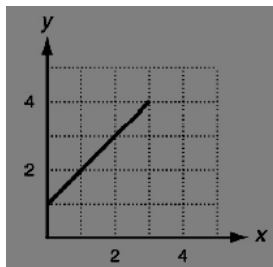
Yes

d)

x	y
–2	5
–1	1
3	1
–1	–2

No

2. For each relation/function shown in number 1, state the domain and range:

a)　　D:___{-5, -2, 1, 4}____　　　b)　　D:___{-3, -2, -1, 0}_____
　　　R:___{-3, -1, 1, 3}____　　　　　R:___{12, 13, 14, 15 }__

c)　　D:___{0 ≤ x ≤ 3}____　　　d)　　D:___{-2, -1, 3}_____
　　　R:___{1 ≤ y ≤ 4}____　　　　　R:____{-2, 1, 5}_____

3. Determine if the given function is linear or non-linear

a)

x	–3	–2	–1	0
y	–9	–6	–3	0

Yes

c) $y = -3x + 2$

Yes

b)

x	–2	–1	0	1
y	4	1	0	1

No

d) $y = x^2 + 7$

No

4   a) Rewrite using function notation as a function f of x the linear equation $y = 2x - 1$

                    f(x) = 2x - 1

        b) For $g(x) = 10 - 3x$ find $g(2)$

                    g(2) = 10 – 3(2) = 4

        c) The function f is graphed below. Find x so that $f(x) = 2$
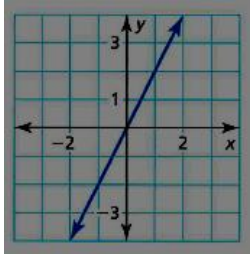
                                        x = 1

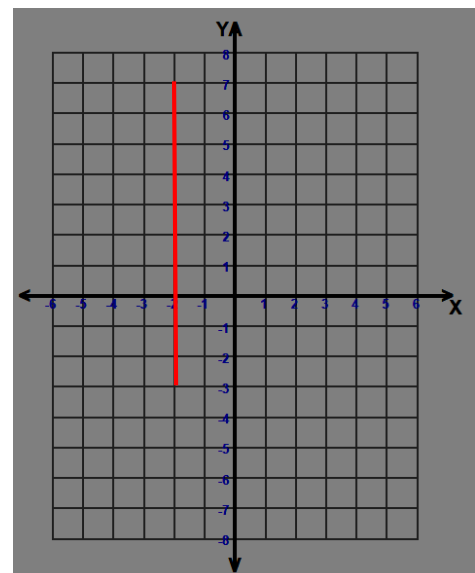   d) g = { (2,1) (5, 8) (7, 15) },   find $g(5)$

            g(5) = 8

5.   a) For $3x + 4y = 12$, find the x and y intercepts:

                    x _____4_____   y _____3_____

        b) graph the function in part a)   c) graph $x = -3$

6. a)
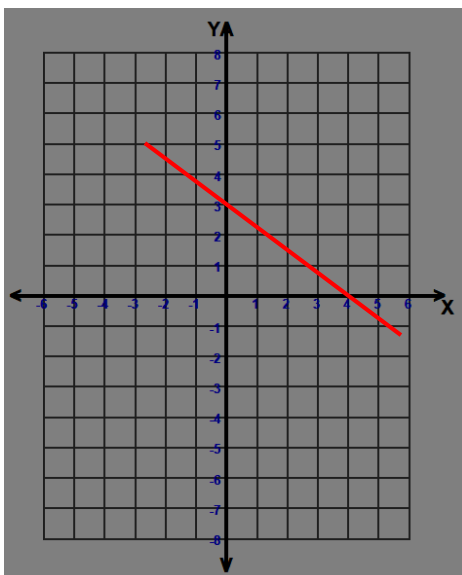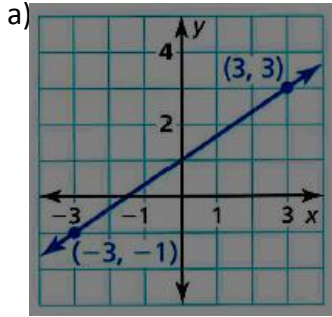
slope_____2/3_____

y-intercept ___1____

b) $y = \frac{1}{2}x - 3$

slope_____1/2_____

y-intercept ___-3____

c) graph

$$y = \frac{1}{2}x - 3$$
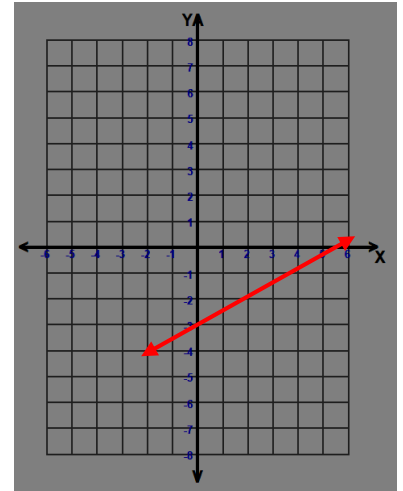
7. $f(x) = 3x + 1$ $g(x) = f(x) - 2$ $h(x) = f(2x)$

a) describe the transformation from f to g

shifts down 2 units

b) describe the transformation from f to h
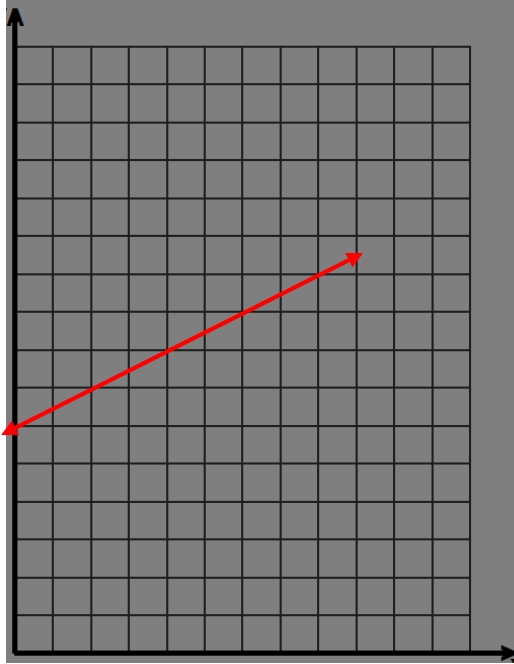
stretch by a factor of 2

c) describe the transformation of the parent function $p(x) = x$ to f

shifts up 1 unit
stretch by a factor of 3

8. The function $d(t) = \frac{1}{2}t + 6$ models the depth d (in inches) of snow on the ground during the first 9 hours of a snowstorm, where t is the time (in hours) after the snowstorm begins.

a) graph the function and identify its domain and range

D: $\{0 \leq x \leq 9\}$
R: $(6 \leq y \leq 10.5\}$

b) interpret the *slope* and the *d-intercept*

slope: 1/2 1 inch of snow accumulates on the ground every 2 hours
d-intercept: 6 when the snowstorm starts there is 6 inches of snow on the ground

Pre Assessment

Students were given a pre-test that was modeled after the test to measure how much the students knew about the topics of the unit before we began. I focused on three main objectives from the test and rated the students with a 1, 2, or 3 on these sections. 1 = none or very little understanding, 2 = limited understanding, and 3 = substantial understanding. After the pre-test, students will be given a 'plotting points' practice worksheet to demonstrate their prior knowledge of graphing ordered pairs. There is limited prior knowledge needed for this unit, so this instrument will be used to determine if they have those necessary skills.

Objective 1	**Objective 2**	**Objective 3**
(Test Questions 1 & 2)	(Test Questions 4 & 8)	(Test Questions 5 & 6)
0-3 examples = 1	0-2 examples = 1	0-2 examples = 1
4-6 examples = 2	3-4 examples = 2	3-4 examples = 2
7-8 examples = 3	5-6 examples = 3	5-6 examples = 3

Objective 1

> **HSF-IF.A.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 = $f(x)$.

Objective 2

> **HSF-IF.A.2** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Objective 3

> **HSF-IF.C.7a** Graph linear and quadratic functions and show intercepts, maxima, and minima.

Student Summary of Pre-Assessment Information			
Student Number	Objective 1	Objective 2	Objective 3
1	1	1	1
2	1	1	1
3	1	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	2	1	1
9	1	1	1
10	1	1	1
11	1	1	1
12	2	1	1
13	1	1	1
14	2	1	1
15	1	1	1
16	2	1	2
17	2	1	2
18	2	1	1
19	2	1	1
20	1	1	1
21	1	1	1
22	1	1	1
23	1	1	1
24	1	1	1
25	2	1	1
26	1	1	1
27	2	1	1
28	1	1	1

29	1	1	1
30	2	1	1
31	2	1	1
32	2	1	1
33	2	1	1
34	2	1	1
35	2	1	1
36	1	1	1
37	2	1	1
38	1	1	1
39	2	1	1
40	1	1	1
41	1	1	1
42	2	1	2
43	1	1	1
44	1	1	1
45	1	1	1
46	1	1	1
47	1	1	1
48	1	1	1
49	2	1	1
50	2	1	2
51	1	1	1
52	2	1	1
53	2	1	1
54	1	1	1
55	2	1	1
56	2	1	1
57	2	1	2

Pre-Assessment Planning for Instruction

Objective/Outcome	Pre-Assessment Strategy	Summary of Results	Implications for Instruction
HSF-IF.A.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).*	Students were given a pencil and paper pre-test of the entire unit. This outcome was measured by questions 1 and 2. Question 1 had four relations and students were ask to identify if they were a function or not. Question 2 had four relations and students were asked to list the domain and range of each. Students receive a 1 rating for 0-3 correct answers, a 2 for 4-6 correct answers, and a 3 for 7-8 correct.	On the pre-test, 32 students were able to correctly answer 0-3 questions and 25 students were able to answer 4-6 questions.	A little over half of the students do not understand the topic, and the others have some knowledge. The activities I design will have a varying level of difficult to accommodate all students.

Objective/Outcome	Pre-Assessment Strategy	Summary of Results	Implications for Instruction
HSF-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	Students were given a pencil and paper pre-test of the entire unit. This outcome was measured by questions 4 and 8. Question 4 had four questions involving function notation. Question 8 had two parts for students to answer and interpret meanings. Students receive a 1 rating for 0-2 correct answers, a 2 for 3-4 correct answers, and a 3 for 5-6 correct.	On the pre-test, all 57 students were only able to score a rating of 1, indicating at most 2 right answers out of 6.	This concept is new for the entire class and I will need to spend an ample amount of class time teaching this topic. I will most likely need a variety of activities and practice.

Objective/Outcome	Pre-Assessment Strategy	Summary of Results	Implications for Instruction
HSF-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.	Students were given a pencil and paper pre-test of the entire unit. This outcome was measured by questions 5 and 6. Both of these questions were related to graphing either standard form or slope-intercept form of linear equations. Students receive a 1 rating for 0-2 correct answers, a 2 for 3-4 correct answers, and a 3 for 5-6 correct.	On the pre-test, 52 students received a rating of 1 and 5 students received a rating of 2.	This concept is new for almost the entire class. The few students who scored a 2 may have had a little more prior knowledge. We will spend a lot of class time on graphing equations until a majority of the class understands the topic.

Pre-Assessment Data Summary

Number of Students who received each rating for each objective			
Rating	Objective 1	Objective 2	Objective 3
1	32	57	52
2	25	0	5
3	0	0	0
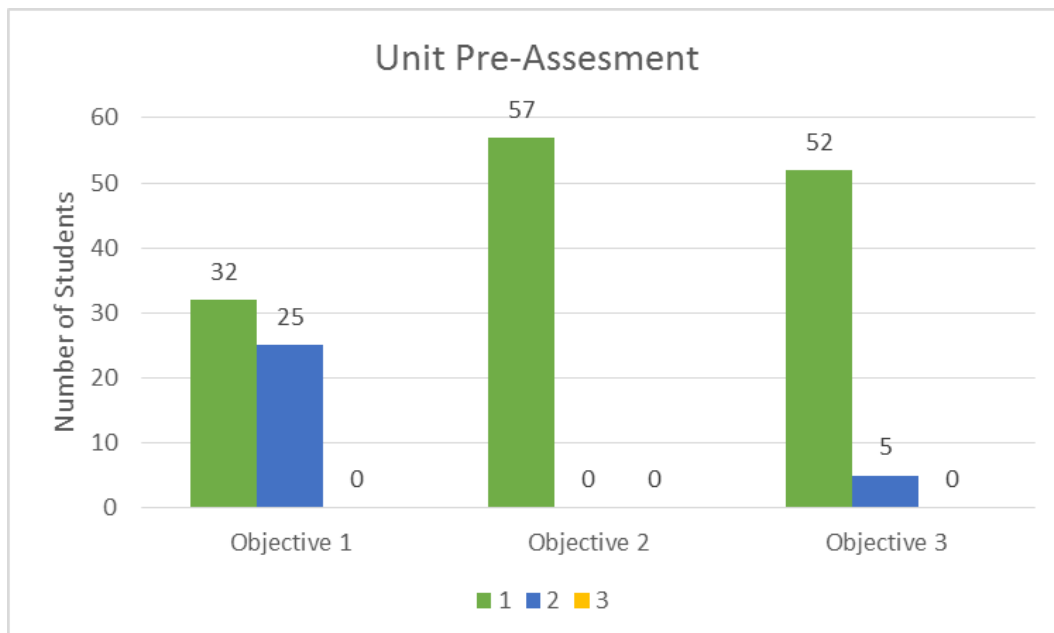
Students of Special Concern

Most students did not do very well on the pre-test, and a few did exceptionally better than their peers, so there are a few students I will have special concerns for. The first student I am concerned about left most of the pre-test blank and received a rating of 1 on the few questions he did answer. This student is repeating Algebra and should have been able to complete most of the test or at least attempt to. I think math does not come naturally to him so he allows himself to get easily distracted as not to have to do the work. Another student I am concerned will almost never do any work. He didn't even turn the pre-test in, but I know he also didn't try any of it. We have a para pro in the room that offers to help him, but most of the time he refuses. He consistently puts his head time and does not participate. I am concerned that he will deter from other students learning. A third student of concern is highly intelligent. He catches on to topics very quickly. However, part of the problem is that he thinks he already knows all of the material. He did better than most students on his pre-test, but he did not receive any ratings of 3 so he still has more to learn than he thinks he does. It tends to be hard to get him to stop talking and pay attention to the lecture because of this ego boost. There are several other students that tend to have the same characteristics of these three students, but not to the extreme of these three.

Student for Learning Analysis

The student I have chosen for my student has potential to do very well, however he has ADHD and can tend to become disruptive in class. He is very talkative and is quick to go off topic because he wants to tell a story rather than work on his math assignment. When he focuses and asks questions, he tends to do well. However, getting him to that point of working on the task at hand can be very difficult. I know he has to work a little bit to understand the material because it doesn't come as naturally as it does for other students, but he tends to take any distraction he can find. If I am standing or sitting with him he does his work, but the moment I walk away he stops. Sometimes he even tries to draw me into a story but I am quick to deter him from that and get back to his assignment. Like most students on the pre-test, he had a rating of 1 for all three objectives. Most of the problems he did not attempt because he didn't know how to answer them.

Lesson Plan 3.1 Relations and Functions, Domain and Range

Topic:

> In this lesson we will discuss what a relation, function, domain, and range is. Students will complete two activities in order to understand these concepts.

Duration:

> Two 50-minute class periods

Purpose:

> In the real world, we can represent many problems by using functions. In order to understand what a function is, we need to know what a relation is. We also need a way to talk about functions intelligently so we use things like the domain and range to specify what values we want to look at. It is important for students to see how they can model situations mathematically to get logical answers to their problems.

Materials:

> Colored paper to make flip books
>
> Scissors (in group supply box)
>
> Glue (in group supply box)
>
> Colored pencils / markers (optional) (in group supply box)
>
> Dice
>
> 3.1 Function activity worksheet
>
> Function sort activity
>
> 3.1-3.2 Notes
>
> Elmo (document projector)

Standards:

> HSF-IF.A.1

Objectives:

- Identify a function as a relation that pairs one input to exactly one output
- List the set of the domain and range for a function represented multiple ways

Assessment:

> Formative – completion of flip book, group activity sheet, and function sort

Anticipatory Set:

Do-Now

Pick up colored paper and group supply box

Review plotting points practice from pre-assessment

Review ordered pairs as (x, y)

Ordered pairs represented by a table

Graphing points on coordinate plane

Input – What and How

Teacher will model how to make the flip book while students follow along

Students will then have time to work on the activity sheet and complete the function sort

We will come together to do a mini lecture on the first part of the 3.1-3.2 notes.

Modeling

Teacher will demonstrate flip book

1. Demonstrate each fold for the students:
   a. Fold the paper in half (hamburger style)
   b. Repeat 3 more times
   c. Unfold paper
2. Cut the two small creases on each side of the paper (hotdog sides)
   a. This creates four flaps that can be folded in to cover up the inside.
3. Label the outside of each flap with these four labels:
   a. Ordered Pairs
   b. Input/Output Table
   c. Coordinate Plane (graph)
   d. Mapping Diagram
4. The inside of the flap part gets the following words to define
   a. Relation
   b. Function
   c. Domain
   d. Range
5. The four other boxes (in the center of the paper) that get covered by the flaps are for examples of each type of relation listed on the front of the flaps.

6. Start the discussion by defining what a relation is: it pairs inputs with outputs. The students can write a definition in their own words in the 'relation' box.
7. I will demonstrate each type of relation while the students watch, and then students will create their own examples for their books. Students are sitting in groups of 4 and each person will be responsible to create one of the example types to share with the group. (ordered pair, table, graph, mapping diagram).
8. We will come back together as a class and discuss the examples and now define how we can express the domain of a relation. I will allow the students to reason that if the domain is the inputs (or x values) then the range must be the outputs (or y values). Students will then have the opportunity to go back and list the domain and range for each of their relations.
9. Finally, we will talk about the definition of a function and how it is a particular type of relation. Once we define a function as a relation that assigns one input to only one output, the students will be responsible to look at their examples and determine which ones are functions.
10. For the remainder of the time the students will work on an activity worksheet in their groups.
    a. The first page has the students determine whether each relation is a function.
    b. The second page starts with the students rolling dice to create ordered pairs. Each student in each group will roll the dice twice to create an ordered pair. There will be four all together since students are seated in groups of four. The group will then decide if their set of ordered pairs makes and function and state the domain and range.
    c. Each group will share the relation their dice made.
    d. The last three problems give students sets of ordered pairs to again decide if it is a function and state the domain and range.
11. This activity will take up all of the first day of the lesson. The second day we will wrap up any sharing or problems left from the activity.
12. I will now pass out a function sort for the students to complete. They will get a red sheet of relations (12) to cut apart and a yellow sheet that is divided into two columns: function and not a function. The students will need to paste the relations in the appropriate column.
13. At the completion of the sort, we will go over the answers.
14. Now we will look at the short notes for this topic. The flip book is the bulk of the notes, so the sheet will introduce the vertical line

test and how to write the domain and range of a continuous function rather than just individual points.

Checking for Understanding

While the students are completing the flip book examples, I will walk around to make sure they are correctly creating examples. I will also answers questions as they come up. The activity worksheet will be another opportunity for me to quickly identify whether or not the students are understanding the concepts.

The second day I will monitor how much of the material sunk in while the students are completing the function sort. Finally we will come together to summarize the lesson with the notes.

Guided Practice

The students will have several opportunities to practice with my supervision when they complete the flip book, the activity worksheet, and the sort.

If students are continuing to struggle with the problems, I will create additional work and problems for them to practice before we move on to the next lesson.

Closure

At the end of the class period for day 1, we will come together the last few minutes of class to summarize what we have learned. I will ask the students to define a relation, domain, range, and a function without looking that their flip books.

The second day we will end with the small lecture of notes that will tie the entire lesson together.

Independent Practice

As long as students complete to assigned work in class, there will not be additional independent work to complete. However, any uncompleted work must be taken home and finished.

Adaptations:

There is a variety of learning styles that can be met with these activities as it has been originally been designed. If any students struggle with motor skills, the folding and cutting may be difficult for them, so I will pre-make the book for them so they can just do the writing portion. Other students may have difficulty keep up with the writing, so I will pre-write basic information for them. These students will still be able to fold and cut the book, but some panels will already be filled in. this should not be a problem if the students follow the instructions, the book will line up.

A **relation** pairs inputs with outputs. When a relation is given as ordered pairs, the *x*-coordinates are inputs and the *y*-coordinates are outputs. A relation that pairs each input with *exactly one* output is a **function**.

EXPLORATION 1   Describing a Function

Work with a partner. Functions can be described in many ways.

- by an equation
- by an input-output table
- using words
- by a graph
- as a set of ordered pairs
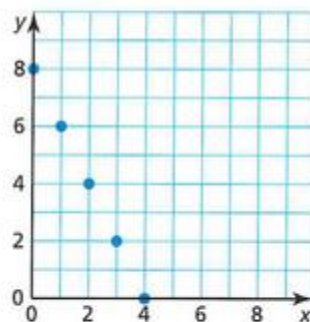
a. Explain why the graph shown represents a function.
b. Describe the function in two other ways.

EXPLORATION 2   Identifying Functions

> **Work with a partner.** Determine whether each relation represents a function. Explain your reasoning.

a.

Input, x	0	1	2	3	4
Output, y	8	8	8	8	8

b.

Input, x	8	8	8	8	8
Output, y	0	1	2	3	4

c. Input, x   Output, y

d.
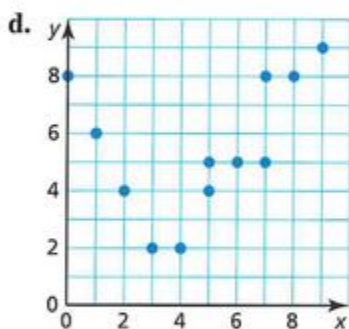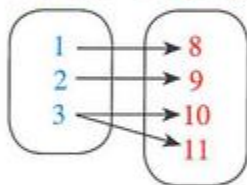
e. $(-2, 5), (-1, 8), (0, 6), (1, 6), (2, 7)$

f. $(-2, 0), (-1, 0), (-1, 1), (0, 1), (1, 2), (2, 2)$

g. Each radio frequency *x* in a listening area has exactly one radio station *y*.

h. The same television station *x* can be found on more than one channel *y*.

i. $x = 2$

j. $y = 2x + 3$

Station 4

You will be given a number cube. As a group, roll the number cube and write the result in the first box. Repeat this process until all the boxes contain a number.

$$\{(\boxed{}, \boxed{}), (\boxed{}, \boxed{}), (\boxed{}, \boxed{}), (\boxed{}, \boxed{})\}$$

1. What is the domain of this relation?

2. What is the range of this relation?

3. Is this relation a function? Why or why not?
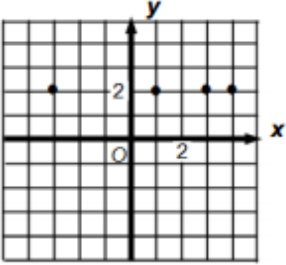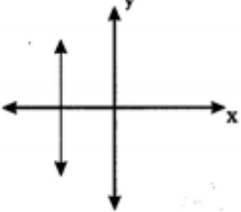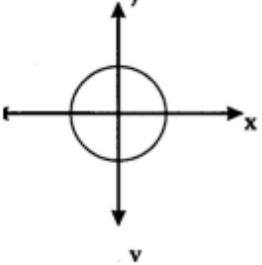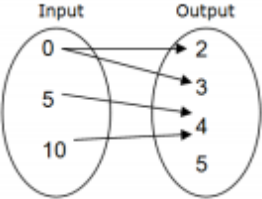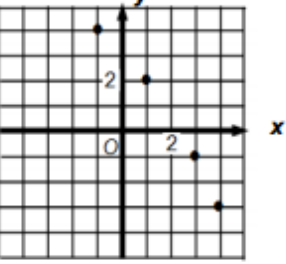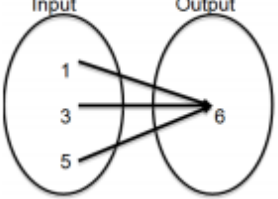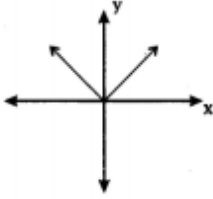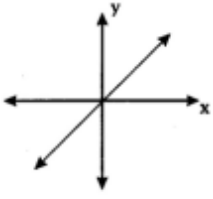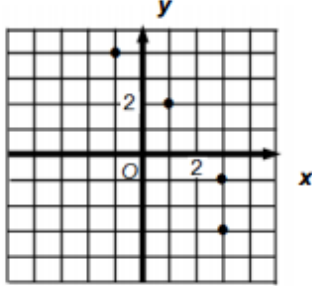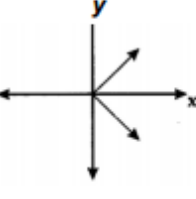
For problems 4–6, state the domain, range, and whether or not the relation is a function. Include your reasoning.

4. {(2, 5), (3, 10), (–1, 2), (4, 5)}

5. {(10, 7), (3, 7), (10, 5), (7, 2)}

6. {(–14, 8), (17, 8), (14, –9), (15, 17)}

3.1 Function Exploration

Not a Function

Function

Input / Output mapping: 0, 5, 10 → 2, 3, 4, 5		Input / Output mapping: 1, 3, 5 → 6
<table>x: −1, 2, 5 / y: −4, 8, 20</table>		
{-1, 5), (2, 5), (3, 5) (8, 5)}		

x	−1	2	5
y	−4	8	20

{-1, 5), (2, 5), (3, 5) (8, 5)}

Function Sort Activity

Algebra
Notes 3.1-3.2 Functions & Linear vs Non-Linear

Core Concept

Vertical Line Test

Words A graph represents a function when no vertical line passes through more than one point on the graph.
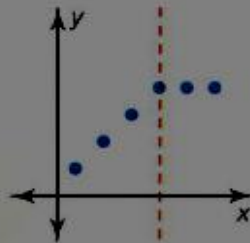
Examples Function   Not a function
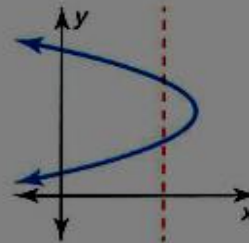
EXAMPLE 2   Using the Vertical Line Test

Determine whether each graph represents a function. Explain.

a.

b.
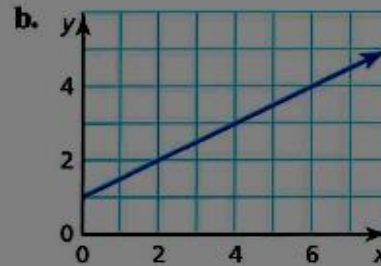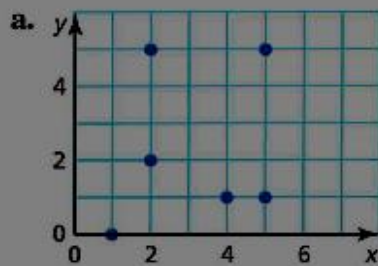
Domain and Range
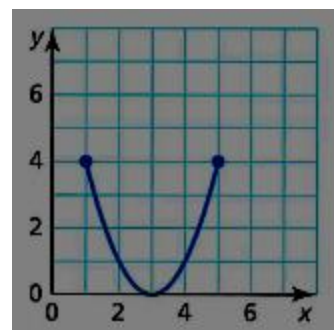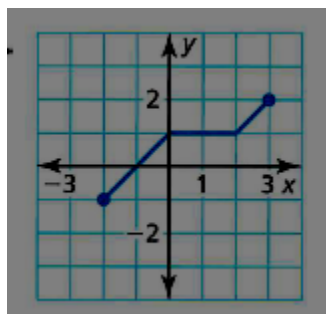
Linear vs Non-Linear Functions

Linear functions have a constant rate of change – which means the quantity that changes by equal amounts over equal intervals. When graphed linear functions will form a straight line (non-vertical).

Does the graph or table represent a *linear* or *nonlinear* function? Explain.

1.

2.
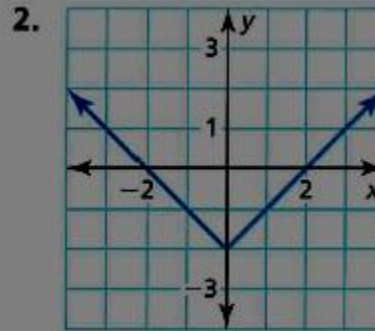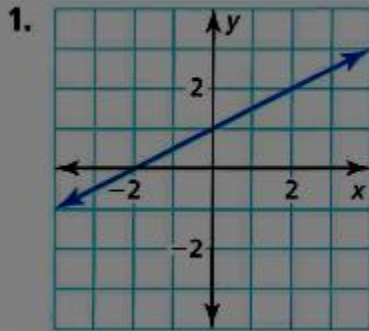
3.

x	0	1	2	3
y	3	5	7	9

4.

x	1	2	3	4
y	16	8	4	2

Any linear equation can be written in the form: y = mx + b

Examples:

$y = 6(x - 1)$

$y = 5 - 2x^2$

$y = 2^x$

y = 8

Lesson Plan 3.2 Linear vs Nonlinear Functions

Topic:

Determine whether or not a function is linear or nonlinear when given a graph, table, or equation.

Duration:

One 50-minute class period, partial of a second if necessary

Purpose:

There are several real-world problems that can be modeled with a linear function. In order to model and graph these functions, we need to be able to identify whether or not a function is linear.

Materials:

Notes 3.1-3.2 Functions & Linear vs Nonlinear

Practice 3.2 Linear Functions

Calculator (class set TI-84)

Elmo (document projector)

Standards:

HSF-LE.A.1b

Objectives:

- Identify a function as linear based on the rate of change
- Create a table of values that represents a linear function and a nonlinear function

Assessment

Formative – 3.2 practice worksheet

Anticipatory Set

Do-Now:

Take out notes from yesterday and pick up practice sheet

Review the definition of a function

Given two mapping diagrams, determine if they are a function:
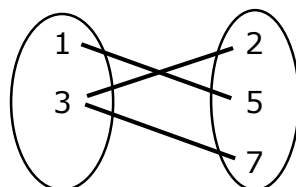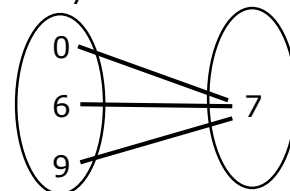
Input – What and How

Mini-Lecture on the notes sheet projected on the document projector (Elmo)

Teacher will walk through most of the examples with the students while allowing them time to answer one or two on their own

Students should be writing notes down and asking questions

Modeling

Teacher will go through notes:

1. The first side was already completed in the previous lesson, so we will start with the back
2. Read definition at top of page and explain in simpler words
3. Look at first 2 examples (graphs) and ask the students if the first graph forms a straight line. (Students should respond with 'yes')
4. Look at the 2nd graph, does it form a straight line?
    a. There may be mixed responses here
    b. Explain that even though the graph is made up by 2 straight lines, it is not just 1 line so it is not a linear function
5. Take any questions students have
6. Example 3 displays a table of values. Show that there is a constant rate of change so it is a linear function. You can add 1 between each x value and you can add 2 between each y value.
7. Explain that a linear function will follow a constant addition or subtraction pattern. The value added to each x does not have to be the same number that is added to each y.
8. Allow students time to independently try example 4 before giving the answer that it is not a linear function and demonstrating that it does not follow a pattern.
9. Examples 5-8 give equations and we need to determine if they are linear. Explain that a linear equation can always be written into the form y = mx + b.
10. Demonstrate number 5 by showing you can distribute and the equation will take that form, so it is linear.
11. Instruct the students to try and decide if 6-8 are linear or not and go over answers. (6 and 7 are no, 8 is yes since it is a special case)

Checking for Understanding

During step 7 of modeling, walk around while students are trying example 4 and see how they are doing. When going over the problem, ask for students' input that will lead to the correct answer.

Step 10 is another opportunity to check for understand as students try to answer examples 6-8.

If necessary, add an additional examples before giving students practice time.

Guided Practice

Students may work in groups of 4 to complete a practice worksheet about linear functions. There are seven graphs, four tables, and six equations for the students to determine if they are linear or not.

The teacher will circulate the room checking students work and answering questions when necessary. If there seemed to be a repeating question or continuous misconception, the problem should be addressed with the entire class.

Closure

Toward the end of the class period, we will come back together to discuss the worksheet. If most students have finished, we will share out the answers. However, if a majority of students have not finished then the worksheet will become homework.

We will review what we have learned for the day: the graphs of linear functions will form a straight line, tables will have an addition or subtract pattern, and equations will be in the form y = mx + b.

Independent Practice

There will not be additional practice for this lesson. If students do not finish the worksheet in class, they will be responsible to take it home and finish it. At the beginning of the next day we will go over the answers if we don't during class.

Adaptations

Some students work at a much slower pace than others. For these students, I will cut back the numbers of problems they must complete on the worksheet.

The students groups are arranged by ability. This way, low-ability students can be assisted by higher-ability students. The high-ability students are then challenged by the necessity to become a pseudo-teacher in helping their classmates.

For students that are struggling with the mathematical portion of the tables and equations, I will provide graph paper. The students will, if they chose, be able to sketch a graph of the problem to help them determine linearity.

Algebra   Name_____
Practice 3.2 Linear Functions

Determine whether or not each graph is a linear function:

5.

6.

7.

8.

9.

10.
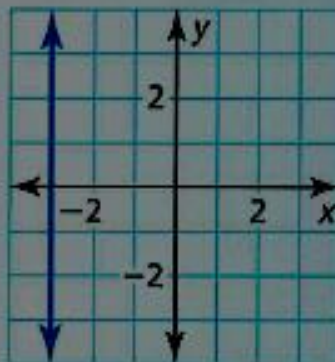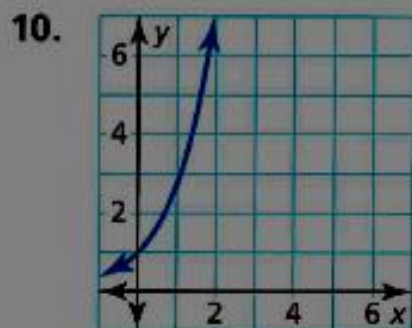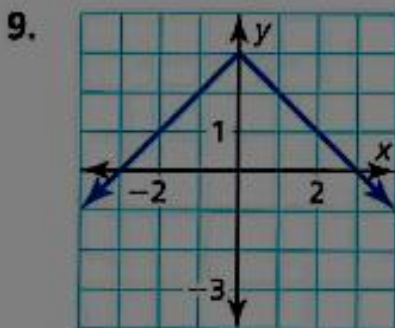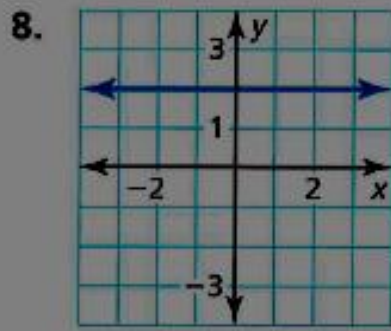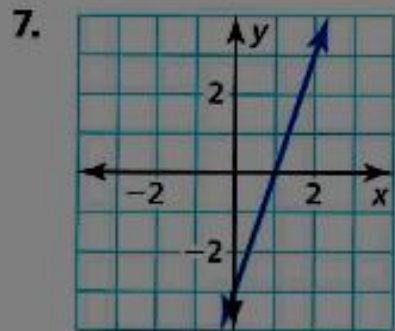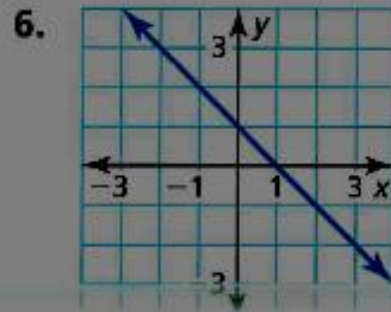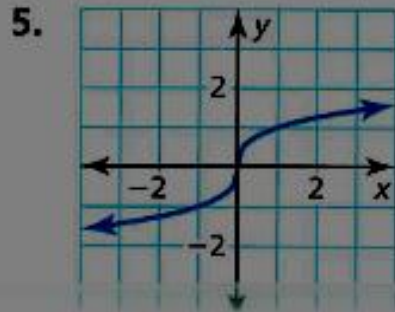
Determine whether or not each table represents a linear function:

x	1	2	3	4
y	5	10	15	20

x	5	7	9	11
y	−9	−3	−1	3

x	4	8	12	16
y	16	12	7	1

x	−1	0	1	2
y	35	20	5	−10

Determine whether or not each equation represents a linear function:
   (hint: remember linear functions can be written as y = mx + b)

1. $y = x^2 + 13$

2. 3x + 2y = 12

3. $\sqrt{x} + 4 = y$

4. 2(y + 3) + x = 4x + 1

5. y = 8

6. x = 9

Lesson Plan 3.3 Function Notation

Topic:

Rewrite linear equations using function notation and use them to evaluate functions for a given value.

Duration:

One or two 50-minute class periods

Purpose:

Sometimes it can be confusing and hard to identify which value is the input and which is the output. Function notation creates an easier method for identifying which variable is independent and which is dependent. This notation also creates an easy way to evaluate functions while still seeing the input and output. For example, $y = 5$ tells me the output is 5. Whereas $f(1) = 5$ still tells us the output is 5, but we also know the input was 1, and that gave us an output of 5.

Materials:

Notes 3.3 Function Notation

Practice 3.3 Function Notation

Calculator (class set TI-84)

Elmo (document projector)

Standards:

HSF-IF.A.1

HSF-IF.A.2

Objectives:

- Find the output, y, when given the input, x, and vice versa when given a graph or a set of ordered pairs
- Write equations using function notation.
- Evaluate functions for the input or output when given the equation of the function
- Interpret the meaning of an input or output relevant to the context of a problem

Assessment

Formative – 3.3 practice worksheet

Summative 3.3-3.5 Quiz

Anticipatory Set

Do-Now:

Take out worksheet from yesterday and pick up new notes

Review the answers from the previous lesson

Are these linear functions:

1. y = x(x + 1)   No   2. y − 2x = 4   Yes

Input – What and How

Lecture on the notes sheet projected on the document projector (Elmo)

Teacher will walk through most of the examples with the students while allowing them time to answer one or two on their own

Students should be writing notes down and asking questions

Modeling

Teacher will go through notes:

12. Read definition at top of page and explain in simpler words
13. Explain the two diagrams. One displays an input of x with an output of y. The second shows the same type of "function machine" but instead of getting out 'y' we get out 'f(x)'
14. Complete example 1
    a. Re-write the function y = x + 3 as f(x) = x + 3.
    b. Fill in the tables with the same values. This shows that the equations are exactly the same, just written a different way.
15. Take any questions students have
16. Move on to example 2. For the first problem, demonstrate how to plug in 2 everywhere there is an x and solve the problem by doing f(2) = 4(2) + 1 = 9.
17. Emphasize that with an input of 2, we got an output of 9 so that students can see the relationship.
18. Have the students try the next problem on the right. Walk and check students work and allow one to share how they did the problem and what the answer is.
19. Repeat this process (6 and 7) with the next two problems.
20. When the students flip the page, have them try the example at the top on their own first. There is a high likelihood there will be a lot of confusion on the third and fourth problems. Once the students have all reached that point, go over the problems together.
21. Example 3 works backward showing that we can solve for x when we are given a value for f(x). Demonstrate the first and have students try the second.

22. Take any questions students have.
23. Example 4 uses table and graph reading ability. When we are given an input/output, we can find the corresponding input/output value.

Checking for Understanding

Multiple times during the modeling process the students will have a chance to do a "you try" problem as explained. This allows the teacher to quickly assess whether or not they are comprehending the information.

If students are struggling with doing problems on their own, then there needs to be further explanation and possibly another example.

Guided Practice

Students may work in groups of 4 to complete a practice worksheet using function notation. The worksheet is quite long and has several problems. This will likely take the remainder of the class period and most of the next class as well. The worksheet has several problems just like the ones modeled in the notes, in addition there are 2 application problems. We will go over all of the directions together so that it is clear of what the students are required to do for each problem.

The teacher will circulate the room checking students work and answering questions when necessary. If there seemed to be a repeating question or continuous misconception, the problem should be addressed with the entire class.

Closure

Toward the end of the class period, we will come back together to discuss the worksheet. The notes will take a lot of time so the students will not have had very long to work on it. I will assure them that we will continue to work on it the next day.

We will review what we have learned for the day: function notation is just a new way to write an equation and it helps us evaluate functions for given values.

Independent Practice

There will not be additional practice for this lesson. The students will be given ample class time to continue the worksheet. At the end of the next class period we will go over the answers, especially for the application problems.

Adaptations

Some students work at a much slower pace than others. For these students, I will cut back the numbers of problems they must complete on the

worksheet. The students groups are arranged by ability. This way, low-ability students can be assisted by higher-ability students. The high-ability students are then challenged by the necessity to become a pseudo-teacher in helping their classmates.

Algebra
Notes 3.3 Function Notation

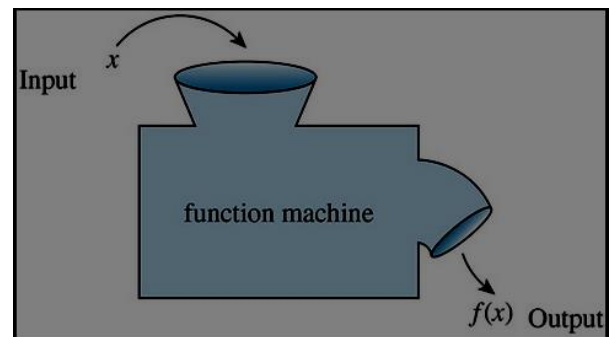Function Notation is another name for y. We use f(x) to represent y, and it is read as "f of x".

In a function, x represents the independent variable. The dependent variable is represented by y or f(x).

Example 1:
Re-write using function notation

1.   y = x + 3

x	y

x	f(x)

Example 2:
We can evaluate functions when we are given a value of x.

f(x) = 4x + 1.   let x = 2   g(x) = 6 − 2x   let x = 5

$h(x) = \frac{3}{2}x - 1$ Find h(4) $f(x) = -(\frac{1}{3})x + 10$ Find f(9)

$f(x) = x - 2$ $g(x) = 2x - 1$

$f(3) =$ _____ $g(4) =$ _____

$f(n) =$ _____ $g(4) - f(3) =$ _____

Example 3:
We can also work backward to solve for x when given a value of f(x).

$f(x) = 12 - 3x$ find x so that $f(x) = 9$

$g(x) = -2x + 4$ find x when $g(x) = -2$

Example 4:
Using a graph, table, or coordinate points

1. (2, 1) , (3, 4) , (-5, 9) , (0, -2) , (10, -4)   Find f(-5).

2.

x	0	1	2	3
y	3	5	7	9

Find x when $f(x) = 9$

3.

$f(5) =$ _____
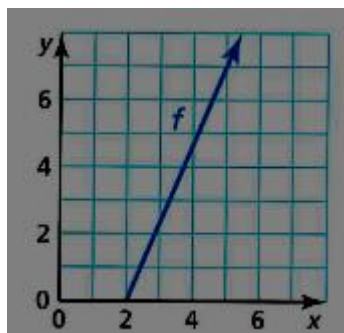
if $f(x) = 0$, then $x =$ _____

Algebra   **Name**_____

3.3 Practice Function Notation

Evaluate each function for when x = 3, -1, 0, and 5.

   1. $f(x) = 8x - 4$ find x when f(x) = 44

   2. $g(x) = 15 - 3x$ find x when g(x) = 18

   3. $h(x) = 2(x + 3) + 1$ find x when h(x) = 7

Evaluate the following compositions:

   4. $f(0) - h(-1)$

   5. $g(5) + h(3)$

   6. $h(0) - f(3) + g(-1)$

   7. $g(f(5))$ 8. $h(f(x))$

Use the graph of f(x) to answer the following:

f(0)=_____

f(1) = _____

f(-3)= _____

f(x) = 2 for what value of x?_____
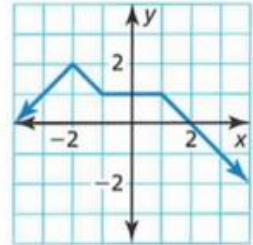
HOW DO YOU SEE IT? The function $y = A(x)$ represents the attendance at a high school x weeks after a flu outbreak. The graph of the function is shown.
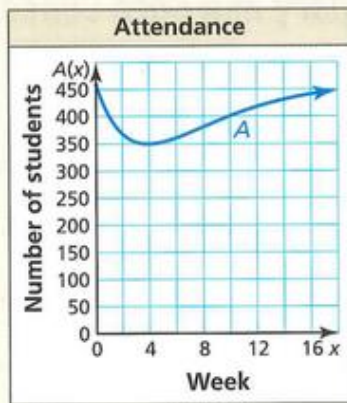
Attendance

a. What happens to the school's attendance after the flu outbreak?

b. Estimate $A(13)$ and explain its meaning.

c. Use the graph to estimate the solution(s) of the equation $A(x) = 400$. Explain the meaning of the solution(s).

d. What was the least attendance? When did that occur?

e. How many students do you think are enrolled at this high school? Explain your reasoning.

MODELING WITH MATHEMATICS The function $d(t) = 300,000t$ represents the distance (in kilometers) that light travels in t seconds.

a) How far does light travel in 15 seconds?

b) How long does it take for light to travel 12 million kilometers?

c) What does d(60) represent?

Lesson Plan 3.4 Graphing Standard Form

Topic:

Graphing linear equations that are in standard form – Ax + By = C

Duration:

One 50-minute class period

Purpose:

Being able to graph data is a skill that can come in handy in several fields of study. Standard form is one way in which we will come across linear equations. In this lesson we will learn the skills necessary to graph this type of linear equation.

Materials:

Notes 3.4 Graphing Equations in Standard Form

Practice 3.4 Graphing Standard Form

Rulers

Calculator (class set TI-84)

Elmo (document projector)

Standards:

HSA-CED.A.2

HSF-IF.C.7a

Objectives:

- Graph a line when given the x- and y- intercepts
- Graph the standard form (Ax + By = C) of a linear equation using the x- and y- intercepts
- Graph linear equations in standard form (Ax + By = C) on a coordinate plane

Assessment

Formative – 3.4 practice worksheet

Summative 3.3-3.5 Quiz

Anticipatory Set

Do-Now:

Pick up new notes and practice sheets

Graph the following points on a coordinate plane:

(0, 1)   (1, 0)   (2, -1)   (-1, 2)   (3, 4)

Check answers, remind students ordered pairs are always (x, y) and we move left or right first, and then up or down.

Input – What and How

Lecture on the notes sheet projected on the document projector (Elmo)

Teacher will walk through one example and have the students try the next one. The second part of the notes are special cases. I will allow the students to first speculate about how the line should look before giving the answer.

Students should be writing notes down and asking questions

Modeling

Teacher will go through notes:

24. Read definition at top of page and explain in simpler words
25. Explain what the x- and y- intercepts are and how to find them from an equation
26. Start the first example by plugging in 0 for y to find the x-intercept and plot that point.
27. Repeat for the y-intercept by plugging in 0 for x.
28. Using a straight edge, connect the two points with a line.
29. Ask for questions the students may have and instruct them to attempt the next problem on their own.
30. Walk around and check student progress before discussing the answer.
31. If there are still no questions, move on to discuss the special cases of vertical and horizontal lines.
32. Graph the two examples together.
33. If there are no questions then students may begin the practice worksheet.

Checking for Understanding

During the modeling process the students will have a chance to do a "you try" problem as explained. This allows the teacher to quickly assess whether or not they are comprehending the information.

If students are struggling with doing problems on their own, then there needs to be further explanation and possibly another example.

Guided Practice

Students may work in groups of 4 to complete a practice worksheet. The practice consists of 12 problems in standard form to graph the line. The students must find the x- and y- intercept in order to graph the problem.

The teacher will circulate the room checking students work and answering questions when necessary. If there seemed to be a repeating question or continuous misconception, the problem should be addressed with the entire class.

Closure

Toward the end of the class period, we will come back together to discuss the worksheet. There should be plenty of class time for the students to complete this task. I will have each group come up to share out an answer and then I will post the answers to any remaining questions.

We will review that to graph standard form equations we must find the x- and y- intercepts by plugging in zeros before we can graph.

Independent Practice

There will not be additional practice for this lesson. The students will be given ample class time to finish the worksheet.

Adaptations

Some students work at a much slower pace than others. For these students, I will cut back the numbers of problems they must complete on the worksheet. The students groups are arranged by ability. This way, low-ability students can be assisted by higher-ability students. The high-ability students are then challenged by the necessity to become a pseudo-teacher in helping their classmates.

Algebra

Notes 3.4 Graphing Equations in Standard Form

The standard form of a linear equation is Ax + By = C. In this equation, A, B, and C are constants (numbers) and x and y are the variables. We can graph lines in this form by using the x- and y- intercepts.

⟳ Core Concept

Using Intercepts to Graph Equations

The **x-intercept** of a graph is the x-coordinate of a point where the graph crosses the x-axis. It occurs when $y = 0$.

The **y-intercept** of a graph is the y-coordinate of a point where the graph crosses the y-axis. It occurs when $x = 0$.

y-intercept = b

$(0, b)$

x-intercept = a

$(a, 0)$

To graph the linear equation $Ax + By = C$, find the intercepts and draw the line that passes through the two intercepts.

- To find the x-intercept, let $y = 0$ and solve for x.
- To find the y-intercept, let $x = 0$ and solve for y.
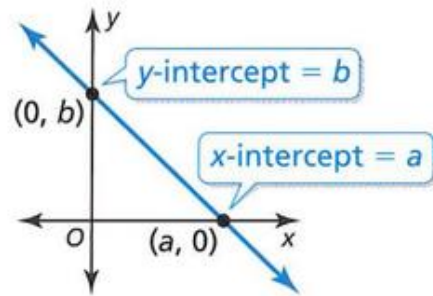
Example 1: Graph

3x + 4y = 12

x-intercept:

y-intercept:
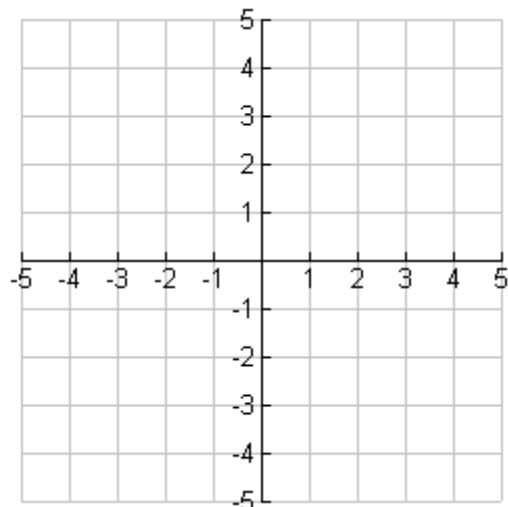
You Try:

$2x - y = 4$

    x-intercept:

    y-intercept:
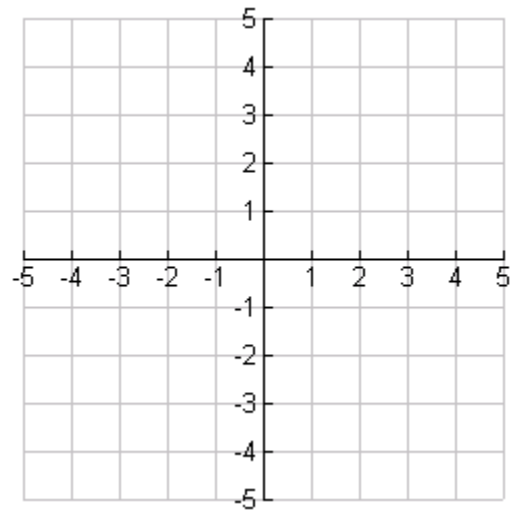
Example 2: Special Cases

Consider what happens when either A = 0 or when B = 0.

Core Concept

Horizontal and Vertical Lines
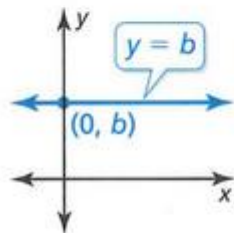
The graph of $y = b$ is a horizontal line. The line passes through the point $(0, b)$.
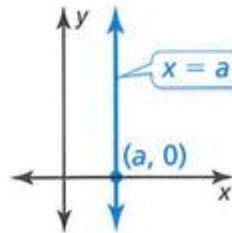
The graph of $x = a$ is a vertical line. The line passes through the point $(a, 0)$.

Graph:

$x = 3$

$y = -2$
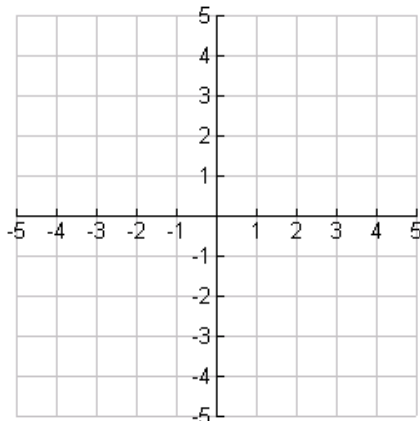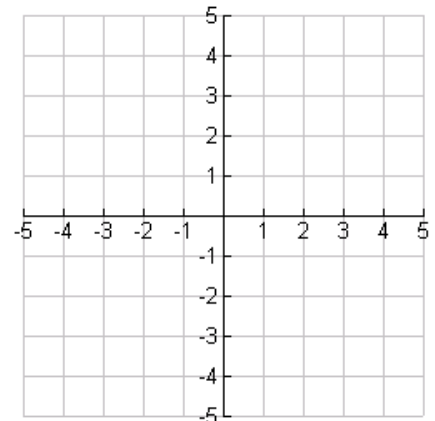
Algebra 1   Name_____ ID: 1
Practice 3.4 Graphing Standard Form
                                                  Date_____ Period____

Sketch the graph of each line.

1) x-intercept = 4, y-intercept = 5
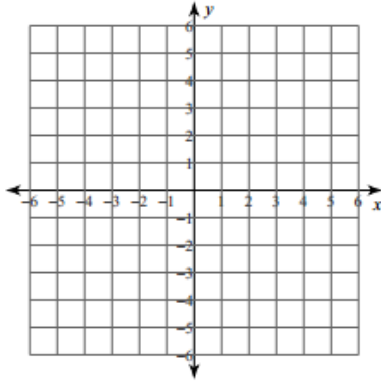
2) x-intercept = −2, y-intercept = 3
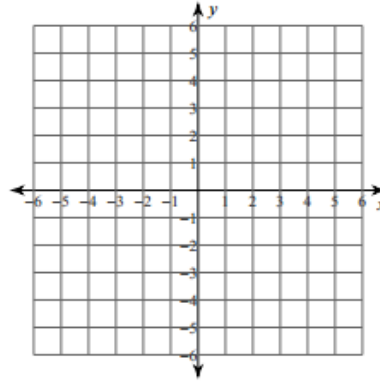
3) $2x + y = -4$
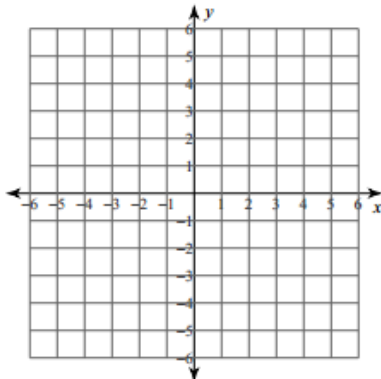
4) $y = -3$
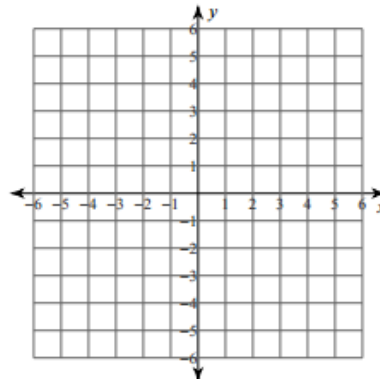
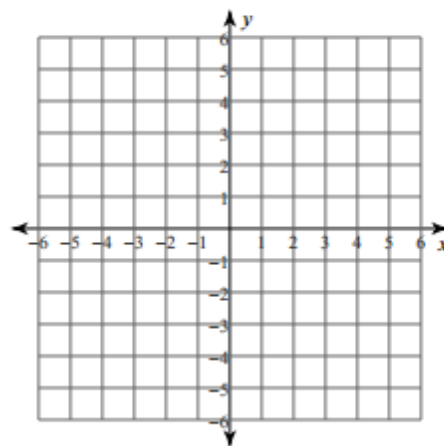

5) $x - 3y = 0$
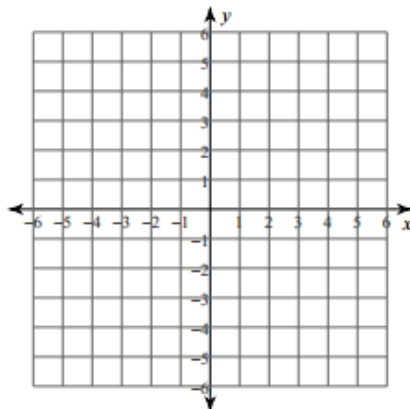
6) $x - 2y = 2$
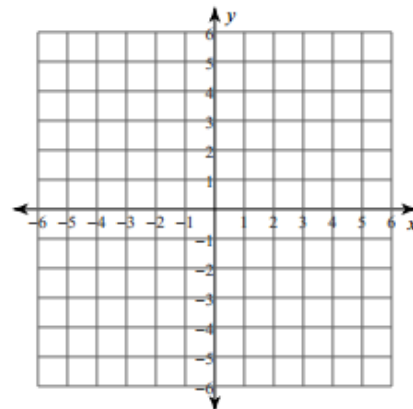
7) $4x + y = 4$
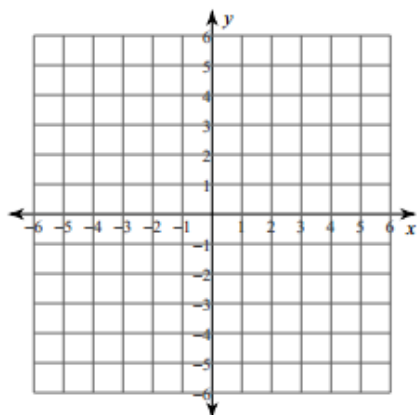
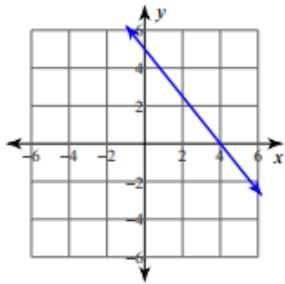8) $x = -4$
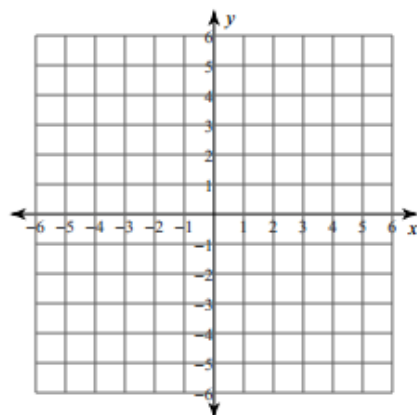
9) $x + y = -4$
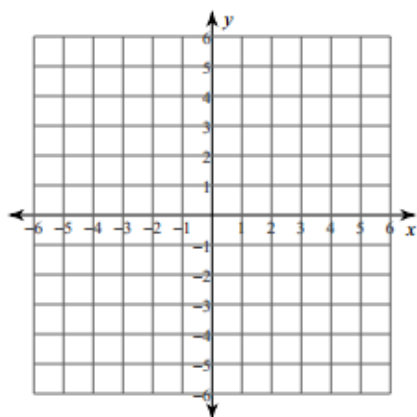
10) $5x + 2y = -10$
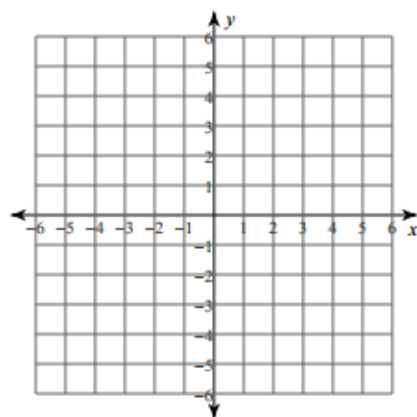
11) $4x + 5y = -5$
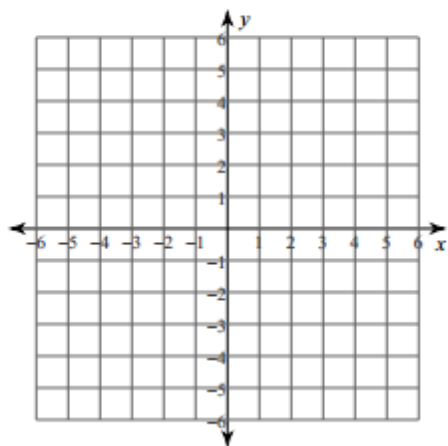
12) $x - 4y = -4$
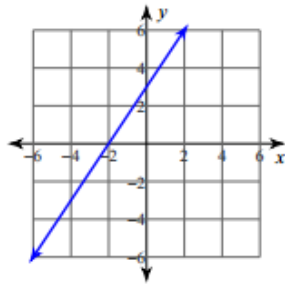
Answers to Practice 3.4 Graphing Standard Form (ID: 1)

1)

2)

3)

4)
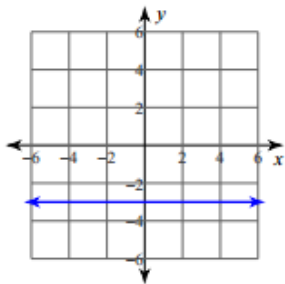
5)

6)

7)

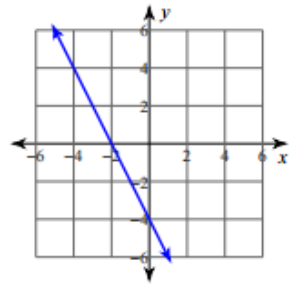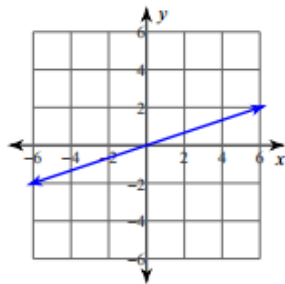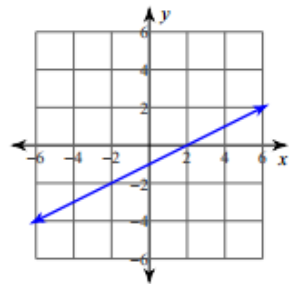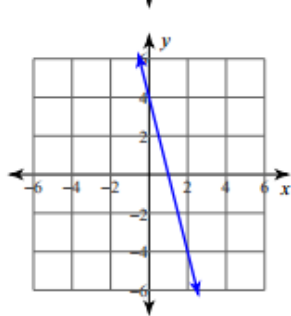8)
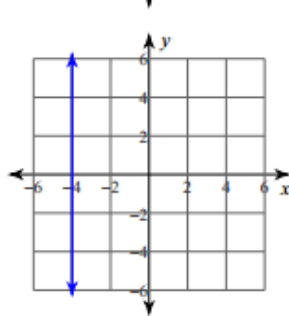
9)

10)

11)

12)

Lesson Plan 3.5 Graphing Slope-Intercept Form

Topic:

Students will learn how to graph linear equations in the form y = mx + b.

Duration:

One to two 50 minute class periods

Materials:

3.5a Slope Notes

3.5a Slope Practice

3.5 Slope-Intercept Exploration

3.5 Practice Slope-Intercept

Rulers

Calculator (class set TI-84)

Elmo (document projector)

Common Core State Standards:

HSA-CED.A.2

HSF-IF.C.7a

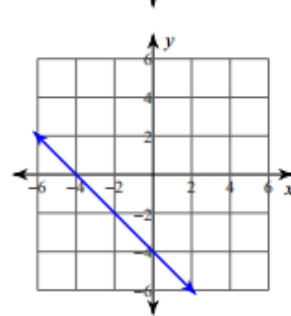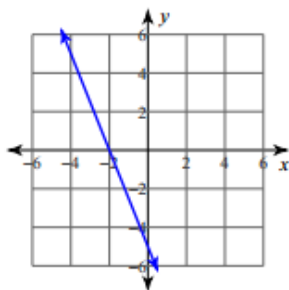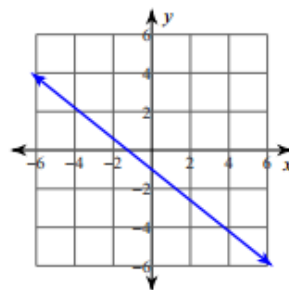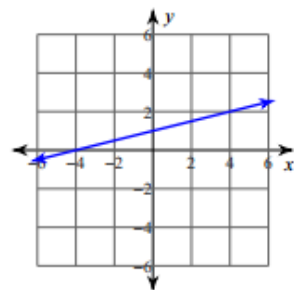HSF-IF-LE.2

HSF-BF.1a

Objectives:

- Write the equation of a line when given the graph using the y-intercept and slope
- Graph a line when given the slope and y-intercept
- Graph a linear equation in slope-intercept form (y = mx + b)
- Identify the slope and y-intercept of a line when given the equation y = mx + b
- Write the linear equation of a line in the slope-intercept form when given a graph of the line

Purpose:

One of the most common forms of a linear equation is y = mx + b. For graphing and reading information from the equation, this is the easiest form to work with. This lesson has been designed to be inductive so that the students can discover what the equation tells us for themselves. (the slope and y-intercept)

Anticipatory Set

Do Now:

Students will pick up slope notes and practice

Review the concept of slope (students should have prior knowledge)

Slope = Rise / Run = $(y_2 - y_1) / (x_2 - x_1)$

We will go over the notes on slope fairly quickly and students will have an opportunity to practice finding the slope for 8 lines. This activity will serve as a refresh of how to find the slope of a line.

Exploration:

The goal of the exploration is to discover the slope-intercept form of linear equations and how easy it is to use to graph. To start the exploration, I will ask students how we can graph a line. The responses should explain that we have to find the x- and y- intercept by plugging in 0 for x or y before we can graph. I will pose the question of whether or not we can find an easier way.

The exploration has four equations for the students to try and graph. The table at the top of the page has four columns. The first reads the equation, then the x-intercept, y-intercept, and finally slope from graph. The equations are already given in slope-intercept form instead of the standard form that the students are used to. The students should start to realize the y- intercept is the same as the number that is in the position of b in $y = mx + b$. They may also start to notice the slope is the same as the number in front of x (m).

Metacognition Opportunities

After the students fill in the table and graph each line, there will be three questions they are going to try to answer. These should be easy if they already noticed the pattern. If they haven't already made the connection, the table should make it easy to see.

1. Do you notice anything about the y- intercept and the equation of the line?
2. Do you notice anything about the slope and the equation of the line?
3. In the equation $y = mx + b$, what is the slope and what is the y-intercept?

Applying Knowledge

The last portion of the exploration asks students to graph two equations. I do not ask them for the x- or y- intercept. The directions say graph the equation using only the slope and y-intercept. Then they are given steps as a

guideline: 1. Graph the y- intercept, 2. "do" the slope starting at that point to graph another point, and 3. draw the line. Students should recognize that the equation is in the slope-intercept form, $y = mx + b$, so they don't have to do any algebra or solving. They can automatically read the y- intercept and slope. After the completion of the exploration students will be given a practice worksheet of several equations to graph using the slope and y-intercept.

Checking for Understanding

I will walk around as students are working on the exploration and help them follow the right path. I will check there work as they go and I will also ask some students to explain their answers to the three questions for me.

Assessment

Formative – completion of exploration and practice worksheet

Summative – 3.3-3.5 Quiz

Closure

When all students have completed the exploration, we will come back together as a class to discuss what they have discovered and learned. I will project the questions and table at the same time. The students will help me fill in the table with their answers and explain the answers to the three questions. We will also cover one of the graphing problems together to make sure all students understand the concept and are using it correctly. The students will be given a practice to independently work on, most likely at home. We will also be taking a quiz on sections 3.3-3.5 the following day in class and students will have the opportunity to demonstrate the skills they have learned from each lesson.

Adaptations

This activity has been set up so that it is complex enough for my advanced learners but yet simplistic to follow. For students that need additional assistance I will give them more direction instructions and steps to follow in order to successfully complete the exploration.

The students will also be working in groups and can help one another. The groups are typically paired by learning ability so advanced workers can help students in need. If need be, I will cut back the number of problems some students need to do. Instead of working on four equations to see the pattern, I may allow them to try only two and see what they discover.
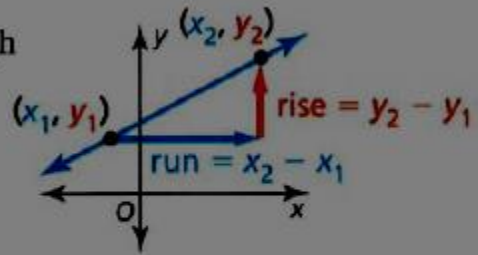
Algebra
Notes 3.5a Slope

m represents the slope of a line. We can find slope given a table, two points, a graph, or from an equation of a line.
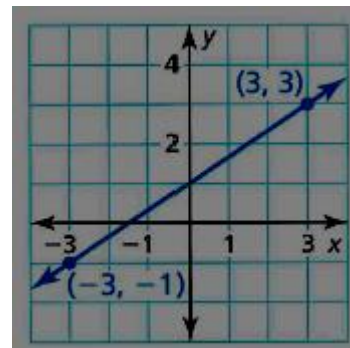
Slope

The **slope** m of a nonvertical line passing through two points (x_1, y_1) and (x_2, y_2) is the ratio of the **rise** (change in y) to the **run** (change in x).

$$\text{slope} = m = \frac{\text{rise}}{\text{run}} = \frac{\text{change in } y}{\text{change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\text{rise} = y_2 - y_1$$
$$\text{run} = x_2 - x_1$$

When the line rises from left to right, the slope is positive. When the line falls from left to right, the slope is negative.
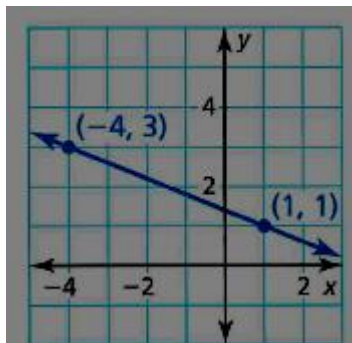
Algebra 1
Name_____ ID: 1

3.5a Slope Practice

Date_____ Period____

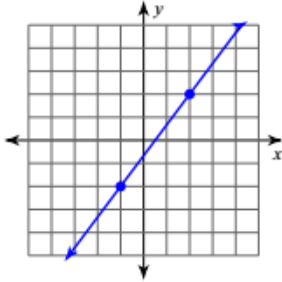**Find the slope of each line.**

1)

2)
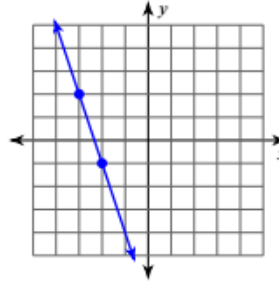
3)
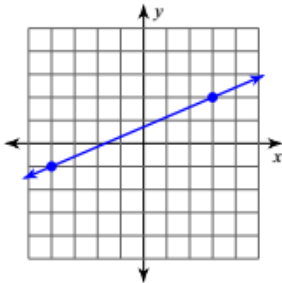
4)
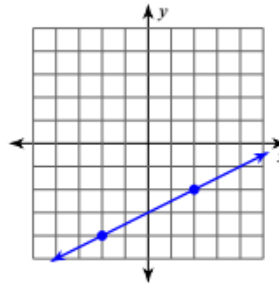
5)
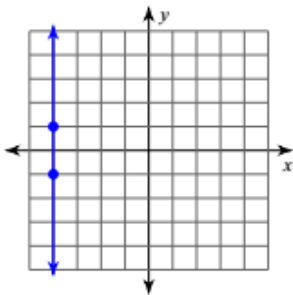
6)
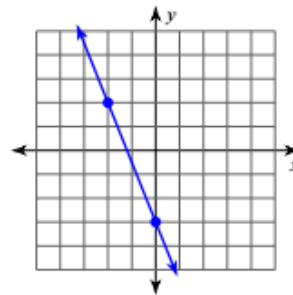
7)
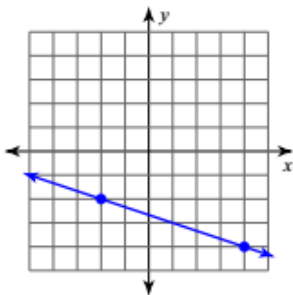
8)
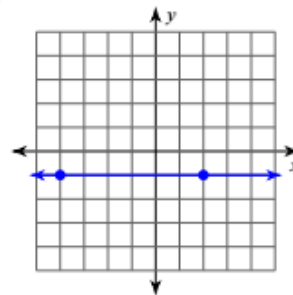
Answers to 3.5a Slope Practice (ID: 1)

1) $\dfrac{4}{3}$

2) -3

3) $\dfrac{3}{7}$

4) $\dfrac{1}{2}$

5) Undefined

6) $-\dfrac{5}{2}$

7) $-\dfrac{1}{3}$

8) 0

Algebra   Name_____

3.5 Slope-Intercept Exploration

Directions:

      1. Find the x-intercept and y-intercept for the equation.

      2. Graph the intercepts and draw the line.

      3. Find the slope of the line.

Equation	X-intercept	Y-intercept	Slope from Graph
a. $y = \frac{1}{2}x - 2$			
b. $y = \frac{3}{2}x + 3$			
c. $y = \frac{-5}{3}x + 5$			
d. $y = \frac{7}{-4}x - 7$			

a.

b.

c.

d.
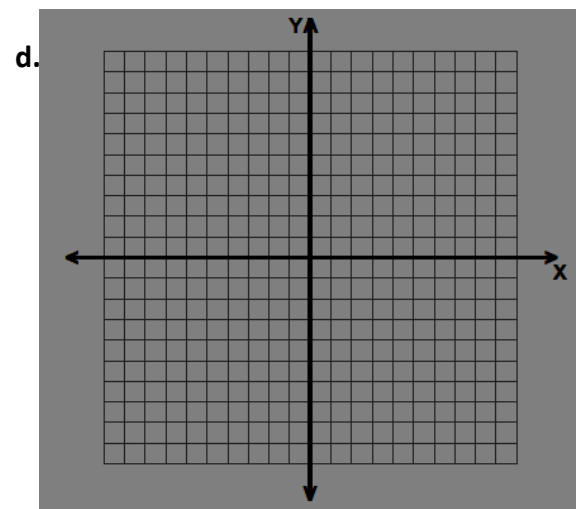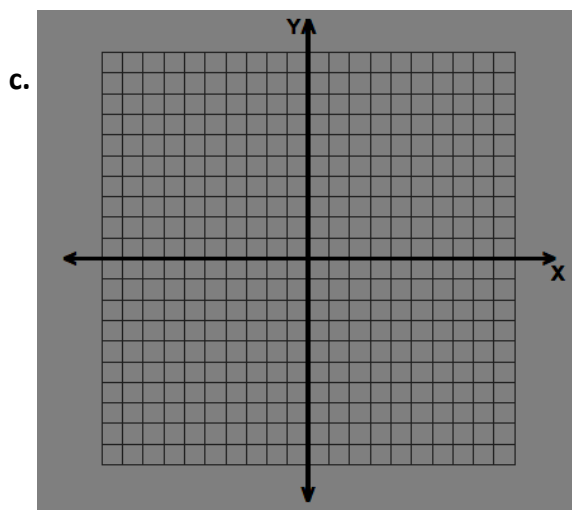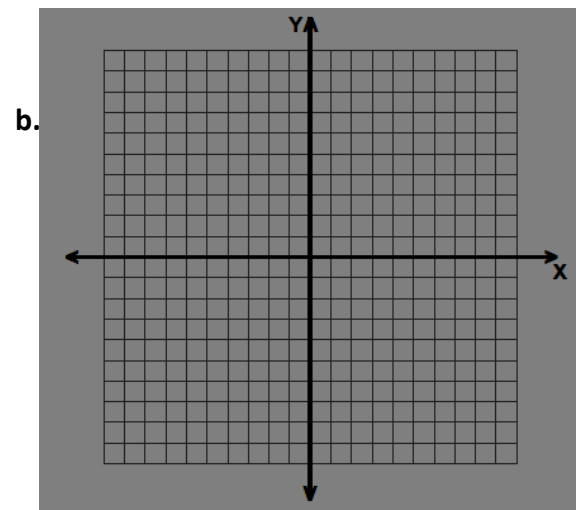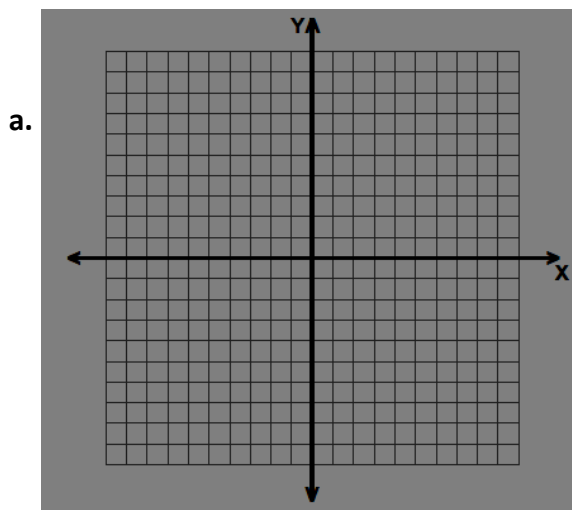
Questions:

1. Do you notice anything about the y-intercept and the equation of the line?

2. Do you notice anything about the slope and the equation of the line?

3. In the equation y = mx + b, what is the slope and what is the y-intercept?

Graph the equation using only the slope and y-intercept
     1. Graph the y-intercept
     2. "Do" the slope starting at that point to graph another point
     3. Draw the line

1. $y = \frac{4}{3}x + 1$ **2.** $y = \frac{-3}{5}x - 3$
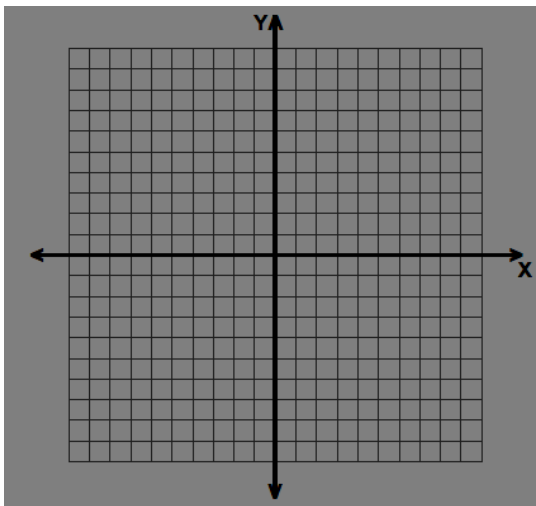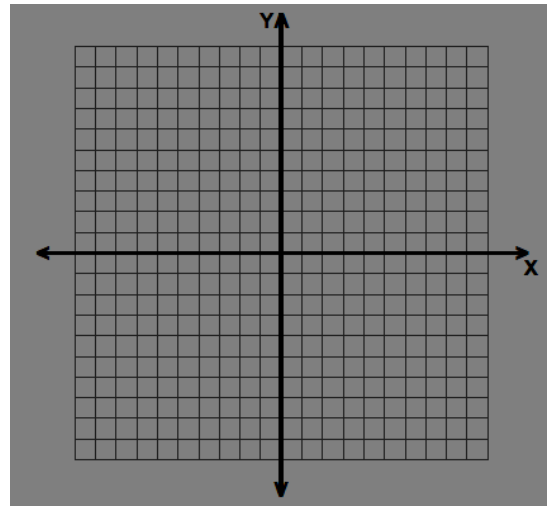
Algebra 1

Name_____ ID: 1

3.5 Practice Slope-Intercept

Date_____ Period____

Sketch the graph of each line.

1) $y = -2x - 4$
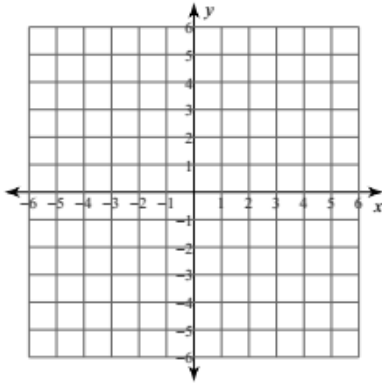
2) $y = \frac{2}{5}x + 1$
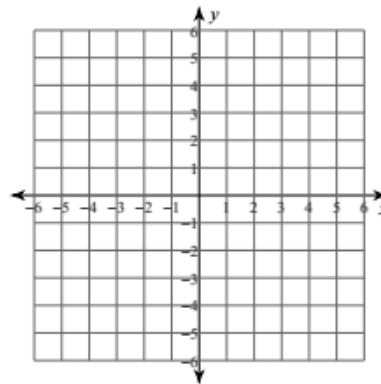
3) $y = x$
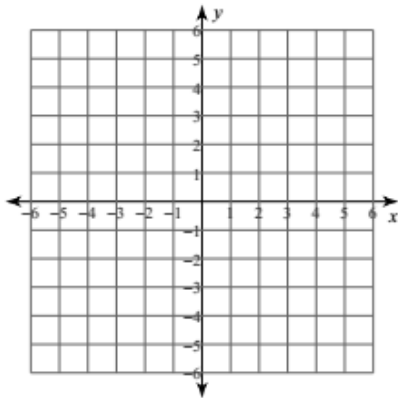
4) $y = \frac{3}{2}x + 1$
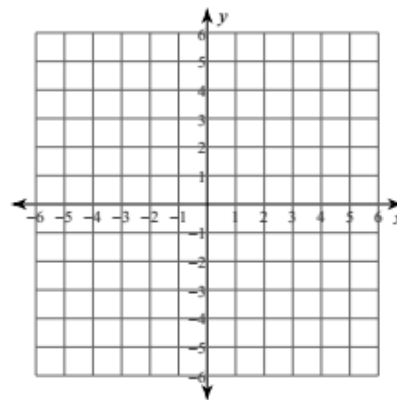
5) $y = -\dfrac{9}{2}x + 5$
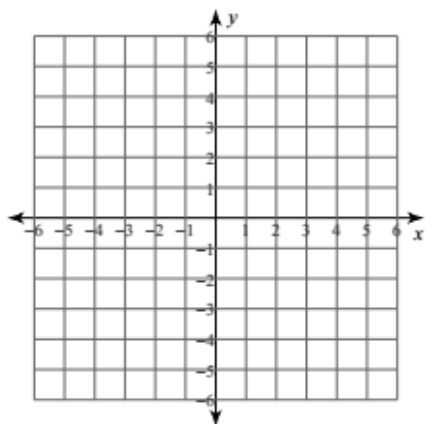
6) $y = -\dfrac{1}{3}x + 2$

7) $y = -4$

8) $x = 1$

Algebra   **Name**_____
Graphing Cheat Sheet

$$slope = m = \frac{rise}{run}$$

Standard Form: Ax + By = C

    1. Find x-intercept (plug in 0 for y)
    2. Find y-intercept (plug in 0 for x)
    3. Graph intercepts

$rise = y_2 - y_1$
$run = x_2 - x_1$

Slope-Intercept Form: $y = mx + b$

slope   y-intercept

    1. Graph the y-intercept
    2. "Do" the slope starting from b
    3. "Do" the slope in the other direction from b to find third point
    4. Connect 3 dots

Algebra   **Name**_____
Graphing Cheat Sheet

$$slope = m = \frac{rise}{run}$$

Standard Form: Ax + By = C

    1. Find x-intercept (plug in 0 for y)
    2. Find y-intercept (plug in 0 for x)
    3. Graph intercepts

$rise = y_2 - y_1$
$run = x_2 - x_1$
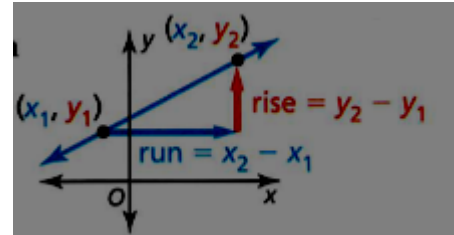
Slope-Intercept Form: $y = mx + b$

slope   y-intercept

    1. Plot the y-intercept
    2. "Do" the slope starting from b
    3. "Do" the slope in the other direction from b to find third point
    4. Connect 3 dots
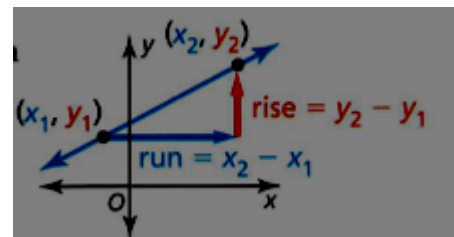
Algebra   **Name**_____

3.3-3.5 Quiz Function Notation and Graphing   **Block**_____

1. $f(x) = 6x - 4$

    a. Find f(3)   b. If f(x) = 20, find x.

2. Graph 5x + 3y = 15

    a. X-intercept:

    b. Y-intercept:
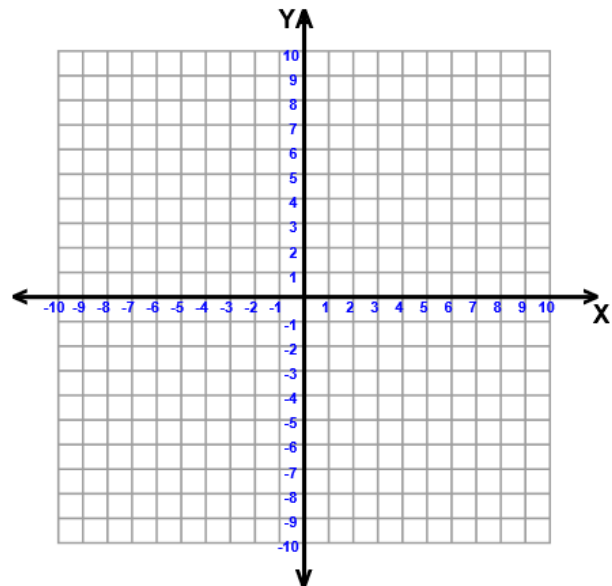
3. Graph $y = \frac{3}{4}x - 5$
    a. Y-intercept:
    b. Slope:
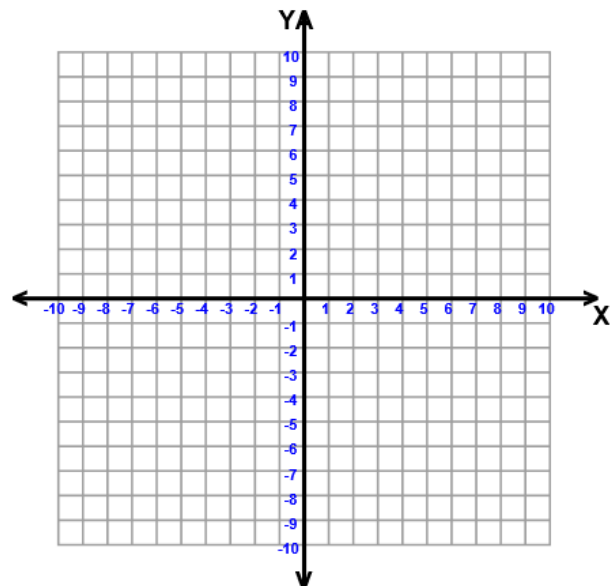
Lesson Plan 3.6 Transformations
Topic:

This lesson focuses on the parent function f(x) = x and transformations made to the function to obtain a new function.

Duration:

The will take two full 50-minute class periods

Purpose:

The purpose of learning transformations is to see how different things can actually be related. We may have two items that look completely different, however, typically there are underlying similarities that can be hard to identify. We will use lines to visualize the similarities between equations of lines.

Materials:

3.6 Transformations Exploration

Notes and Practice 3.6 Transformations

Colored Pencils and Rulers

Calculator (class set TI-84)

Elmo (document projector)

Standards:

HSF–IF.C.7a

HSF–BF.B.3

Objectives:

- Graph lines when given the equation in function notation or given a table of values
- Identify the slope and y-intercept from the graph of the line
- Identify transformations on f(x) as either a translation, shrink, stretch, or reflection
- Identify a vertical translation as f(x) + k
- Identify a shrink as f(kx) when 0 < k < 1
- Identify a stretch as f(kx) when 0 < k
- Identify a reflection over the y-axis as f(-x)
- Interpret the transformations from one equation to another and graph the functions on the same coordinate plane

Assessment:

Formative – completion of exploration and 3.6 practice sheet

Anticipatory Set

Do-Now:

Class will begin with a quiz on lessons 3.3-3.5

Following the quiz students will pick up the exploration packet to work on. Once all students have completed the quiz they will work cooperatively to complete the activity.

Social Objective

Every student will have a voice in their group for this activity. Students must remember to be respectful when one of their classmates is speaking. They are to actively listen and respond to one another's thoughts. The focus must also be on the task at hand.

Face to Face Interaction

As for most activities in our classroom, the desks will be arranged in to groups of four. We have enough desks for nine groups. Two students will be seated side by and side and facing the other pair that is also side by side. Each student will be directly across and next to another student in order to promote cooperative learning.

Positive Interdependence

Each student will have a role in their group. One student will be responsible for keeping track of time and making sure the group is on task. Another will be responsible for getting and putting away all group materials. The third will serve as the official recorder. Every student should be completing the activity, but if the group is asked to share out their work, the recorded will be the one whose work is displayed so it must be clear and easy to follow. The fourth student will be the speaker or voice of the group. They will do any explaining when the group shares and answers questions.

Individual Accountability

In addition to the group roles, each student in the group will have a number assigned to them 1-4. There are four equations per section on the exploration. Each student will start with the equation corresponding to their number and explain to their group how to do that problem. Through each group member's problem and explanation, the group will end up with a completed exploration and they should all have similar findings in noticing

the patterns. If each student can successfully explain their problem, it will demonstrate that they are meeting the lesson objectives.

Group Accountability

Each group will be responsible for sharing and explaining a problem to the class. If the group cannot provide a clear explanation to the class, then disciplinary actions may be taken. This activity is a formative assessment and if the group doesn't complete it and cannot demonstrate a clear understanding of the concept, then they will be assigned additional work to complete and turn in.

Input – What and How

Transformations are a completely new and different topic for the students. Along with the cooperative exploration activity, we will have a set of formal notes. If the exploration is completed, the students should have a somewhat appropriate level of understanding of the topic.

The lecture should be interactive and students should be able to help lead and answer questions. We will go through the notes together, projected on the board.

Students should be writing down the notes and asking questions to further understand the concept.

Modeling

Teacher will go through notes:

1. The exploration demonstrates a good portion of the topic and how the transformations work, but it does not give any formal names or explanations for each type of transformation.
2. The first transformation we will cover is a translation. For linear equations we will only be looking at vertical translations, so as to not confuse the students.
3. Work through the example together by filling out the table by plugging in values and then graphing each function.
4. The general form of a vertical translation is $g(x) = f(x) + k$ where the graph shifts up when k is positive and down when it's negative.
5. Take questions about translations before moving on
6. The next transformation is shrinks and stretches. The students should recognize this as a change in the slope of the line. When the slope is bigger than 1, it is a stretch, and when it is a fraction between 0 and 1 it is a shrink.
7. Once again work through the example together. If students are confident, they may work ahead and complete the table and graph on their own.

8. The last transformation we will look at is reflections over the y-axis which are notated as g(x) = f(-x)
9. The next example we will work through to identify the transformations that have occurred from one equation to another.
10. These are the kind of problems the students will be expected to be able to complete.
11. Take questions about these problems before assigned the students the practice portion which is the next section of the notes packet.

Checking for Understanding

Throughout the exploration activity, I will be walking around and checking each groups work. When I notice misconceptions I will point them out and help redirect the students to where they should be. Each group should be able to explain the exploration. If there is a lot of confusion, then I know we will have to take the notes at a slower pace and possibly add additional examples.

During the notes, students should be actively participate because the exploration set them up for this concept. If there is hesitation we will slow down and I will answer any questions the students have. If necessary, we will complete two or three of the practice problems together before the students are given time to work in groups and on their own.

Guided Practice

As explained, the last page of the notes is a practice exercise worksheet. The students will be able to work together to complete these problems under my supervision. If there tends to be common mistakes, we will come together to look at a particular problem to clear up the misconception. Students will be able to ask for help during this practice to insure that they understand the problems they are working on.

Closure

Once the class period for the exploration is ending we will come together for each group to have a chance to demonstrate and explain their findings in the exploration. I will review with the class that we can notice each new line we added originated from the parent function and just moved around.

At the end of the notes and practice class period, we will come together to recap and summarize the types of transformations we know.

Translations represented by g(x) = f(x) + k

Shrinks/Stretches represented by g(x) = f(ax)

Reflections represented by g(x) = f(-x)

Independent Practice

The students will be responsible to take home and do any problems not finished in class on the practice sheet. The next day in class we will go over the answers.

Adaptations

Some students work at a much slower pace than others. For these students, I will cut back the numbers of problems they must complete on the worksheet because there are several. The students groups are arranged by ability. This way, low-ability students can be assisted by higher-ability students. The high-ability students are then challenged by the necessity to become a pseudo-teacher to help their classmates learn, rather than just doing the work for them.

Algebra   **Name**_____

3.6 Transformations Exploration
You will need:
        1. A ruler or straight edge
        2. 4 different colored pencils
        3. Regular pencil
EXPLORATION 1
Step 1:
        Graph the equation f(x) = x   (Remember f(x) is another name for y)
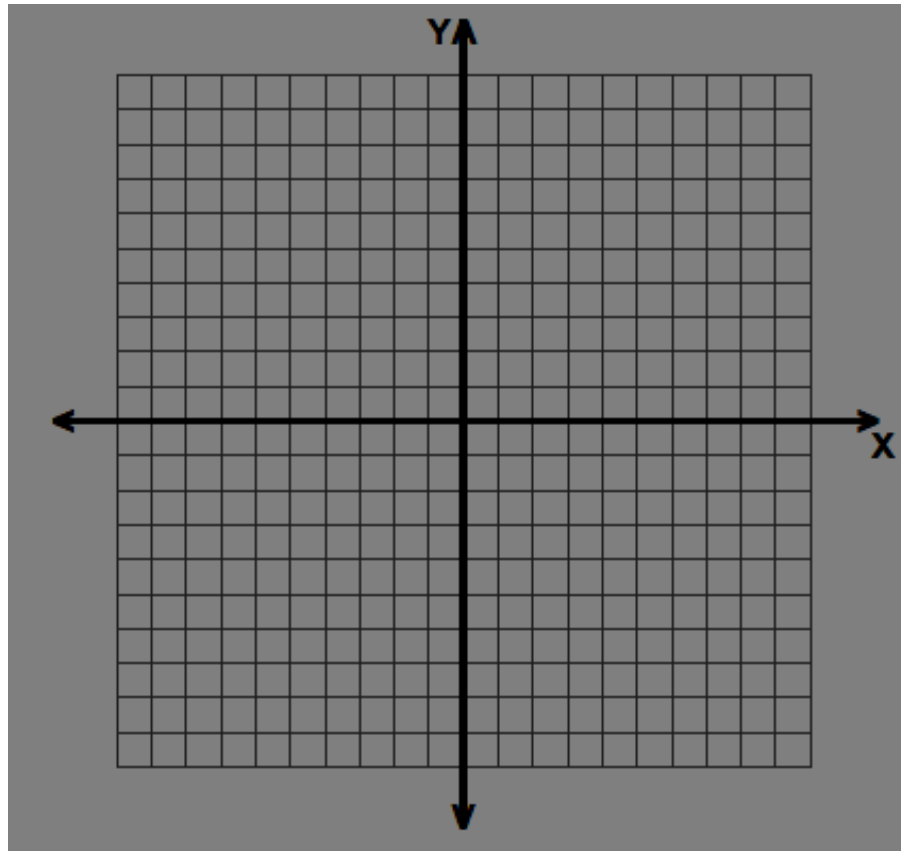
Step 2:
        Graph each of the following functions on the same coordinate plane above.
        Use a different color for each function.

        1. g(x) = x + 2   2. g(x) = x − 2

        3. g(x) = x − 4   4. g(x) = x + 4

Step 3:
        What patterns do you notice?

EXPLORATION 2
Step 1:

Graph the equation f(x) = x   (Remember f(x) is another name for y)
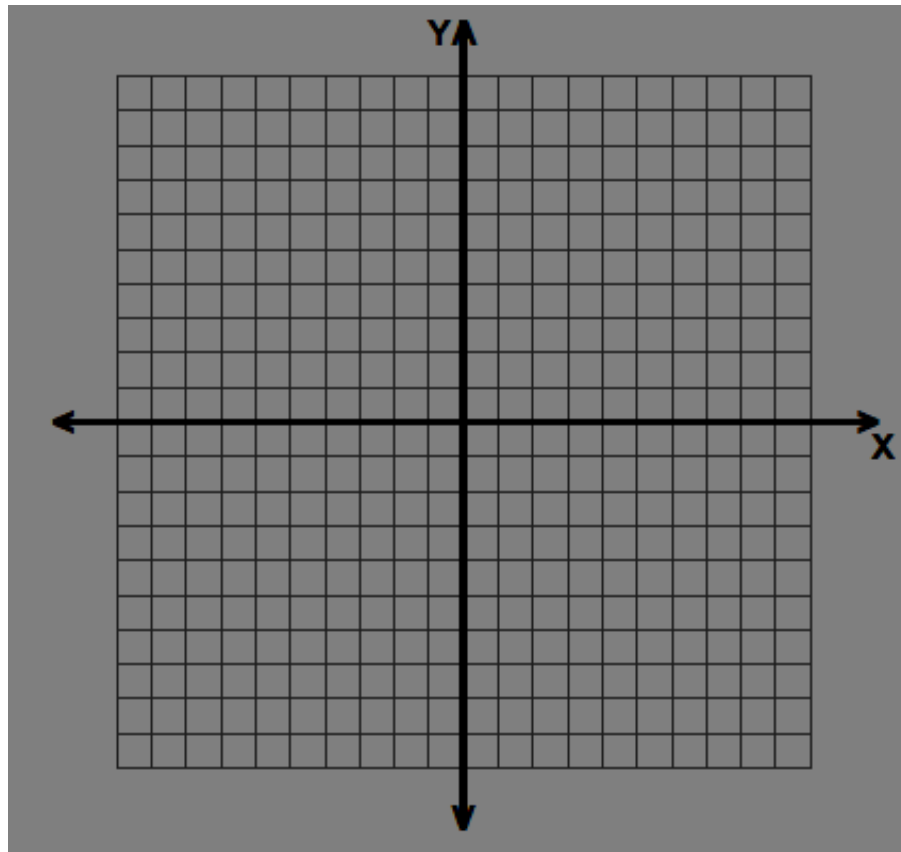
Step 2:

Graph each of the following functions on the same coordinate plane above.
Use a different color for each function.

1. $h(x) = \frac{1}{3}x$

2. $h(x) = 3x$

3. $h(x) = \frac{-1}{3}x$

4. $h(x) = -3x$

Step 3:

What patterns do you notice?

EXPLORATION 3

Step 1:

Match each function with the appropriate graph.

a. $k(x) = 2x - 4$

b. $k(x) = -2x + 2$

c. $k(x) = \frac{1}{2}x + 4$

d. $k(x) = -\frac{1}{2}x - 2$

A.

B.

C.

D.
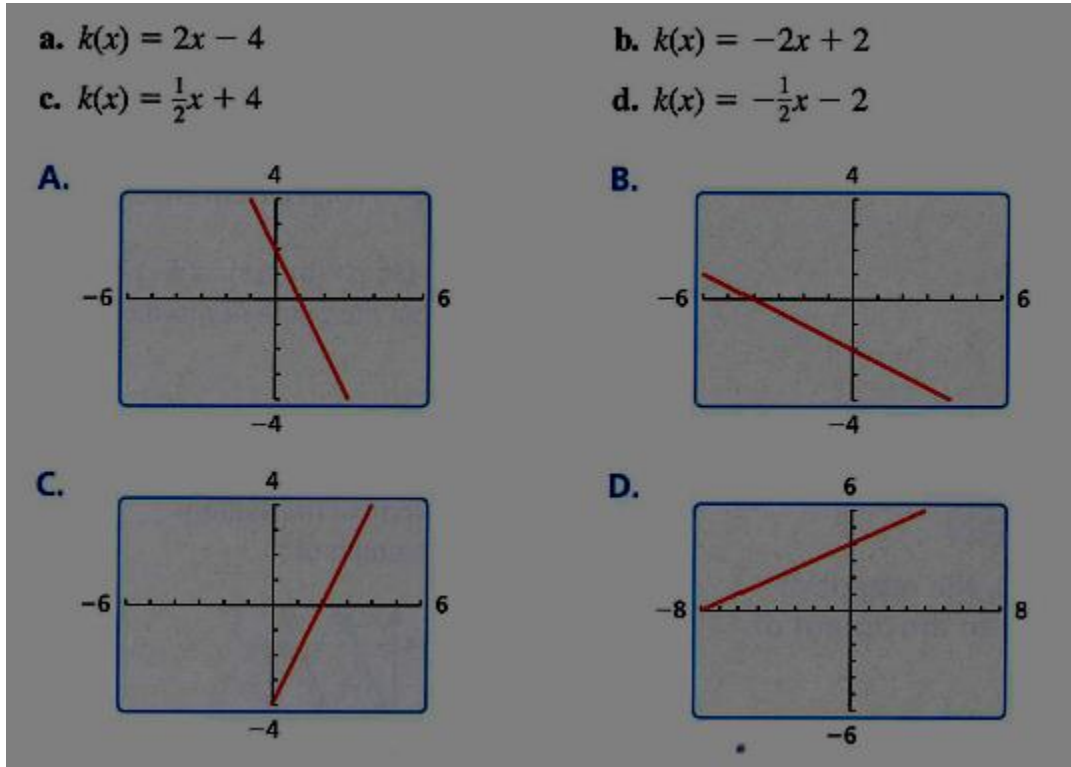
Step 2:

Compare each graph to the graph of f(x) = x. (use exploration 1 and 2 to help you)

Step 3:

Compare the function f(x) = x to the functions below.
Explain how the graphs would be different.

a) g(x) = $f(x) + c$

b) h(x) = $c \cdot f(x)$

Algebra
Notes 3.6 Linear Transformations

The function f(x) = x can be called the **parent function** for all other linear functions. We can get any linear graph by doing a transformation on f(x) = x. A **transformation** changes the size, shape, position, or orientation of a graph.

Translations

A translation shifts a graph left, right, up, or down. For linear graphs, we will shift the line up or down.

Start with:

$$f(x) = x$$

To move up or down:

$$g(x) = f(x) + k$$

We are adding k to the outputs of the function f(x) to move to g(x).

Note: k is a number.
If k > 0, the graph will shift up.
If k < 0, the graph will shift down.

Vertical Translations

The graph of $y = f(x) + k$ is a vertical translation of the graph of $y = f(x)$, where $k \neq 0$.
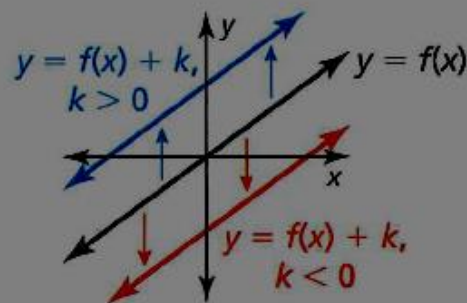
Adding k to the *outputs* shifts the graph down when $k < 0$ and up when $k > 0$.

Example 1:
f(x) = 2x − 1   g(x) = f(x) + 3   h(x) = f(x) − 3

x	f(x)	g(x)	h(x)
- 1			
0			
1			
2			
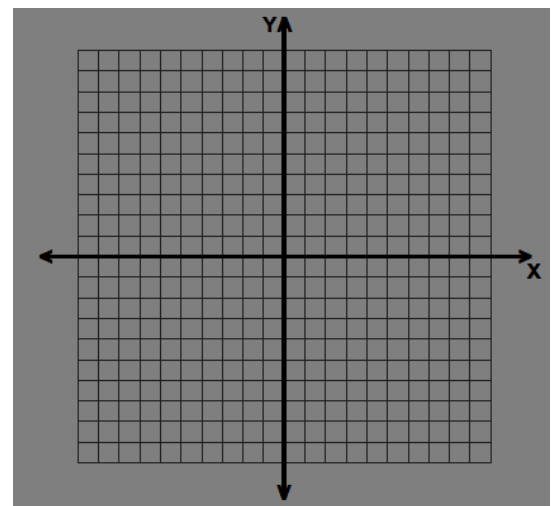
Stretches and Shrinks

Stretches and Shrinks are a transformation that changes how close a line is to the x or y axis. For linear graphs, a stretch or shrink can be thought of as making the line steeper or shallower.

Start with:

$$f(x) = x$$

To Stretch or Shrink:

$$g(x) = f(ax)$$

We are multiplying x by a to change the slope

Note: a is a number
If a > 1 the graph will stretch up and become steeper
If 0 < a < 1 the graph with shrink down and become shallower
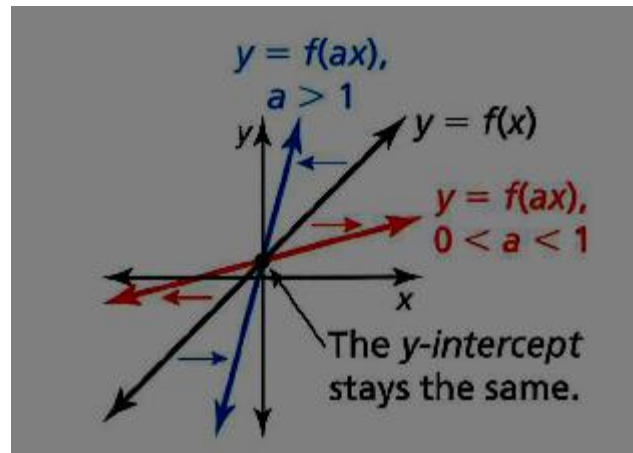
Example 2:

$$f(x) = x + 2 \qquad g(x) = f(2x) \qquad h(x) = f\left(\frac{1}{2}x\right)$$

x	f(x)	g(x)	h(x)
- 2			
0			
2			
4			
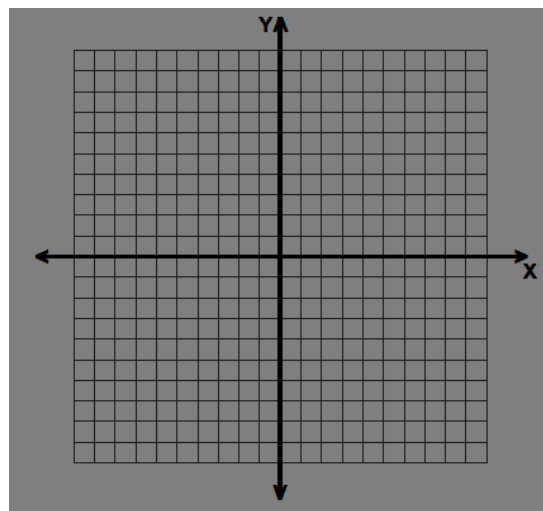
Reflection

A reflection is a transformation that flips a graph over a line.
For linear graphs, a reflection changes the sign of the slope.

Start with:

The graph of $y = f(-x)$ is a reflection in the y-axis of the graph of $y = f(x)$.

f(x) = x

To Reflect:

g(x) = f(- x)

The graph will reflect over the y-axis.

Multiplying the inputs by -1 changes their signs.
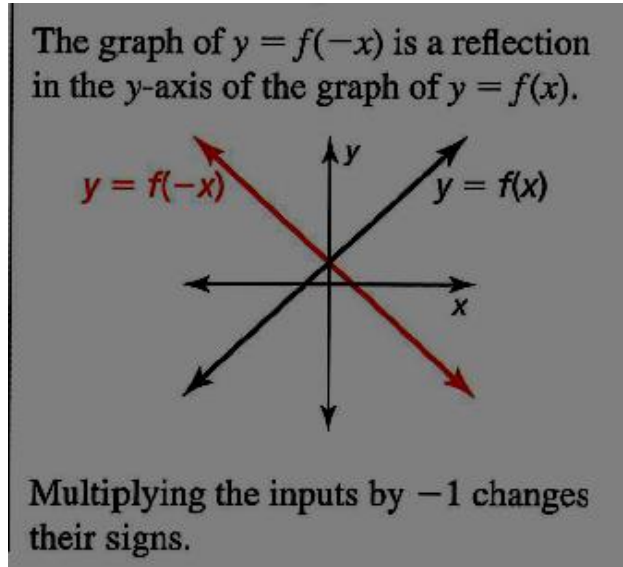
Example 3: Combining Transformations

f (x) = x and g(x) = - 2 x + 3   Describe the transformation from the function f to g.

$f(x) = \frac{1}{3}x + 4$ g(x) = f (5x) -2   Describe the transformation from f to g.

Write in function notation the function g(x) which is a transformation of f (x) up 5 units and a shrink by a factor of $\frac{1}{4}$

Practice 3.6 Linear Transformations

Describe the transformation from the first function to the second function.

1. $f(x) = x$
   $g(x) = x - 4$

2. $f(x) = x$
   $g(x) = 6x$

3. $f(x) = x + 1$
   $g(x) = -x + 1$

4. $f(x) = x$
   $g(x) = \frac{1}{5}x + 9$

5. $f(x) = 3x$
   $g(x) = -3x - 5$

6. $f(x) = x$
   $g(x) = \frac{-2}{3}x + 7$

7. $f(x) = 4x - 8$
   $g(x) = f(x) + 1$

8. $f(x) = -2x - 4$
   $g(x) = f(2x)$

9. $f(x) = \frac{3}{4}x + 2$
   $g(x) = f(\frac{-1}{2}x) - 9$

Write in function notation the function $g(x)$ which is a transformation of $f(x)$.

10. Shifts down 3 units and is a stretch by a factor of 12.

$g(x) =$ _____

11. A reflection and shrink by a factor of $\frac{2}{3}$

$g(x) =$ _____

12. Shifts up 6 units, is a reflection, and a stretch by a factor of 5.

$g(x) =$ _____

13. Shifts down 3 units and is a shrink by a factor of $\frac{4}{5}$

$g(x) =$ _____

Algebra
Unit 3 Word Problems Practice

EXAMPLE 6   **Modeling with Mathematics**

A submersible that is exploring the ocean floor begins to ascend to the surface. The elevation h (in feet) of the submersible is modeled by the function $h(t) = 650t - 13{,}000$, where t is the time (in minutes) since the submersible began to ascend.

a. Graph the function and identify its domain and range.

b. Interpret the slope and the intercepts of the graph.

37. **MODELING WITH MATHEMATICS** The function shown models the depth d (in inches) of snow on the ground during the first 9 hours of a snowstorm, where t is the time (in hours) after the snowstorm begins.
(See Example 6.)
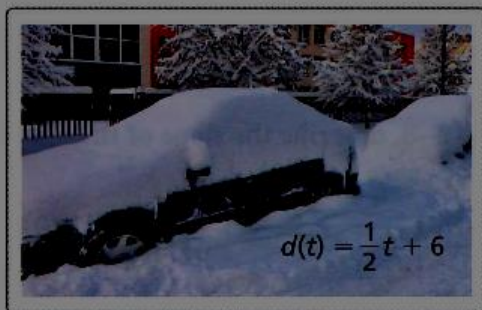
$$d(t) = \frac{1}{2}t + 6$$

a. Graph the function and identify its domain and range.

b. Interpret the slope and the d-intercept of the graph.

MODELING WITH MATHEMATICS You are researching the speed of sound waves in dry air at 86°F. The table shows the distances d (in miles) sound waves travel in t seconds. *(See Example 5.)*

Time (seconds), t	Distance (miles), d
2	0.434
4	0.868
6	1.302
8	1.736
10	2.170

a. Does this situation represent a linear function? Explain.

The table shows your earnings y (in dollars) for working x hours.

Time (hours), x	Earnings (dollars), y
4	40.80
5	
6	61.20
7	71.40

a. What is the missing y-value that makes the table represent a linear function?

b. What is your hourly pay rate?

Algebra   Name_____

Unit 3 Review

Determine if each relation is a function:

1a.
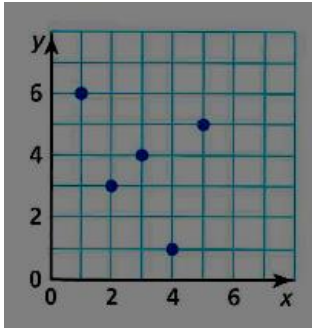
2a.
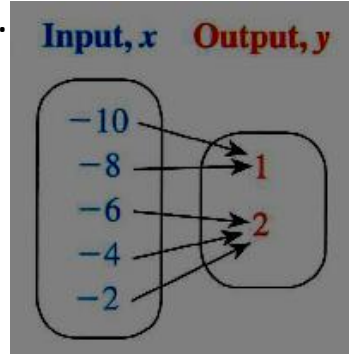
3a. $(7, 4), (5, -1), (3, -8), (1, -5), (3, 6)$

4a
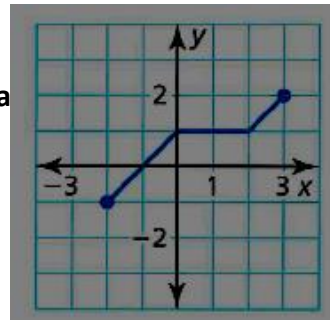
State the domain and range for each question above.

1b. D:_____   **2b. D:_____**

R: _____   **R:_____**

3b. D:_____   **4b. D:_____**

R: _____   **R:_____**

Determine if the function is linear or non-linear.

5.
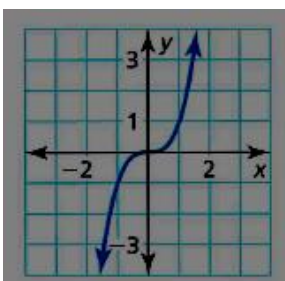
6.

x	5	7	9	11
y	-9	-3	-1	3

7. $2x + 3y = 9xy$

Evaluate each function as directed.

8. For g(x) = {(0 , 2) , (-2 , 6) , (8, 3) , (3, 5), (1, -4)} **, find g(-2)**

9. For $f(x) = 2(x + 1) - 3$, **find f (5)**

10. The function h is graphed at the right

           Find x so that h(x) = -1
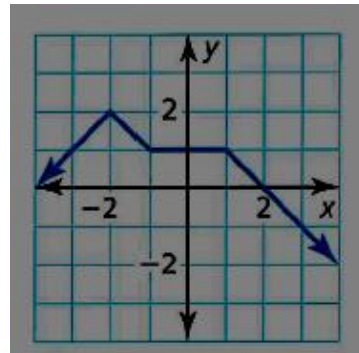
Graph the following lines.

11. 4x − 2y = 8

    x-intercept:

    y-intercept:

12. y = $\frac{3}{4}x + 3$

    y-intercept:

    Slope:
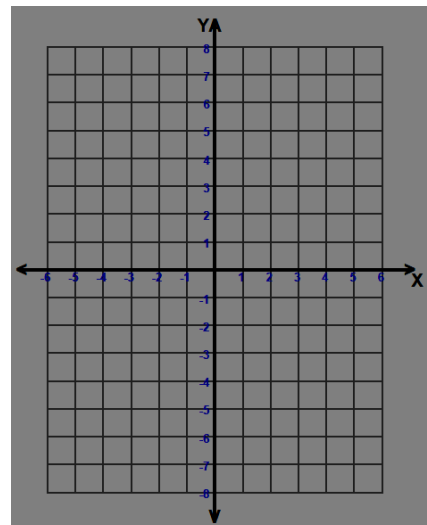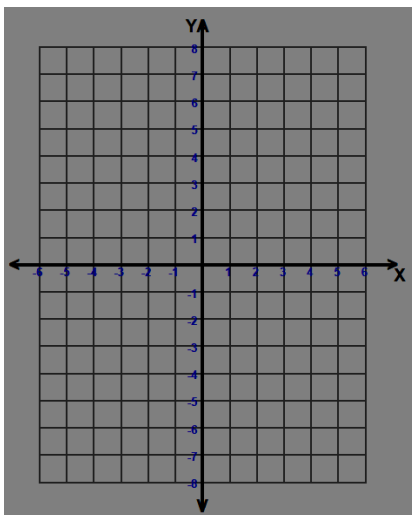
Graph:

13. x = 2
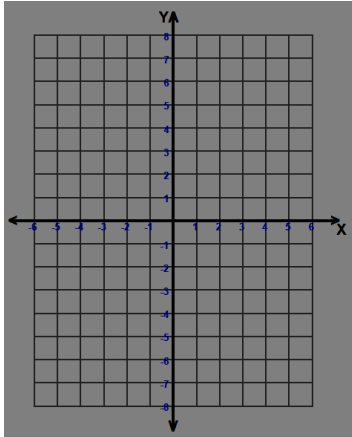
14. y = 3
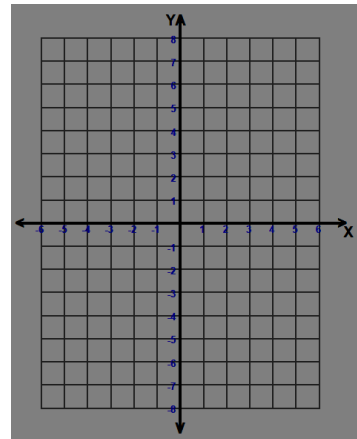
Given the graph, list the slope and y-intercept.

15.

Slope:

int:
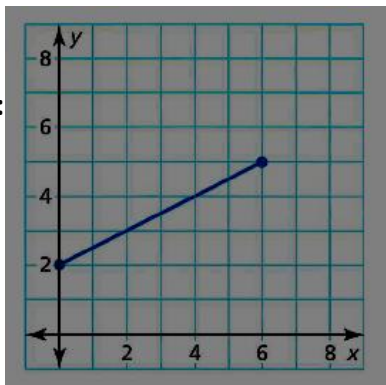
Slope:

Y-int:

16.
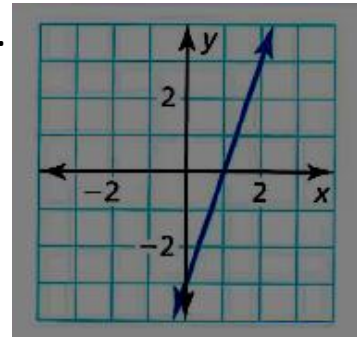
Y-

Describe the transformation from *f(x)* **to** *g(x).*

17. $f(x) = x$

$g(x) = 4x - 3$

18. $f(x) = -2x + 3$

$g(x) = f(-x) + 2$

19. Write the function *g(x)* **in function notation that is a transformation of** *f(x)* **shifted down 1 unit, a shrink by a factor of** $\frac{1}{4}$, **and a reflection.**

$g(x) =$ _____

Unit Overview

Monday	Tuesday	Wednesday	Thursday	Friday
			30 Unit 3 Pre-Assessment	31 Unit 3 Intro to Functions Exploration and Flip Book
3 Finished Intro Exploration Function Sort	4 Begin 3.2 Notes Linear Functions	5 Wrapped up Linear Function Notes and Practice in class	6 3.3 Notes Function Notation	7 Practice Function Notation
10 Began 3.4 Notes Graphing with intercepts	11 Finish 3.4 Notes 3.5a Slopes	12 Slope Intercept Exploration (3.5)	13 3.5 Notes and Practice	14 Quiz 3.3-3.5 Started Exploration
17 3.6 Transformations	18 Finished 3.6 Practice	19 Word Problems Review	20 Unit 3 Test	21 Test analysis and wrap up

Summative Assessment

At the end of the unit, student will be assessed with a pencil and paper test that is modeled after the pre-test. The first part will have 3 questions per topic that we covered. The second part will have 2 application word problems.

Rubric for Summative Assessment

The point of the test is to assess the skills the students have developed over the course of the unit and how well they can apply those skills. Students will receive one point per question they answer correctly. There is a maximum of 3 points available per topic and a total of 31 points for the entire test. Students will be able to retake any portion of the test that they do not do well on.

Algebra 1 Post Test   **Answers in Red**   NAME_____Key_____
Unit 3: Linear Functions

1. Determine if each relation is a function:

a) $(0, 1), (5, 6), (7, 9)$ **b)**

Yes   **Yes**

c)
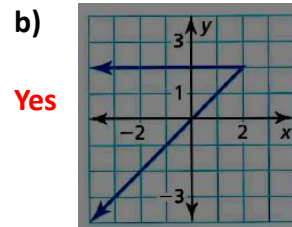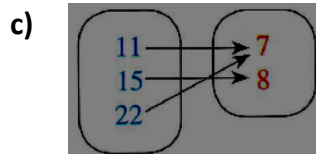
No

2. State the domain and range of each:

a)   **b)**

D:_____{0, 1, 2, 3, 4}___   D:_____{- 3 $\leq$ x $\leq$ 3}___
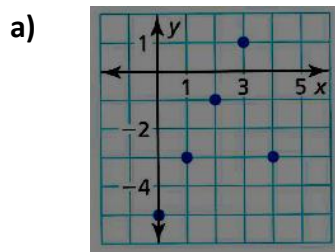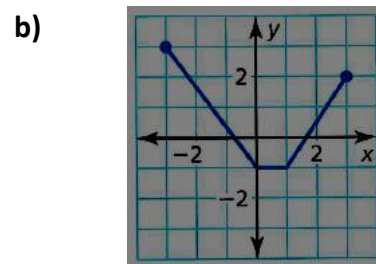
R:_____{-5, -3, -1, 1}___   R:_____{ -1 $\leq$ y $\leq$ 3}___

c) $(-10, 2), (-8, 3), (-6, 5), (-8, 8), (-10, 6)$

D:_____{-10, -8, -6}___

R:_____{2, 3, 5, 6, 8}___

3. Determine if the given function is linear or nonlinear:

a)

x	2	7	12	17
y	2	-1	-4	-7

b)
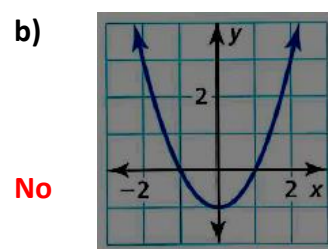
Yes   **No**

c) $2(y - 3) + 4 = 5x + 7$ **Yes**

4.

a) For $g(x) = \frac{x+2}{3}$, find g (10)

g(10) = 4

b) For $h(x)$ = { (-2, 4), (-1, 1), (0,0), (1,1), (2, 4) } , find h(1)

h(1) = 1

c) The function f is graphed at the right

Find x so that $f(x) = 5$

X = -1
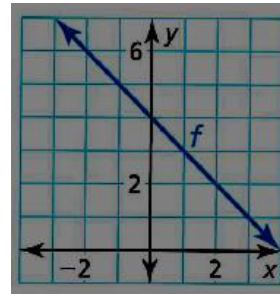
5. Use $-2x + 3y = -6$ **to answer a & b**

a) give the x- & y- intercepts for the linear equation

x-intercept_____3_____   y-intercept_____-2_____

b) using the intercepts,
graph $-2x + 3y = -6$ c) graph $y = 4$

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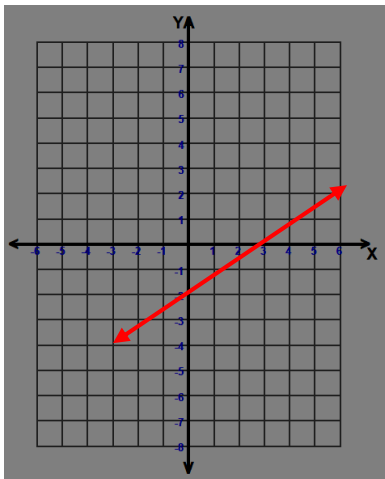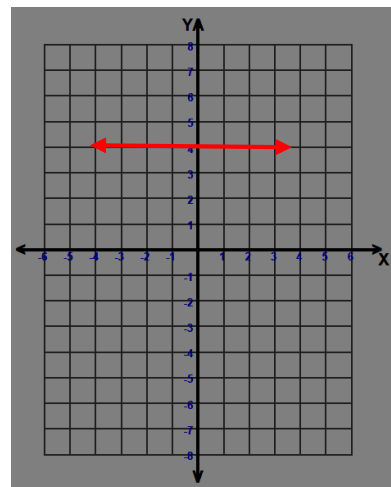
6.

a) Identify the slope and y-intercept
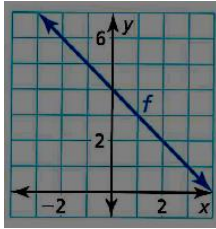
slope _____-1_____

y-intercept____4_____

b) graph $w(x) = \frac{3}{5}x - 1$
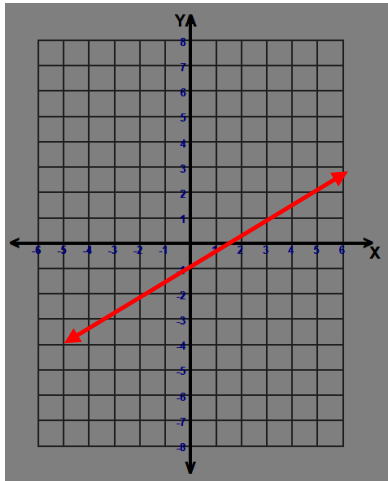
slope ____3/5_____

y-intercept_____-1_____

c) graph $y = -6x + 3$
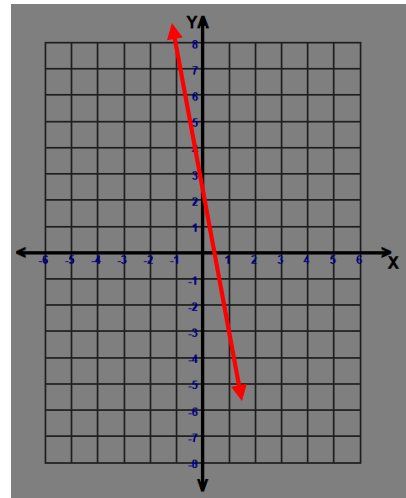
slope _____-6_____

y-intercept___3_____

7. $f(x) = 2x - 5$ $g(x) = f(\frac{3}{4}x) + 1$ $h(x) = f(-x) - 3$

a) describe the transformation from f(x) to g(x)
   shifts up 1
   shrink by a factor of 3/4

b) describe the transformation from f(x) to h(x)
   shifts down 3
   reflection

c) write in function notation the function j(x) that is a transformation of f(x) shifted up 2 units and is a stretch by a factor of 6.

   j(x) = _____f(6x) + 2_____

8. A mountain climber is scaling a 500 ft cliff. The graph shows the climbers elevation over time:

Mountain Climbing

$f(x) = 125x + 50$

Elevation (feet) vs Time (hours)
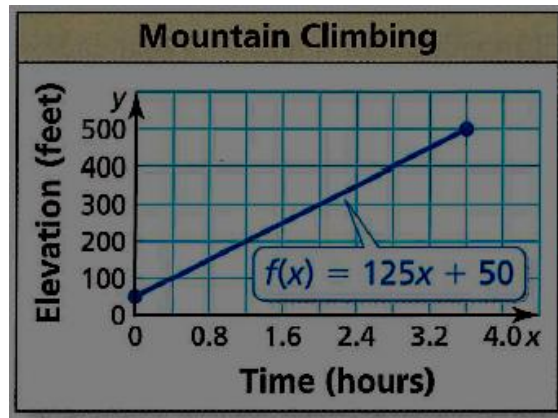
a) identify the slope and interpret its meaning

125, the mountain climber goes up 125 feet every hour

b) find f(3) and interpret its meaning

425, in 3 hours the mountain climber has reached 425 feet

c) identify the y-intercept and interpret its meaning

50, the mountain climber starts climbing at 50 feet

Algebra Test   Answers in Red   Name_____

Unit 3– Part B

1.

You claim you can create a table of values that represents a linear function. Your friend claims he can create a table of values that represents a nonlinear function. Using the given numbers, what values can you use for x (the input) and y (the output) to support your claim? What values can your friend use? *(HSF-LE.A.1b)*

Your claim					Friend's claim			
x					**x**			
y					**y**			

−4	−3	−2	−1	0
1	2	3	4	5

Answers will vary
Possible answers:
Your Claim: X = 1, 2, 3, 4   Friend's Claim: X = 1, 2, 3, 4
Y= -1, -2, -3, -4   Y = -2, 0, 1, 5

2.

Use the numbers to fill in the coefficients of $ax + by = 40$ so that when you graph the function, the x-intercept is -10 and the y-intercept is 8. *(HSA-CED.A.2)*

−10	−8	−5	−4	4	5	8	10

A = -4   B = 5   -4x + 5y = 40

Post Assessment

Students were given a post-test to measure how much the students learned about the topics of the unit after we finished. I focused on three main objectives from the test and rated the students with a 1, 2, or 3 on these sections. 1 = none or very little understanding, 2 = limited understanding, and 3 = substantial understanding. After the test, if students are not happy with how they did on any portion of the test, they will be permitted to come after school and retake those portions on a new, similar test.

Objective 1	**Objective 2**	**Objective 3**
(Test Questions 1 & 2)	(Test Questions 4 & 8)	(Test Questions 5 & 6)
0-2 examples = 1	0-2 examples = 1	0-2 examples = 1
2-4 examples = 2	3-4 examples = 2	3-4 examples = 2
5-6 examples = 3	5-6 examples = 3	5-6 examples = 3

Objective 1

HSF–IF.A.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).*

Objective 2

HSF–IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Objective 3

HSF–IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.

Student Summary of Post-Assessment Information			
Student Number	Objective 1	Objective 2	Objective 3
1	2	2	3
2	2	1	1
3	3	2	2
4	3	3	3
5	2	1	3
6	2	2	2
7	1	1	2
8	3	3	2
9	2	1	1
10	2	2	2
11	2	2	3
12	3	3	3
13	3	3	3
14	3	3	3
15	2	3	2
16	3	3	3
17	2	3	3
18	3	3	3
19	3	2	3
20	2	2	2
21	3	3	2
22	1	1	1
23	2	2	2
24	2	3	3
25	2	2	2
26	3	3	2
27	3	3	3
28	1	1	2

29	2	2	2
30	2	1	1
31	2	3	2
32	3	3	3
33	3	2	3
34	2	2	3
35	3	2	2
36	1	1	2
37	2	1	2
38	2	3	2
39	3	2	3
40	1	1	1
41	1	1	1
42	2	2	3
43	3	1	1
44	2	1	1
45	2	1	1
46	1	1	1
47	1	1	2
48	2	1	1
49	2	1	1
50	3	3	3
51	2	2	2
52	3	2	3
53	2	2	3
54	1	1	1
55	3	3	2
56	3	2	2
57	2	3	1

Group Analysis of Student Learning

Objective/Outcome	Assessment Strategy	Summary of Results
HSF-IF.A.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)*.	Students were given a paper and pencil test and this objective was assessed by questions 1 and 2. Each question had three parts and students had to identify if the relation was a function and the domain and range of given relations. A rating of 1 was given for 0-2 correct, 2 was given for 3-4 correct, and 3 was given for 5-6 correct.	On the test, 9 students still receive a rating of 1, 27 students received a 2, and 21 students received a 3. Most students still in the 2 range were only short of a 3 by one question.

Objective/Outcome	Assessment Strategy	Summary of Results
HSF-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	Students were given a paper and pencil test and this objective was assessed by questions 4 and 8. Each question had three parts. Question 4 used function notation to evaluate for given values. Question 8 used function notation to model a real problem. Students had to evaluate and interpret meanings. A rating of 1 was given for 0-2 correct, 2 was given for 3-4 correct, and 3 was given for 5-6 correct.	The data for this outcome were even across the board, 19 students received a 1, 19 students received a 2, and 19 students received a 3. The issue here was many students made silly mathematical errors and also forgot the interpretation portions of question 8.

Objective/Outcome	Assessment Strategy	Summary of Results
HSF-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.	Students were given a paper and pencil test and this objective was assessed by questions 5 and 6. Each question had three parts. Both questions involved graphing and identifying the slope and intercepts of lines. A rating of 1 was given for 0-2	For this outcome, 14 students still received a 1, 22 students received a 2, and 21 students received a 3. Many students received partial credit for some of these problems, but it was

	correct, 2 was given for 3-4 correct, and 3 was given for 5-6 correct.	not enough to bump them up to the next rating.

Post Assessment Data Summary

Number of Students who received each rating for each objective			
Rating	Objective 1	Objective 2	Objective 3
1	9	19	14
2	27	19	22
3	21	19	21
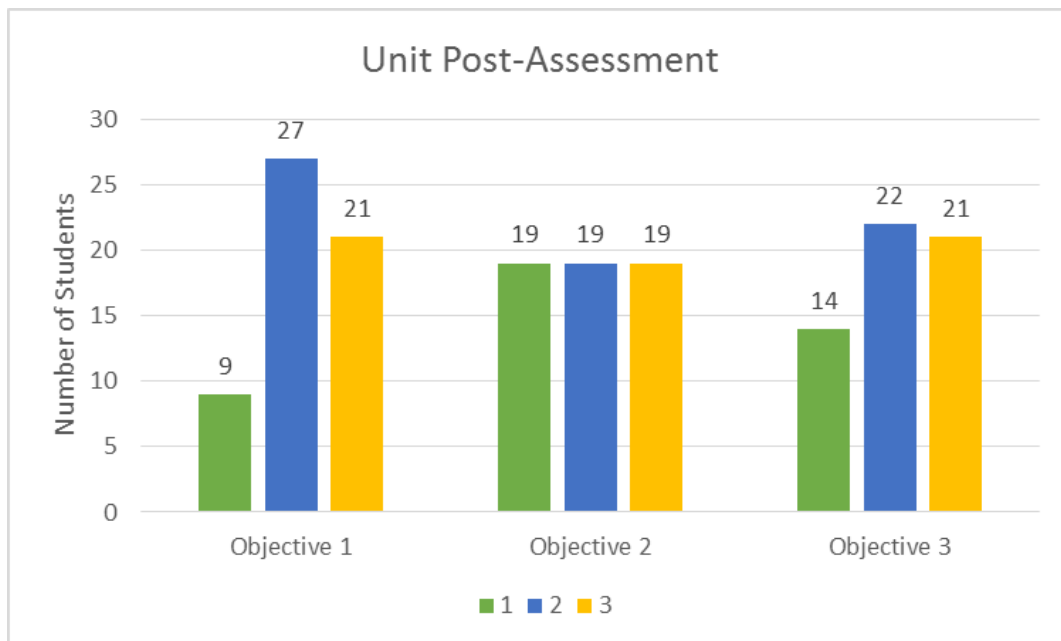
Summary Statement for Student Learning

There was evidence of student learning for each outcome that was addressed. For the first outcome, students were being assessed to see whether they could determine a relation was a function, and to state the domain and range of a function. 19 students stayed where they were and did not improve ratings. 32 students moved up one rating, whether it be from a 1 up to a 2 or a 2 up to a 3. 6 students actually moved up 2 ratings, from a 1 up to a 3. On this objective, 67% of the class improved.

There were substantial gains in the second outcome. On the pretest, all 57 students received a rating of 1. This outcome was testing how well students could evaluate and interpret information using function notation. On the post test, 19 students stayed at a rating of 1, 19 students moved up to a rating of 2, and 19 students moved up to a rating of 3. Once again here, 67% of the class improved.

For the third outcome there were also significant learning gains made. This objective was measuring students' ability to graph linear equations and identify the slope and x- and y- intercepts of the function. On the pre-test 52 students received a 1 and only 5 students received a 2. 13 students stayed at the rating they were at, being a 1. 26 students improved their rating by 1 point, 22 of them moved from 1 to 2 and the other 4 moved from a 2 up to a 3. 17 students were actually able to improve by 2 ratings, from a 1 up to a 2. Unfortunately, 1 student actually went backward, they had received a 2 on the pre-test but only received a 1 on the post test. On this outcome, 75% of the class improved in their ratings.

While teaching this unit, I could tell that all students were learning. When we took a quiz about mid-unit, the scores were really good. The class average was 80%, which is much higher than the typical quiz or test. I was impressed with how well everyone did on the test as well. There were still errors made, but I feel they were minor problems. The overall concepts were pretty well mastered and understood.

Individual Analysis

Christian showed improvement on all three objectives I focused on in this unit. On the pre-test, he scored a 1 in every section. However, he did attempt a majority of the problems on the pre-test. On the post test, he actually did quite well. He received a rating of 2 on the first two objectives, and he scored a 3 on the third, jumping 2 ratings here. Christian has several older siblings including step siblings. Lately he has been very focused on trying to get accepted to the Early College Alliance program at EMU. I feel this helped motivate him to try and focus throughout the unit. Occasionally I even used it as a reminder that he needs to do well in school and that he will have to take on a lot more responsibility if he is accepted. Christian also unexpectedly joined the swim team about midway through the unit, and it was obvious when he was fatigued from practice.

Christian still tended to be very chatty throughout class periods when students were permitted to work in groups, which was often. Many times I had to redirect

him to the task at hand. I would often make him show me how to do a problem before I walked away. Most of the time, he was able to demonstrate the skills necessary to complete the problems. At other times, however, he was not. I knew it was because he hadn't been paying attention when we were doing notes. At those times I helped walk him through the problem to get him back on track. Most of the mistakes he made on the post-test were minor. I feel it was very obvious he had mastered the concepts of linear functions. A couple of weeks after we finished the unit he decided to come after school to get help and retake the portions of the test in which he did not receive a 3. On his retake he was able to correctly answer all of the questions he missed on the post-test.

Reflection and Self Evaluation

The class showed significant improvement in all three of the outcomes that I focused on. The most improvement was made on the third objective with 75% of the class improving their rating. 30% of the class actually improved by two, going from a 1 to a 3, or no understanding to substantial understanding. On the first and second objectives, 67% of the class improved on both of them. However, the second objective was the most difficult and split the class evenly. 33% did not improve, 33% improved by 1 rating, and 33% improved by 2 ratings. One the first objective, 33% did not improve, 57% improved by 1 rating, but only 10% improved by 2 ratings. I was very surprised by this because I felt that the first objective was the easiest.

For the first objective, students were determining whether or not a relation was a function and listing the domain and range. The most common mistake on identifying the functions was that students forgot that each input can only have one output, but it is ok if two different inputs go to the same output. This was the very first thing we learned in the unit. The students understood when we did the lesson on this topic, but I think we did not spend enough time reviewing it before the test. The most common mistake in identifying the domain and range was how to list in when it is a continuous functions. Most students chose random points on the line to include and only a small percentage remembered that they had to write it as an inequality. The other problem with domain and range was that many students missed one of the points on the first. It was on the y-axis and hard to see. Since I was looking to see if the students knew the domain and range, I probably should have chosen a problem where all of the points were easily identifiable. They had mastered the concept, but made a silly error because they were moving too fast. We also only had 2 examples for a continuous function, and there was practice for that. Next time I teach the unit I would make sure to include more practice on this topic.

I am fairly happy with the performance the students had on the third objective after the unit. 13 students still stayed at the same rating they already had, but this is only 23% compared to the 33% that did not change on the other two objectives.

45% of the class, or 26 students improved their rating by 1 point. 4 of those students moved from a 2 to a 3 and the other 22 changed from a 1 to a 2. 17 students, or 30% of the class went from a rating of 1 up to a rating of a 3. I was very impressed with the growth these students displayed. Unfortunately 1 student went back from a 2 to a 1, but overall this outcome still had the best improvement. This objective was all about graphing linear equations from either standard form or slope-intercept form. Graphing was not a completely new topic, but starting from just an equation was new. Most students had prior knowledge of how to graph individual points when given ordered pairs and how to find the slope of a line when given the graph. The new skills were reading or solving for the information from the equation. I feel students were most improved in this area because of the activities we did. The inductive lesson of this unit was about the slope-intercept form of a line and I think that could have played a major factor in why the students did so well. The class was allowed to make discoveries on their own, and typically you learn better from finding things out by yourself.

I really enjoyed having the opportunity to watch these students grow while learning about linear functions. I did not focus on the objectives that would be met by the application portion of the test, but I was impressed with the scores students received on that part. Many students did relatively well on these harder questions. It made me feel good knowing that they could do that because of what I taught them. I also feel that there were not as many 3's on the standards I looked at because of silly errors. I strongly believe a majority of the class has mastered the skills of the unit, and I am happy with that.

I do still have some things I need to work on when I am teaching a unit. Sometimes the notes presentation did not go as well as I had hoped. I had to backtrack a few times to rid the students of the confusion that they were having. I also had to make things a lot simpler than I would have thought they needed to be. Another struggle I had was with time. Many times we were very rushed when trying to bring the concept all together at the end of a unit. I didn't realize how long some activities would take the students, but we were still able to get through everything we needed to. If we had spent a little more time on some of the sections I believe the scores would have improved as well. However, this unit was already long and I didn't want to have to eat up even more class time than we already had.

Overall, I feel my unit went well. I think the students had fun with some of the different activities we completed since it was not all just lectured. They really enjoyed doing things and making their own discoveries. It can tend to be difficult to find many good activities for math topics, but I'm glad I found some that were fitting.

Teaching Materials
- Group supply boxes (4 students per box)
    - Scissors
    - Colored pencils
    - Markers
    - Glue
- Rulers
- Dice
- Colored Paper (any color)
- ELMO (document projector)
- White Board
- Dry Erase Markers
- Graph Paper
- Class set of TI-84 Calculators
- All handouts are included with each lesson plan

Resources

Algebra 1 Station Activities for Common Core State Standards. Portland: J. Weston Walch, 2011. 270. Print.

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