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Curriculum Redesign with an Emphasis on Mathematical Literacy in an 8th Grade Function Unit

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Curriculum Redesign with an Emphasis on Mathematical Literacy in an 8th Grade Function Unit

By
Caitlin Mosher
December, 2015

A thesis project submitted to the Department of Education and Human Development of the State University of New York College at Brockport in partial fulfillment of the requirements for the degree of Master of Science in Education
Abstract

Most teachers in the United States are going through a paradigm shift. Teachers have to switch from using the National Council of Teachers of Mathematics (NCTM) Standards or State Standards to the Common Core State Standards. With this shift in standards, teachers are now creating new curriculum that follow the CCSS. This thesis provides a unit on function that is aligned with CCSS. This unit has an emphasis on mathematical literacy to help students have a deeper understanding of the concepts they are learning.
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Chapter 1: Introduction

With the implementation of the Common Core State Standards (CCSS) in 42 states, the District of Columbia as well as 4 territories starting in 2010 (www.corestandards.org), these states are now going through a paradigm shift from National Council of Teachers of Mathematics (NCTM) standards/state standards to CCSS. The teachers in these states must adjust to the new curriculum and develop new materials. There are several major changes between state standards and the new CCSS. According to Porter, McMaken, Hwang, and Yang (2011) when comparing mathematics standards

...one quickly sees that the Common Core Standards do not contain any probability, analysis, special topics, or instructional technologies, whereas the state standards include at least some of each of those topics. Both the Common Core and state standards put heavy emphasis on number sense and operations, but state standards put more emphasis on measurement then do the Common Core standards, and the Common Core standards put more emphasis on "demonstrate understanding" and "conjecture" then do the state standards. (Porter, McMaken, Hwang, & Yang, 2011, p. 107)

With this change from the NCTM and or state standards to CCSS, there is a change in what is being taught in school. The standards have become more focused than the majority of other state standards and NCTM. There is a desire to have students that are able to "demonstrate understanding" and be able to make "conjectures", which requires teachers to change the way they are teaching, as well as, what they are teaching (Porter, McMaken, Hwang, & Yang, 2011).

For some students, it is hard to understand what is being taught in their mathematics classes because to them mathematics looks and sounds like a foreign language. It may look like English at first glance, but then they notice that some of the terms don't make sense when the
English definition of the word is used. For example, the word number has a different meaning depending on whether you are referring to the English definition (meaning 2 or more) or the mathematical definition (any numeric digit) (Reuben, 1997). Reuben (1997) and Tall (2004) both explain that there are inconsistencies not only between word definitions in math and English but also terms in math that will have different meanings depending on how they are used. Tall (2004) explains that in mathematics the definitions of terms change over time as people start using the term for new meanings. It is important to have students that are mathematically literate with the changes taking place since the implementation of the CCSS.

**Problem Statement**

Because of the recent changes in mathematics education and the push for the student’s ability to demonstrate understanding and make conjectures, it is important for students to have a deeper understanding of what they are learning. According to Steen (1999) "...most U.S. students leave high school with far below even minimum expectations for mathematical and quantitative literacy" (p. 8). Steen (1999) goes on to explain that businesses and colleges have difficulty finding students that have strong quantitative skills and mathematical skills. By becoming mathematically literate, students are able to show that they fully understand what they are being taught, as well as, being able to reason their way through new information being presented. The goal of this curriculum study is to provide teachers with an introduction to functions unit containing mathematical literacy strategies that will help students become more mathematically literate.

**Rational**

The purpose of this curriculum study is to create a unit on the topic of functions for an eighth grade classroom that is aligned to the CCSS with strategies involving mathematical
literacy. This unit will start out with the basics of having students learn or discover what a function is, the ability to tell if they have a linear function or a non-linear function, and how to graph functions. Throughout this unit there will be instructional strategies that teachers can incorporate to support students' development of mathematical literacy. These strategies will help students have a firmer foundation on which to build on in the future. They will be able to apply this knowledge to future learning. These strategies can also be used when teaching 6th, 7th, and high school grade mathematics.
Chapter 2 Literacy Review

Mathematical Literacy:

In order to bring mathematical literacy into classrooms, teachers themselves need to understand mathematical literacy. Both mathematical literacy and numeracy have multiple abstract meanings. Gardiner (2004) provided a definition of mathematical literacy from the Program for International Students Assessment:

Mathematics literacy is an individual’s capacity
to identify and understand the role that mathematics plays in the world,
to make well-founded mathematical judgments, and
to engage in mathematics in ways that meet the needs of that individual’s current and future life as a constructive, concerned and reflective citizen (p. 9)

Gardiner (2004) explains that this definition cannot be used for “reliable assessment even in a single classroom” (p.9) because every student learns and engages differently with varied career interest. Gardiner also gives a definition of numeracy, which comes from the word numerate

“the word ‘numerate’ [implies] the possession of two attributes. The first is an ‘at-homeness’ with numbers and an ability to make use of mathematical skills which enables an individual to cope with the practical demands of his everyday life. The second is an ability to have some appreciation and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables …” (as cited in Gardiner, 2004, p.4)

Gardiner (2004) says that if the students do not master what they are learning, then there will not be an “at-homeness” with what they are learning (p. 9). This implies that students will not understand how the concepts work or how they can be applied to future learning. If students do
not understand what they are learning then they will not be able to appreciate the information that they are being given (Gardiner, 2004).

Gardiner expresses that mathematical literacy and numeracy are “by-products of effective instruction” (Gardiner, 2004, p.2). In order to have effective instruction, teachers need to assure that students understand that mathematics is abstract and flexible and that the “core techniques” can be combined to problem solve (Gardiner, 2004, p.4). There is no shortcut to help students understand how to think abstractly and make connections during problem solving and learning mathematics.

Kilpatrick (2001) relates mathematical literacy to mathematical proficiency:

The five strands of mathematical proficiency are (a) conceptual understanding, which refers to the student's comprehension of mathematical concepts, operations, and relations; (b) procedural fluency, or the student's skill in carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately; (c) strategic competence, the student's ability to formulate, represent, and solve mathematical problems; (d) adaptive reasoning, the capacity for logical thought and for reflection on, explanation of, and justification of mathematical arguments; and (e) productive disposition, which includes the student's habitual inclination to see mathematics as a sensible, useful, and worthwhile subject to be learned, coupled with a belief in the value of diligent work and in one's own efficacy as a doer of mathematics (Kilpatrick, 2001, p. 107)

Therefore if students can exhibit mathematical proficiency, then they are mathematically literate. These definitions of mathematical proficiency are important skills to model and teach in a mathematics classroom. If a student is able to learn how to be mathematically proficient/literate, they will be able to not only learn basic mathematical concepts but also be able to think and
reason through complex mathematical concepts, and see that they are made up of a bunch of basic mathematical concepts.

Most high school mathematics students struggle with reading and understanding mathematical literature (i.e. textbooks, word problems, etc…), that is due to the fact that mathematics is a language in and of itself (Phillips, Bardsley, Bach, & Gibb-Brown, 2009). According to Fuentes (1998), students tend to only see mathematics as “… only numbers, abstract symbols, and their interrelationship; they forget that mathematics involves natural thought and processes as well” (p. 81). Fuentes (1998) states that for “…students to reach their potential as mathematicians, they must learn to comprehend mathematical text, that is, text constructed of numbers, abstract symbols, and-yes-words” (p. 81). Barton and Hidema (2000) explain that “…’reading mathematics’ means the ability to make sense of everything that is on a page…” (p.3). Phillips, Bardsley, Bach, and Gibb-Brown (2009) explain that even though mathematics texts are written in English, some of the terms have a different meaning when used in a mathematical text. This makes it hard for students to recognize the need to translate English meanings into mathematical meanings. “For example, the word difference could easily confuse the young students faced with the question, ‘what is the difference between 4 and 7?’ A student might answer, ‘Four is even, but seven is odd,’ when the correct response is ‘three’” (Barton & Hidema, 2000, p.9-10).

**Implementation Strategies**

It is important for students to fully understand the mathematical vocabulary that is being taught in the classroom. According to Barton and Hidema (2000), teaching vocabulary in mathematics can be challenging. Some of the mathematical concepts “…are embedded within other concepts…” which can make defining the concepts difficult (Barton & Hideman, 2000,
Other challenges include English terms that may have different meanings in mathematics, and lastly sometimes a clear definition is not given but rather implied from the surrounding text (Barton & Hidema, 2000). Comprehension of terms is related to the understanding of the concepts taught. Effective teaching strategies will enable students to gain this understanding.

With the shift to CCSS, textbooks are being transitioned out of most schools. It is vital that when new vocabulary is introduced, students are given a clear definition of the term or allowed to help define the term. Students also need to feel comfortable stopping the teacher when they don’t understand the meaning of a term. Phillips, Bardsley, Bach, and Gibb-Brown (2009) give the idea of having a “word wall” (p.471) where students put new terms and their definitions on the wall. This will help the students remember the terms when first using them. Meaney and Flett (2006) have students work together to come up with definitions for the unknown terms in the lesson. The students would then put the definitions in the glossary in the back of their exercise book (Meaney & Flett, 2006). By allowing students to come up with the definitions for terms, they will have an easier time remembering the term’s meanings. They will also need to explain and give proof as to why their definition is appropriate which will aid in retaining the definitions.

Mathematics teachers know that there is more to reading mathematics then just reading terms. Students need to have the ability to also read mathematical symbols and understand their meanings. As Fuentes (1998) points out “Learning mathematics is learning a new language. Because mathematics writing is unique with its combination of terms and symbols and compact style…Every word and abstract symbol must be read (or written) and understood with precision” (p. 81-82). Fuentes (1998) states that students will need to be able to read both terms and symbols and have the ability to convert from one form to the other.
In mathematics writing, every word and punctuation mark has a specific meaning that is important for solving a problem or for learning a new concept (Fuentes, 1998). It is important to teach students how to read mathematical writing and to understand what the text is saying (Fuentes, 1998).

Meaney and Flett (2006) have come up with “The Read, Think, Do (x2)” cyclic model to help guide students through mathematical reading (p.10). This model asks students questions that will help them learn how to process the information they are reading and then to check their answers to make sure that they also make sense (Meaney & Flett, 2006). Here are the questions:

“Read: Why did the author write this? Why are you reading it? What information does it give you?

Think: How is this like other information that you know? What will you do with this information? Is there other information that you need to know? How can you get this information?

Do: Make notes about what you have read. Use the information to solve the problem.

Read: Do your notes or answers make sense? Is there anything that you should change or add?

Think: What were the mathematical ideas you used or learnt? Where else might these ideas be useful?

Do: Talk about what you have done with someone else. Try ideas out in another area” (Meaney & Flett, 2006)

In answering these questions students will learn how to read and understand word problems. Having students work in groups when using Meaney and Flett (2006) “The Read, Think, Do
(x^2)” will be beneficial because they will have the chance to bounce ideas off their peers as well as explain the thinking behind their answers.

Another activity that can be helpful for students is to have them keep a learning log (Fuentes, 1998). The log is a record that students keep of the vocabulary learned, the main idea for the lesson, what rules, facts, or formulas they learn, and then general reflection on what they learned that day (Fuentes, 1998). Students will have a summary of the day’s class as well as give the teacher an opportunity to see what they learned. It will give important insight to the teachers. It will show the students’ take away and the impact of the different activities used in class. If their reflections or main idea sections are missing the point of the lesson, then the teacher will know to re-teach the lesson in a different way.

Burns (2004) also sees the importance of students being mathematically literate. Burns (2004) quoted Zinsser saying that, “Writing is a way to work yourself into a subject and make it your own” (as cited in Burns, 2004, p. 33) which introduces the idea of teaching writing in mathematics classrooms. Writing in class will help students learn how to properly express their mathematical thoughts with clarity and depth (Burns, 2004). When students are able to express themselves mathematical, they will be able to ask specific questions when they don’t understand how to solve a problem, or understand an example being taught in class (i.e. solve for x given the following equation: \(-(-6x - x^2) = -5\)). If a student is not mathematically literate they might say, “I don’t get this…” The teacher might ask “At what point did I lose you?” They answer “Umm…I don’t know…” When a student is able to articulate a question with specifics like “I see how you distributed the negative sign through, but why did you then add the constant to both sides of the equation?” Then the teacher knows that the student understands the concept of
distribution but they are not able to make the connection that by getting all of the terms on one side of the equation will make it possible for them to factor and solve for x.

Burns (2004) further explains that the writing they are doing in the classroom “… isn’t meant to produce a product suitable for publication, but rather to provide a way for students to reflect on their own learning and to explore, extend, and cement their ideas about the mathematics they study” (p. 30). Burns (2004) explains the importance for teachers to pay attention to “…what they write, and how they write it” (p. 30). When students understand this they will have less stress in mathematical writing (Burns, 2004).

Burns (2004) also sees the advantage of having students keep a mathematics journal to record what they are learning in class. Teachers can offer different suggestions for what students should write in the journal to help students reflect on the lesson or a discussion that happened in class that helped clarify a concept (Burns, 2004). Students should also record the steps involved in solving a mathematical problem with justification which will help them have a clear picture of what is being taught (Burns, 2004). This is helpful when students are working on problem solving questions in class. They can work in groups to solve the problems but must write their own perspective of how and why they performed each step to solve the problem. This will give the teacher insight in how their students process information and how well they grasp the concepts taught.

Writing a short essay to explain mathematical concepts is another method that Burns (2004) has found to be useful in assessing the students’ understanding of a concept. It can also be beneficial to have students give written feedback on their favorite activities or least favorite activities in the unit, as well as, what they find most useful for providing a positive learning
environment (Burns, 2004). Both of these activities can help either assess students’ learning or help plan activities that will improve the learning environment.

In conclusion, teachers who define mathematical literacy as being mathematically proficient need to instruct students that mathematics is a different language with its own vocabulary, symbols, and sentence structures. The best way to help students be mathematically literate is to teach them how to read, write, and think mathematically in the classroom. It is also important that a teacher use strategies that will help students fully understand the vocabulary. There are a few different activities that have been explained above that will be implemented into the unit in the next chapter.
Chapter 3: Unit Plan

With the implementation of this unit, it is important to have/develop a classroom where sociomathematical norms that include “taken-as-shared” (Yackel & Cobb, 1996, p.460) communication, collaborative learning groups, and learning mathematics by discovery are included. According to Yackel and Cobb (1996) “…the development of individuals’ reasoning and sense-making processes cannot be separated from their participation in the interactive constitution of taken-as-shared mathematical meanings” (p.460). This is done when the teacher models sociomathematical norms, like showing students how to justify that their solution was mathematically correct (not just explain the procedures that they took to come to the solution), as well as how to work corroboratively with others and learn how to justify their rational for the solution of the problem (Yackel & Cobb, 1996).

Throughout this unit it is important to have a classroom that incorporates sociomathematical norms. There are strategies that were discussed in the above chapters that are being implemented in this unit. One of the strategies used in every lesson is mathematical journaling at the end of every lesson. The journaling is a combination of the math journal that Burns (2004) talks about having the students keep a record of what they are learning and Fuentes (1998) log to keep a record of what they have learned in the class. Another strategy that is used in every lesson is Phillips, et. All (2009) word wall combined with Meaney and Flett (2006) concept of having students come up with the definitions for the vocabulary that they are learning in the class. When teaching this unit the vocabulary is on the first page of the unit but it is important to have the students come up with the definitions as they work through the lesson for that day.

Burns (2004), also talks about the importance of having students be able to express themselves mathematically. One way that is implemented is by the project in the middle of the
unit. They can choose to either make two posters or write a poem/song/rap that explains a concept that they have learned in this unit as well as implementing the vocabulary learned. The other way that this is implemented in the unit is the paper at the end of the test. The one to two page paper has the students explain what they have learned in the unit and which activities helped them learn the material the best (Burns, 2004).

Please note that this chapter is not in APA formatting. The reason the author decided to do this was to make the information flow in a logical manner that will help in student understanding. After chapter three the formatting will go back to APA. The author also intentionally adds extra problems in the guided notes so that there is extra practice for students if they make it through the lessons quickly.

Table 1

*Unit Calendar: Introduction of Functions as per a 50 Minute Class period*

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<tr>
<td>Day 6: Create a Linear Function and Graph it.</td>
<td>Day 7: Interpret the Function and Graph it.</td>
<td>Day 8: Review</td>
<td>Day 9: Test</td>
<td>Day 10: Essay due</td>
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<tr>
<td>8.F.4 and 8.F.5</td>
<td>8.F.5</td>
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</table>
Lesson Title: What is a Function?

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

Objective: (SWBAT)
- Understand the difference between a function and a relation.
- Determine if the data given is a function.

Lesson Materials:
- Guided notes: What is a Function?, Day 1 Homework, Word Wall Cards, and Mathematics Journal.

Vocabulary:
- Input/ Domain/ Independent Variable
- Output/ Range/ Dependent Variable
- Function
- Relation
- Vertical Line Test

Introduction:
- Talk about different things that are related like animals that live in the arctic and animals that live in the jungle. Inform students that there are also relationships within math as well. A function is an important relation that is used in mathematics.

Classroom Activity:
Teach: Discuss what a relation is using the example of student's name and eye color. Explain that if asked for a name there is a given eye color, or if asked a specific eye color you can give a list of names that have that eye color. Show the table (in the guided notes) and have students come up with a definition for Domain/ Input/ Independent Variable and Range/ Output/ Dependent Variable from the above example to be put on the Word Wall. Than explain that a function is a relation with rules that have to be followed. Have students work together on the function activity to see if they can come up with the rules for functions. Add Function and Relation to the Word Wall with students’ definition. Go over the vertical line test and how it helps determine if a relation is a function.

Re-Teach:
1. Students may have trouble finding the domain and range of a graphed function. You may need to re-emphasize the importance of the arrows on the graph that indicate they are going to either a positive or negative infinity which would mean that the domain or range is all real numbers. You might need to remind students what the definition of a vertical line is and how it differs from a horizontal line.

Conclusion:
- Ask students to explain in their own words a function and a relation, and how to find the domain and range of each.
**Homework:** Day 1 worksheet

**Reflection:**
Guided Notes: What is a function?

Name: ____________________________

Block: ______________ Date: ________

New Vocabulary:

- Relation:

- Domain/ Input/ Independent Value:

- Range/ Output/ Dependent Value:

- Function:

- Vertical Line Test:

Relation Activity

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<tr>
<th>Names</th>
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19
What is a Function?

The following are examples of relations.

What are the conclusions that we can make about relations?

The following are examples of functions.

What are some conclusions that we can make about functions?
Vertical Line Test:

Not a Function

Function

Function

Using the vertical line test state if the following is a function or not.

Finding the Domain and Range:

What is the domain and range of the following functions?

a) \{ (10, 8), (13, 7), (16, 6), (17, 7) \}

b) \[
\begin{array}{c|c}
X & Y \\
-1 & 4 \\
0 & 3 \\
1 & 2 \\
2 & 1 \\
3 & 0 \\
\end{array}
\]

When finding the domain of a graph look for x values that do not fall on the graph. When finding the range look for y values that do not fall on the graph.
Work in your group to determine if the following relations are functions? Explain your answer using a complete sentence.

1) ![Graph]

Function: Yes  No

2) ![Diagram]

Function: Yes  No

3) \{(0, 0), (1, 1), (2, 8), (3, 27)\}

Function: Yes  No

4) 

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
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<tbody>
<tr>
<td>-1</td>
<td>4</td>
</tr>
<tr>
<td>-1</td>
<td>3</td>
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<tr>
<td>0</td>
<td>2</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>2</td>
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</table>

Function: Yes  No

Ticket out the door: Write a paragraph in your class journal explaining what you learned about functions today. (Don't forget to incorporate the new vocabulary that you learned.)
Homework: Day 1 What is a Function?  

Name:______________________________  

Block: _____________Date:____________

Define the following:  

What are the differences and similarities between functions and relations?  

What does the domain represent?  

What does the range represent?  

Put it into practice:  

Determine if the following relations are functions. Explain the reasoning behind your answer.

1)  

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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<tbody>
<tr>
<td>20</td>
<td>2</td>
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<td>30</td>
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<td>35</td>
<td>5</td>
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</table>

Function: Yes  No

2)  \{(2, 4), (3, 5), (4, 4), (5, 3)\}

Function: Yes  No
What are the domain and range for the following functions?

5) $\begin{array}{c|c}
X & Y \\
4 & -4 \\
6 & -3 \\
8 & -2 \\
10 & -1 \\
12 & 0 \\
\end{array}$

6) $\{(1, 0), (4, 3), (7, 6), (10, 9)\}$

7) $\begin{array}{c|c}
X & Y \\
4 & 0 \\
6 & -1 \\
8 & -2 \\
10 & -3 \\
12 & -4 \\
\end{array}$
Day 2

Lesson Title: Finding the Rate of Change of a Function

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

8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

Objective: (SWBAT)

- Understand how to find the rate of change for a function when given a table of data, a set of coordinate points, and a graph.
- Determine if the function is increasing, decreasing, or neither.

Lesson Materials:

- Guided Notes: Finding the Rate of Change of a Function, Day 2 Homework, Word Wall Cards, and Mathematics Journal.

Vocabulary:

- Rate of Change
- Increasing
- Decreasing

Introduction:

- Do Now: What is a relation? What is a function?
- Go over the homework from the night before and answer any questions.

Classroom Activity:

Teach: Explain that today we will be finding the rate of change of functions. Ask the students if they remember when they were working with linear equations and if they remember what the slope was and how to find it. Explain that the rate of change for a function is like finding the slope of a linear equation. Go through the Finding the Rate of Change guided notes then have the students work together on the Rate of Change Activity at the end of the notes.
Re-Teach:
  1. If students have questions from the homework you might need to re-teach the concepts from the last lesson.
  2. How to find the slope of a linear equation.

Conclusion:
- Ask students to explain how to find the rate of change and to explain what the rate of change tells you about a function. Have them write this in their class journal.

Homework: Day 2 worksheet

Reflection:
Guided Notes: Finding the Rate of Change of a Function

Name:__________________________
Block:____________Date:____________

Vocabulary:

- Rate of Change:

- Increasing:

- Decreasing:

How to find the Rate of Change:

Rate of change formula:

<table>
<thead>
<tr>
<th>From a Table</th>
<th>From Ordered Pairs</th>
<th>From a graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Find the common _______________ of the range (_______________)</td>
<td>1) Find the difference of the_______________</td>
<td>1) Find the slope of the _______________</td>
</tr>
<tr>
<td>2) Find the common _______________ of the domain (_______________)</td>
<td>2) Find the difference of the_______________</td>
<td></td>
</tr>
<tr>
<td>3) Plug into the rate of change formula.</td>
<td>3) Plug the answers from 1 and 2 into the _______________</td>
<td></td>
</tr>
</tbody>
</table>

If you have a _______________ rate of change then the graph will be ________________, and if it has a _______________rate of change then the graph will be ________________ (sometimes it is only for a given domain and sometimes it will be for the whole graph).
Find the rate of change:

1) Find the rate of change for the table below. 2) Find the rate of change for the table below.

\[
\begin{array}{|c|c|}
\hline
X & Y \\
3 & 2 \\
4 & 6 \\
5 & 10 \\
6 & 14 \\
\hline
\end{array}
\quad
\begin{array}{|c|c|}
\hline
X & Y \\
-2 & 21 \\
0 & 18 \\
2 & 15 \\
4 & 14 \\
\hline
\end{array}
\]

3) Find the rate of change between these two points (7, 0) and (13, 5)

4) Find the rate of change of the line that passes through the two points (-1, -4) and (5, -3)

5) Find the rate of change of the graph below

6) Find the rate of change of the graph below
Which has the biggest rate of change?

7) \{(2, 2), (3, 4), (4, 6), (5, 8)\} or

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>24</td>
</tr>
<tr>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

8) or the line that passes through the points (4, 7) and (7, 14).

9) The line that passes through (5, 8) and (8, 9) or \{(2, 4), (3, 7), (4, 10)\}
Work with a partner to find the rate of change for the five different sections of the graph below.

1) What is the rate of change from 0 to 4 minutes?

2) What is the rate of change from 4 to 9 minutes?

3) What is the rate of change from 9 to 14 minutes?

4) What is the rate of change from 14 to 21 minutes?

5) What is the rate of change from 21 to 30 minutes?
Write a story to explain the graph above that compares the rates of change. (Hint you can use someone driving.)

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Explain what the rate of change is telling us in the above graph. How is this helpful when looking at data? (Hint: Increasing and Decreasing)

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Homework: Day 2

Name:______________________________

Finding the Rate of Change of a Function

Block:______________ Date:___________

Answer the following:

1) How do you find the rate of change from a table of data?

2) If a graph is increasing then it has what kind of rate of change?

3) If a graph is decreasing then it has what kind of rate of change?

Put into Practice:

Find the rate of change for the following data and graphs.

4) \{(-3, 4), (1, 2), (5, 0), (9, -2)\}

5) 

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>13</td>
</tr>
<tr>
<td>-5</td>
<td>16</td>
</tr>
<tr>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>22</td>
</tr>
</tbody>
</table>

6) 

![Graph](image)
List the rate of change from least to greatest for the following questions.

7) The line that passes through the points (-12, 4) and (-6, 8), {(-2, 2), (0, 2), (2, 2), (4, 2)}, and the table

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>7</td>
</tr>
</tbody>
</table>

8) Looking at question 8 could you guess which graph has the smallest rate of change and which one has the largest? Explain why you could or could not see the order of the rate of change.
Lesson: Is it Linear or Non-linear?

CCSS: 8.F.3: Interpret the equation y = mx + b as defining a linear function whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s² giving the area of a square as a function of its side length is not linear because its graph contains the points (1, 1), (2, 4) and (3, 9), which are not on a straight line.

Objectives: (SWBAT)
- Determine whether a function is linear or non-linear by looking at a graph.
- Determine if a function is linear or non-linear when given a table of data.

Lesson Material:
- Guided notes: Is the Function Linear or Non-linear, Worksheet Homework Day 3 and 4, Quiz: Functions Quiz 1, and Class Journal.

Vocabulary:
- Linear
- Non-linear

Introduction:
Go over the homework and answer any questions that they did not understand or did not get correct and needs clarification. Discuss that if a data set has a constant rate of change or a zero rate of change then you can put a ruler through the points and connect all of the points with one line. Show this using two of the data sets from last night's homework.

Classroom Activity:
Teach: This is a two day lesson. The first day go over the Guided Notes. If the students are able to get through the notes quickly, then they can get started on the activity that is meant for day 4. The notes start off with identifying if a graph is linear or non-linear. Above each graph will be the equation of the graph so that students can start to see what the different types of equations look like. After that go over identifying linear and non-linear functions by data sets and tables. When completed, have the students work in groups to identify functions as linear and non-linear and explain how they reached that conclusion using the mathematical vocabulary learned so far.

Re-Teach: You might need to re-explain how to find the rate of change both graphically and algebraically if students have questions from the homework.

Quiz: At the start of day 4 give Functions Quiz 1.

Conclusion:
- Day Three: Have students explain the difference between linear and non-linear functions when looking at a graph.
- Day Four: Have students explain how to determine if a set of data or a table is linear or non-linear.

Reflection:
Guided Notes: Is it a Linear or Non-linear Function Name: ____________________________

Block:______________ Date:_____

Vocabulary:

Linear Function:

Non-linear Function:

How to determine if a function is linear or non-linear graphically:
The following graphs are non-linear. Look at both the equations and graph.

1) \( y = x^2 \)  
2) \( y = x^3 \)  
3) \( y = \sqrt{x} \)  
4) \( y = 2^x \)  
5) \( y = \frac{1}{x} \)  

What are some conclusions that you can make about non-linear functions based on the graphs above? What are some conclusions that you can make about non-linear functions based on the equations?
Here are some linear equations. Look at both the equations and the graphs.

7) \( y = -\frac{1}{3}x + 4 \)  
8) \( y = \frac{3}{4}x - 2 \)  
9) \( y = 4 \)

What are some conclusions that you can make about linear functions based on the graphs? What are some conclusions that you can make about linear functions based on the equations?

Looking at the conclusions you have made about linear and non-linear functions, work with a partner to come up with a definition for linear and non-linear functions. Be prepared to share your definitions with the class. (Use the space below to brainstorm your ideas.)
Now you try:

Use your definition to decide which graphs are linear and which are non-linear. Explain your reasoning. (You can still work with your partner for this exercise)

1) Put your answer and reasoning here.

2)

3)

4)
Look at the following equations and try to determine if the equation is linear or non-linear. Explain your reasoning.

5) \( y = x^2 \)  
6) \( y = \frac{1}{4} \sqrt{x} \)

7) \( y = \frac{x}{2} \)  
8) \( y = \frac{2}{x} \)

9) \( y = \frac{5}{6} x - 1 \)  
10) \( y = -5 - \frac{1}{4} x \)

Write in your class journal how to tell graphically if a function is linear or non-linear.
Guided Notes: Is it a Linear or Non-linear Function

Name: _______________________

Block: ________________ Date: _____________

Make a table for a given equation to see if the equation is a linear or non-linear function.

1) \( y = \frac{1}{4}x + 2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

2) \( y = x^2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
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<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

3) \( y = \frac{4}{x} + 2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

4) \( y = x \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
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<tr>
<td>0</td>
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<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Now that we have a basic idea of how to see if a function is linear or non-linear, work with your partner on the following activity in which you will be finding if the functions are linear or non-linear by either looking at the function graphically or algebraically (constructing a table of data and finding the rate of change). Explain if the function is linear or non-linear and why.

1) $\begin{array}{|c|c|} \hline X & Y \\ \hline -2 & 4 \\ -1 & 3 \\ 0 & 2 \\ 1 & 1 \\ 2 & 0 \\ \hline \end{array}$

2) $\begin{array}{|c|c|} \hline x & Y \\ \hline -4 & 8 \\ -2 & 4 \\ 0 & 0 \\ 2 & 4 \\ 4 & 8 \\ \hline \end{array}$

3) $\begin{array}{|c|c|} \hline X & Y \\ \hline 0 & 7 \\ 1 & 4 \\ 2 & 1 \\ 3 & -2 \\ 6 & -11 \\ \hline \end{array}$

4) $\begin{array}{|c|c|} \hline X & y \\ \hline -7 & -3 \\ -5 & -4 \\ -3 & -5 \\ -1 & -6 \\ 1 & -7 \\ \hline \end{array}$
Determine if the following functions are linear or non-linear by making tables of data and determining if the functions have a constant rate of change or not.

11) \( y = 2x + 4 \)  
12) \( y = x^2 + 4 \)  

13) \( y = \frac{-x}{4} \)  
14) \( y = x^3 - 2 \)  

15) \( y = \frac{2}{x} \)  
16) \( y = \frac{4}{7}x + 2 \)
Quiz: Function Quiz 1

Name: _____________________________
Block: _____________Date:____________

1) What is a relation?

2) What is a function?

3) Explain one way to find the rate of change.

What is the domain and range of the following sets of data?

4) \{ (2, 4), (3, 8), (4, 12), (5, 16) \}

Domain:

Range:

5) 

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>7</td>
</tr>
<tr>
<td>-2</td>
<td>4</td>
</tr>
<tr>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>-5</td>
</tr>
</tbody>
</table>

Domain:

Range:

6) Find the rate of change for both questions 4 and 5.
Homework: Day 3

Name: __________________________

Block: ___________ Date: ________

Look over the projects for this unit. You will be working with a partner and can choose which project to complete. You and your partner will need to sign up for it tomorrow in class.

**Project one:** Make posters. This project requires partners (or your group) to create two posters for the classroom. For one of your posters, you will pick one topic that has been covered in this unit and make a poster that clearly and creatively (not just words on a piece of paper) depicts that topic. Include the steps for how to solve problems that deal with your topic and also a few examples (not from your homework). An example topic would be finding the rate of change graphically. Explain the steps taken to find the rate of change graphically and then show graphs with how to find their rate of change for examples. The other poster will be the vocabulary covered in this unit. Make the poster fun and use all of the vocabulary from this unit. You will have to present the topic poster to the class explaining the topic that you picked and what you know about it (this should take 5-8 minutes)

**Project two:** Make a poem or song. This project will require your group to either write a poem (not a haiku) or a song/rap about a concept covered in this unit. The poem/song/rap needs to explain the concept and how to solve a problem using that concept as well as use the vocabulary taught in this unit. For example, for the concept how to tell if a function is linear or non-linear you could talk about having a constant rate of change and not having a constant rate of change. You would include how they look different when graphed or how the equations look different.

Projects are due on day 8 of this unit and are worth a quiz grade.
### Rubric for Posters:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>Well-rehearsed with smooth delivery that holds audience attention.</td>
<td>Rehearsed with fairly smooth delivery that holds audience attention most of the time.</td>
<td>Delivery not smooth, but able to maintain interest of the audience most of the time.</td>
<td>Delivery not smooth and audience attention often lost.</td>
</tr>
<tr>
<td>Attractiveness</td>
<td>Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.</td>
<td>Makes good use of font, color, graphics, effects, etc. to enhance the presentation.</td>
<td>Makes use of font, color, graphics, effects, etc. but occasionally these distract from the presentation.</td>
<td>Use of font, color, graphics, effects etc. but these often distract from the presentation.</td>
</tr>
<tr>
<td>Requirements</td>
<td>All requirements are met and exceeded.</td>
<td>All requirements are met.</td>
<td>One requirement was not completely met.</td>
<td>More than one requirement was not completely met.</td>
</tr>
<tr>
<td>Content</td>
<td>Covers topic in-depth with details and examples. Subject knowledge is excellent.</td>
<td>Includes essential knowledge about the topic. Subject knowledge appears to be good.</td>
<td>Includes essential information about the topic but there are 1-2 factual errors.</td>
<td>Content is minimal OR there are several factual errors.</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>Interesting, well-rehearsed with smooth delivery that holds audience attention.</td>
<td>Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.</td>
<td>Delivery not smooth, but able to hold audience attention most of the time.</td>
<td>Delivery not smooth and audience attention lost.</td>
</tr>
<tr>
<td>Workload</td>
<td>The workload is divided and shared equally by all team members.</td>
<td>The workload is divided and shared fairly by all team members, though workloads may vary from person to person.</td>
<td>‘The workload was divided, but one person in the group is viewed as not doing his/her fair share of the work.</td>
<td>‘The workload was not divided OR several people in the group are viewed as not doing their fair share of the work.</td>
</tr>
</tbody>
</table>

(Rubistar, 2000)
# Rubric for Poem/Song/Rap

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>Well-rehearsed with smooth delivery that holds audience attention.</td>
<td>Rehearsed with fairly smooth delivery that holds audience attention most of the time.</td>
<td>Delivery not smooth, but able to maintain interest of the audience most of the time.</td>
<td>Delivery not smooth and audience attention often lost.</td>
</tr>
<tr>
<td>Requirements</td>
<td>All requirements are met and exceeded.</td>
<td>All requirements are met.</td>
<td>One requirement was not completely met.</td>
<td>More than one requirement was not completely met.</td>
</tr>
<tr>
<td>Content</td>
<td>Covers topic in-depth with details and examples. Subject knowledge is excellent.</td>
<td>Includes essential knowledge about the topic. Subject knowledge appears to be good.</td>
<td>Includes essential information about the topic but there are 1-2 factual errors.</td>
<td>Content is minimal OR there are several factual errors.</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>Interesting, well-rehearsed with smooth delivery that holds audience attention.</td>
<td>Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.</td>
<td>Delivery not smooth, but able to hold audience attention most of the time.</td>
<td>Delivery not smooth and audience attention lost.</td>
</tr>
<tr>
<td>Originality</td>
<td>Product shows a large amount of original thought. Ideas are creative and inventive.</td>
<td>Product shows some original thought. Work shows new ideas and insights.</td>
<td>Uses other people's ideas (giving them credit), but there is little evidence of original thinking.</td>
<td>Uses other people's ideas, but does not give them credit.</td>
</tr>
<tr>
<td>Workload</td>
<td>The workload is divided and shared equally by all team members.</td>
<td>The workload is divided and shared fairly by all team members, though workloads may vary from person to person.</td>
<td>The workload was divided, but one person in the group is viewed as not doing his/her fair share of the work.</td>
<td>The workload was not divided OR several people in the group are viewed as not doing their fair share of the work.</td>
</tr>
</tbody>
</table>

(Rubistar, 2000)
Homework: Day 4

Name:____________________________________

Block: ________________ Date: ____________

Work with your partner on your project. Put your ideas in the space below for the project you have signed up for. This is for brainstorming how you plan to complete your project and what topic/concept you are planning to use. Make deadlines for your group so you will have a plan to follow.
Day 5
Lesson: Creating a Linear Function using Rate of Change and Y-intercept
CCSS: 8.F.4 Construct a function to model a linear relationship between two quantities.
Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
Objectives: (SWBAT)
- Write a linear function in y-intercept form.
- Find the y-intercept and rate of change when given a set of data or when looking at a graph.
Lesson Materials: Guided Notes: Creating a Linear Function using Rate of Change and Y-intercept, Worksheet: Homework Day 5, and Class Journal.
Vocabulary:
- Y-intercept:
Introduction:
Hand back Quizzes and go over the answers. Have students who got a question right explain how they reached their solution. Explain to students that since we know what a linear function is, we will now be learning how to write a function to model the linear relationship between two quantities using the y-intercept and finding the rate of change.
Classroom Activity:
Teach: Have students brainstorm definitions for y-intercept. If they are having problems with that, graph a linear function from the lesson yesterday. Ask them which axis is the y-axis and what they think the word intercept means. See if they can come up with the definition of a y-intercept. Do the first few problems with your students then have them work together with their partners to complete the in class activities.
Re-Teach: If most of the students did not perform well on the quiz then go back and re-teach the concepts they do not understand from the first 3 days.
Conclusion: Have students write in their journals explaining how to find the y-intercept and how to model a linear function. (They need to use the vocabulary they have been learning throughout this unit).
Reflection:
Guided Notes: Creating a Linear Function Using Rate of Change and Y-intercept

Name_______________________________

Block:______________ Date:___________

Vocabulary:

Y-intercept:

How to find the y-intercept:

What do you think y-intercept means?

How to find the y-intercept when given...

<table>
<thead>
<tr>
<th>A table of data</th>
<th>A set of points on the line</th>
<th>A Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are looking to see when _____ _______ is _______ and the _____ _______ at that point is the y-intercept.</td>
<td>When given a set of data (two or more points on a line) you need to find the _____ _______ _______ and then you can either make a _____ _______ _______ and fill it in till you find the y-intercept or _____ _______ the points and find the y-intercept.</td>
<td>Look for where the line _____ _______ the _______ and the ____ value at the point is the y-intercept</td>
</tr>
</tbody>
</table>

*Sometimes it is not given in the table. When that is the case you need to find the \_____ \_______ \_______ and extend your table till you are able to follow the instruction above.
What is the y-intercept of the following functions?

1) 

2) 

3) 

<table>
<thead>
<tr>
<th>X</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
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<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

4) 

<table>
<thead>
<tr>
<th>X</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
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<tr>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>-1</td>
</tr>
</tbody>
</table>

6) The line that passes through the points (2, 7) and (3, 4).

7) The line that passes through the points (4, 9) and (-2, 3).
How to model a linear function:

When trying to model a linear function there are two things you need to know. One is y-intercepts and the second is the rate of change. Once you know that information, you can write a model for a linear function by filling in this equation: \( f(x) = mx + b \) where \( b \) is the y-intercept and \( m \) is the rate of change.

Let's try it. Write a model to represent the linear function.

8) 

Rate of Change:

Y-intercept:

Model of the Function:

9) 

<table>
<thead>
<tr>
<th>X</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
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<tr>
<td>4</td>
<td>2</td>
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<tr>
<td>5</td>
<td>4</td>
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<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Rate of Change:

Y-intercept

Model of the Function:

10) What is the equation of the linear function that passes through these two points (4, 6) and (6, 6)?
Now you try:

Match the following models with the linear functions that are either given as a graph, a table, or points.

| Models | \( y = -2x + 14 \) | \( y = 4 \) | \( y = 2/5 \, x - 1 \) |
|--------|-------------------|------------|----------------|---|
|        | \( y = \frac{1}{2}x + 6 \) | \( y = -\frac{1}{2}x + 10 \) |               |   |

1) \((-1, 4), (4, 4), (9, 4)\)

2)

3) | X  | y  |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
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<tr>
<td>4</td>
<td>8</td>
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<tr>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

4) | x  | y  |
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
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<tr>
<td>5</td>
<td>4</td>
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<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>-2</td>
</tr>
</tbody>
</table>
What does it mean?

What is the y-intercept?

Explain in your own words one way to find a y-intercept when given points on a line.

Write the model for the given linear functions.

1) 

2) 

3)
4) | X | y  
---|---|---
-2 | 5  
-1 | 0  
0  | -5 
1  | -10 
2  | -15 

5) | x | y  
---|---|---
-10| 0  
-7 | 5  
-4 | 10 
-1 | 15 
2  | 20 

6) Model the linear function that passes through the points (2, 5) and (4, 6)

7) Model the linear function that passes through the points (5, 10) and (7, 12)
Day 6 and 7

Lesson Title: Create a Function and Graph it.

CCSS: 8.F.4: Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or non-linear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Objective: (SWBAT)
- Understand that a linear function is a linear equation.
- Graph a linear function using slope intercept form.

Lesson Materials: Guided Notes: Create a Linear Function and Graph it, Extra Practice in class work, Rulers, Worksheet: Homework Day 6 and 7, Word Wall Cards, and Class Journal.

Vocabulary:

Introduction:
Ask students to write a model for the following linear function: \{(9, 0), (6, 4), (3, 8)\} (Answer: \(y = -\frac{4}{3}x + 12\)). Go over homework and answer any questions the students might have. Explain that today they will practice modeling linear functions, learn how to interpret them and also learn how to graph linear and non-linear functions based off of a description.

Classroom Activity:
Teach: If students are still having problems making models then hand out the Extra Practice in Class worksheet to review with them. Then go through the guided notes. The notes start with some of the tables from the extra practice with the equations next to the tables. Have the students re-explain what increasing and decreasing mean. Then have the students make predictions as to whether they think the linear functions are increasing or decreasing then graph the equations (review of linear equation graphing) to see whether their predictions are correct. This is also a review of the vocabulary from day one of this unit. Next, have the students look at graphs of non-linear functions. Work through the first problem of describing the characteristic of the function and have them explain the characteristic. Then have them work on some of the problems with their partner. Lastly have them work on reading a word problem and modeling it by graphing, work through the two examples with them. Have them work on their own to complete the rest of the notes. This lesson may take one to two days depending on how quickly your students are grasping the concepts. (The homework is for the completion of the lesson)

Re-Teach: You might need to re-teach how to write a model for a linear function as well as how to graph a linear equation.

Conclusion:
• **Day 6:** Ask students to explain how to determine from a table of data for a linear function if the function is increasing or decreasing.

• **Day 7:** Ask students to explain how to determine from a word problem if part of a function is increasing or decreasing.

**Homework:** Worksheet Day 6 and 7

**Reflection:**
Extra Practice Sheet:  

Name: ____________________________  
Block: _______ Date: ____________  

Write a model for the following linear functions.  

1)  

<table>
<thead>
<tr>
<th>X</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>6</td>
</tr>
<tr>
<td>-2</td>
<td>3</td>
</tr>
<tr>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>-3</td>
</tr>
</tbody>
</table>

2)  

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>-1</td>
</tr>
<tr>
<td>12</td>
<td>-4</td>
</tr>
<tr>
<td>16</td>
<td>-7</td>
</tr>
</tbody>
</table>

3)  

<table>
<thead>
<tr>
<th>x</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>2</td>
</tr>
<tr>
<td>-3</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>-1</td>
<td>-4</td>
</tr>
</tbody>
</table>

4)  

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-4</td>
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<tr>
<td>0</td>
<td>-4</td>
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<tr>
<td>2</td>
<td>-4</td>
</tr>
<tr>
<td>4</td>
<td>-4</td>
</tr>
</tbody>
</table>
Guided Notes: Create a Function and Graph it

Name: _____________________________

Block: _______________ Date: _______________

Make a prediction from the tables of data and linear function equations as to whether you think the linear function is increasing or decreasing. Graph the linear function to see if the prediction is correct.

1) \[ y = \frac{1}{2}x + 4 \]

\begin{tabular}{|c|c|}
  \hline
  x & y \\
  \hline
  -4 & 2 \\
  -2 & 3 \\
  -1 & 3.5 \\
  0 & 4 \\
  \hline
\end{tabular}

2) \[ y = -\frac{3}{4}x + 5 \]

\begin{tabular}{|c|c|}
  \hline
  x & Y \\
  \hline
  4 & 2 \\
  8 & -1 \\
  12 & -4 \\
  16 & -7 \\
  \hline
\end{tabular}

3) \[ y = -2x - 6 \]

\begin{tabular}{|c|c|}
  \hline
  x & Y \\
  \hline
  -4 & 2 \\
  -3 & 0 \\
  -2 & -2 \\
  -1 & -4 \\
  \hline
\end{tabular}
4) \[
\begin{array}{c|c}
 x & y \\
-2 & -4 \\
0 & -4 \\
2 & -4 \\
4 & -4 \\
\end{array}
\]

\[y = -4\]

Is it increasing, decreasing, or neither and where?

Look at the following functions. Tell where the function is increasing, decreasing, or neither by giving the domain for each.

5) 

<table>
<thead>
<tr>
<th>Time in minutes</th>
<th>Distance in miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
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<tr>
<td>6</td>
<td>30</td>
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<tr>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
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<tr>
<td>12</td>
<td>60</td>
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<td>14</td>
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<tr>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
</tr>
</tbody>
</table>

Increasing:

Decreasing:

Neither:
Now you try:

6) 

Increasing:

Decreasing:

Neither:

7) 

Increasing:

Decreasing:

Neither:
How to sketch a graph from a word problem:

Steps to follow:

1) Read the problem and determine what the x and y axis will be representing

3) Determine where your function is going to start and what it is going to do.

4) Sketch a graph.

Ex) You are tracking your workout for today in a graph. You start off walking, before moving up to jogging. Then you start to run, then drop back down to a jog and end with a walk. Your graph will show speed vs. time.
Ex2) Bill is running late for school. He runs to his bus stop in hopes of catching the bus. He stops and waits for the bus. When he realizes that he missed the bus he walks home and has his mom take him to school. Graph using distance vs. time.
Now you try:

For questions 8 and 9 graph as speed vs. time.

8) Alec decided that he wanted to be a runner so he started running. He found out that he was unfit and came to a stop gradually.

9) Raja was at a friend's house hanging out. When it was close to dinner time she walked home at a steady rate.
For questions 10 and 11 graph as distance from home vs. time

10) Sam was leaving for a road trip. He drove to the gas station and filled up his tank. He got back on the road and drove to the thruway where he realized he forgot to lock his front door and had to turn around and go home.

11) Tasha was going to the grocery store to buy snacks for her party. She drives her car to the store and parks. She goes shopping then gets back into her car and drives home at the same speed in which she drove to the store.
Homework: Day 6 and 7

Name:____________________________________
Block: _______________ Date: ______________

Vocabulary Review:

Define the following terms.

1) Domain:

2) Increasing:

3) Y-intercept:

4) Rate of change:

5) Decreasing:

Put it into practice:

For the following, determine if the function is increasing, decreasing, or neither. Explain your answer.

6) \{(-3, 4), (-1, 4), (1, 4)\}

7)\[
\begin{array}{|c|c|}
\hline
x & Y \\
\hline
0 & 5 \\
3 & 7 \\
6 & 9 \\
9 & 11 \\
\hline
\end{array}
\]
Describe the characteristic of the following graph.

8) 

Increasing:

Decreasing:

Neither:

Make a graph for the following word problems.

9) Hunter was getting ready to go to school. He leaves his house and walks to the bus stop where he waits for a few minutes. He gets on the bus which makes 3 other stops before arriving at school. Make a distance (from Hunter’s home) vs. time graph to represent the above information.
Day 8

Lesson: Review Day

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

8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3: Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points $(1,1), (2,4)$ and $(3,9)$, which are not on a straight line.

8.F.4: Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two $(x, y)$ values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Objective: (SWBAT)

- Show their strengths and weakness of their knowledge of functions, and see what areas they need to study for the test.

Lesson Materials: Jeopardy Game Cards, Score Cards, Rulers, Dry Erase Boards (laminated paper), Markers, Paper Towels, and Prize.

Introduction:

Go over homework and explain any questions. Collect projects. Have the students get with their partner to get ready for Jeopardy.
**Classroom Activity:**

**Teach:** Hand out the dry erase board markers and paper towels. Explain how to play Jeopardy and randomly select a group to go first.

How to play Jeopardy: Winning team picks a topic and point amount, the teacher then reads the question (works best with either a power point jeopardy template from http://www.edtechnetwork.com/powerpoint.html, or a smart board Jeopardy template. You can use cards but they can sometimes be hard to read from where the students are sitting). Students must show work and answer on their dry erase board to get credit and the first team to hold up their board and have the correct answer wins the points. I have the slides written up as pieces of paper at the end of the lesson.

**Re-Teach:** If there are questions that no one is able to answer correctly you will need to re-teach that section.

**Homework:** Study for the test

**Conclusion:** Turn in class journals.

**Reflection:**
# Jeopardy

Function Review

<table>
<thead>
<tr>
<th>Terms</th>
<th>Graph it</th>
<th>Rate or Change</th>
<th>Function?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
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</tbody>
</table>
Terms – 10 Points

QUESTION:
  • This is a set of data.

ANSWER:
  • Relation

Terms – 20 Points

QUESTION:
  • The test that tells you that a relation is also a function.

ANSWER:
  • Vertical Line Test
QUESTION:
• When you have a positive rate of change

ANSWER:
• line is increasing

QUESTION:
• This does not have a constant rate of change.

ANSWER:
• Non-linear
Terms – 50 Points

**QUESTION:**

• Represents the vertical values.

**ANSWER:**

• Impute/Domain/Independent variable

---

Graph It – 10 Points

**QUESTION:**

• Bobby walked at a steady rate from his house to his friend's house. Graph as speed vs. time.

**ANSWER:**

[Graph with x-axis labeled 'Time', y-axis labeled 'Speed']
Graph It – 20 Points

QUESTION:

• Ty was running late for school. He ran out his front door to the bus stop and saw that he had just missed the bus. He walked home to ask his mom for a ride.

ANSWER:

Graph It – 30 Points

QUESTION:

• Phil is training for a race. He starts off with a walk for a warm up. He then alternates between jogging and running 3 times then ends with a walk. Graph as speed vs. time.

ANSWER:
Graph It – 40 Points

QUESTION:

• Steve was going home from a party at a friend’s house. He got into his car and started to drive home only to realize halfway there that he had left his wallet at his friend’s house. He turned around to get his wallet then drove back home. Graph as distance from home vs. time.

ANSWER:

Graph It – 50 Points

QUESTION:

• Gina was going out to dinner with friends. She left her house and drove to the restaurant. When she got there she noticed that she had forgotten her wallet so she went back home to get it. Then drove back to the restaurant. Graph as distance from home vs. time.

ANSWER:
Rate of Change—10 Points

QUESTION:

• Find the rate of change. 
{(2, 6), (4, 12), (6, 18)}

ANSWER:

• 3

Rate of Change—20 Points

QUESTION:

• Find the rate of change.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>-5</td>
</tr>
<tr>
<td>6</td>
<td>-10</td>
</tr>
</tbody>
</table>

ANSWER:

• -5/2
Rate of Change—30 Points

**QUESTION:**

- Find the rate of change and y-intercept.

**ANSWER:**

- ROC: 3 and y-intercept: -8

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
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<tr>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
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<tr>
<td>7</td>
<td>13</td>
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<tr>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

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Rate of Change—40 Points

**QUESTION:**

- Write a function model for the following data.

**ANSWER:**

- \( y = \frac{1}{2} x - 1 \)

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>-6</td>
</tr>
<tr>
<td>-8</td>
<td>-5</td>
</tr>
<tr>
<td>-6</td>
<td>-4</td>
</tr>
<tr>
<td>-4</td>
<td>-3</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
</tr>
</tbody>
</table>
**Rate Of Change– 50 Points**

**QUESTION:**

• The following points lie on a linear function (7, 2) and (14, 7)

**ANSWER:**

• $y = \frac{5}{7} x - 3$

---

**Function? – 10 Points**

**QUESTION:**

• What is a function?

**ANSWER:**

• A set of data that for every input there is exactly one output.
QUESTION:

• A relation can be a set of inputs with exactly one output. True or false? Explain.

ANSWER:

• True, all functions are relations.

QUESTION:

• Is this set of data a function or relation? Explain.

ANSWER:

• Function, because every input has exactly one output.
**QUESTION:**

Is this set of data a function or relation? Explain.

**ANSWER:**

Function, every input has one output.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

**QUESTION:**

Is this set of data a function or relation? Explain.

**ANSWER:**

Relation, the inputs 2 and 5 both have two outputs.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
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<tr>
<td>5</td>
<td>6</td>
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<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>
Day 9

Lesson: Test.

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

8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

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8.F.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Objective: (SWBAT)
- Show what they have learned in this unit.

Lesson Materials: Test: Function Unit

Introduction:
Answer any last second questions your students have.

Classroom Activity:
Give your students the test.

Conclusion: Write a one to two page essay on what you learned in this unit. What activities did you find the most helpful and which were the least helpful?

Reflection:
Test: Function Unit

Name: ________________________________

Grade: __/95

Block: _________ Date: ___________

Vocabulary:

Match the vocabulary words with their definition (2pts each).

1. Relation
   a) The input values of a function
2. Function
   b) The point at which the graph crosses the y-axis
3. Domain
   c) The output values of a function
4. Range
   d) The rate at which a linear equation is either increasing or decreasing.
5. Linear Function
   e) Every input has only one output
6. Rate of Change
   f) Is a function with a consistent rate of change.
7. Y-intercept
   g) Is any set of data points

State the domain and range of the following sets of data and state if it is a function or relation (4 pts each).

8) \{(3, 3), (3, 4), (3, 5)\}  9) \[
\begin{array}{|c|c|}
\hline
X & Y \\
\hline
-1 & 4 \\
0 & 3 \\
1 & 2 \\
2 & 1 \\
3 & 0 \\
\hline
\end{array}
\]

Domain:

\[
\text{Range:}
\]

10) \{(4, -2), (5, -3), (6, -2), (7, -1)\}

Domain:

\[
\text{Range:}
\]
Find the rate of change of the following functions (3pts each).

11) \[ \begin{array}{c|c}
X & Y \\
4 & -4 \\
6 & -3 \\
8 & -2 \\
10 & -1 \\
12 & 0 \\
\end{array} \]

12) \{(1, 0), (4, 3), (7, 6), (10, 9)\}

Make a table to determine if the following functions are linear or non-linear (6 pts each).

14) \[ y = \frac{2}{3}x - 2 \]

15) \[ y = x^3 + 2 \]

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
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<tr>
<td>-1</td>
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<table>
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</tbody>
</table>
What is the y-intercept of the following? (4 pts each)

16) \[
\begin{array}{|c|c|}
\hline
x & Y \\
\hline
-3 & 7 \\
-2 & 4 \\
-1 & 1 \\
0 & -2 \\
1 & -11 \\
\hline
\end{array}
\]

17) \[
\begin{array}{|c|c|}
\hline
x & y \\
\hline
-7 & -3 \\
-5 & -4 \\
-3 & -5 \\
-1 & -6 \\
1 & -7 \\
\hline
\end{array}
\]

18) \{(-2, 2), (0, 2), (2, 2), (4, 2)\}

19) Write a model for the linear function that passes through these points \{(-6, 7), (-3, 8), (0, 9)\} (5pts)

20) Write a model for the linear function that passes through these two points (-1, 1) and (2, -2). (6pts)
Graph the following word problems.

20) Seth is going skiing over winter break. He rides the ski lift to the top of the mountain where he gets off. He then waits for his friends to get off the lift. They decide to take the slow run down the mountain. Graph as a distance from the bottom vs. time. (5 pts)

22) Beth decided to take her dog (Spotty) for a run. They started out at a slow jog for a few minutes then started to run. At the end of the run they walked for a cool down before stopping. Graph as speed vs. time. (5 pts)
Remove this page of your test and take it home. This part of the test is due tomorrow by the end of the school day.

23) Type a one to two page essay on:

What you learned in this unit.

What was your favorite activity that we did and explain why.

What was your least favorite activity and explain why. (15 pts)
Chapter 4 Validity of Curriculum Project

This unit was reviewed by Jennifer Miller, a middle school mathematics teacher who is part of the creation and implementation of mathematics curriculum for her school. Miller has been a middle school mathematics teacher for over four years, teaching sixth, seventh, and eighth grades.

When reviewing this unit Miller (2015) liked that "... it focused on vocabulary without distracting from the other objectives of the lesson" (personal communication, November 22, 2015), meaning that the vocabulary was integrated into the lessons in such a way that it was meaningful to the lesson and applied throughout the unit. When referring to new vocabulary Miller comments, "It wasn't just learned for the sake of learning new words, but the students were then shown how it applies in the context of a problem. I think that helps the students create more meaning for the words they're learning, which, in turn will hopefully help them remember them in the future" (J. Miller personal communication, November 22, 2015). Vocabulary should not be viewed as a check list item. Vocabulary should help meet the objectives of the lesson so the students will have a complete understanding of the concept taught.

Miller (2015) also liked the fact that the lesson plans included asking students’ responses to the "... new vocabulary and mathematical concepts (particularly in the introduction)" (personal communication, November 22, 2015). It is easy as a teacher to focus on just getting through the material in the lesson, and forget to engage the students in what is being taught, or to "access the students' prior knowledge" (personal communication, November 22, 2015) which is a "critical step" (personal communication, November 22, 2015) in student learning.

The one negative that Miller (2015) found in this unit was how closely this unit lines up with the linear equations unit (personal communication, November 22, 2015). Both units have a lot of the same vocabulary and concepts, so it is important to make sure that both units are...
consistent in the ways that they are taught so that the students can see the similarities between these units (personal communication, November 22, 2015).
Chapter 5 Final Reflection

Due to the recent shift from the NCTM and state standards to the CCSS, teachers have had to find new units that are aligned to the new standards. The purpose of this thesis is to give a unit plan that teachers can use in their classrooms, as well as, to use as a tool to model other units. The unit in this thesis has been created for an eighth grade classroom, though the strategies can be used in other grades.

After examining the many different ways to implement mathematical literacy in a mathematics classroom, this unit focuses on mathematical journals, integration of mathematical vocabulary in the learning process, having students discover the definitions of new vocabulary and putting those definitions on the word wall, as well as, introducing writing into a mathematics classroom through a short informational paper written at the end of the unit. These strategies combined with cooperative learning groups in a classroom that have the sociomathematical norms as discussed in chapter three will help students in their understanding of the lessons.

Ultimately, this unit does need to be tweaked so that it aligns with the teacher’s unit on linear equations so that students can see how the concepts transfer from one unit to the next. The strategies that are implemented in this unit will help students have a better understanding of the information being taught as well as help them become more mathematically literate.
Appendix

The appendix does not follow APA formatting. That is because it is the solutions keys and word wall cards for the unit outlined in this thesis.

Appendix A: Word Wall Cards

Input/ Domain/ Independent Variable

Definition:

Example:
Output/ Range/ Dependent Variable

Definition:

Example:
Function

Definition:

Example:
Relation

Definition:

Example:
Vertical Line Test

Definition:

Example:
Rate of Change

Definition:

Example:
Increasing

Definition:

Example:
Decreasing

Definition:

Example:
Linear

Definition:

Example:
Non-linear

Definition:

Example:
Y-Intercept

Definition:

Example:
Appendix B: Day 1 Notes and Worksheet Solutions

Guided Notes: What is a function?

Name: __________________

Block: __________ Date: __________

New Vocabulary: Have students come up with these

- **Relation:** A set of ordered pairs
- **Domain/ Input/ Independent Value:** All possible x-values for the relation/ function
- **Range/ Output/ Dependent Value:** All possible y-values for the relation/ function
- **Function:** Is a relation where every input has one and only one output
- **Vertical Line Test:** Is a way to tell if a relation is a function or not. If a vertical line crosses a graphed relation more than one time the relation is not a function.

Relation Activity

<table>
<thead>
<tr>
<th>Names</th>
<th>Eye Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrienne</td>
<td>Brown</td>
</tr>
<tr>
<td>Bobby</td>
<td>Blue</td>
</tr>
<tr>
<td>Jillian</td>
<td>Green</td>
</tr>
<tr>
<td>Jordan</td>
<td>Brown</td>
</tr>
<tr>
<td>Alex</td>
<td>Green</td>
</tr>
<tr>
<td>John</td>
<td>Brown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eye Color</th>
<th>Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Adrienne</td>
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<tr>
<td>Brown</td>
<td>Jordan</td>
</tr>
<tr>
<td>Brown</td>
<td>John</td>
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<tr>
<td>Blue</td>
<td>Bobby</td>
</tr>
<tr>
<td>Green</td>
<td>Jillian</td>
</tr>
<tr>
<td>Green</td>
<td>Alex</td>
</tr>
</tbody>
</table>
What is a Function?

The following are examples of relations.

\[
\begin{array}{c|c}
X & Y \\
\hline
-1 & 4 \\
0 & 3 \\
1 & 9 \\
1 & 12 \\
4 & 7 \\
\end{array}
\]

What are the conclusions that we can make about relations?

They are just sets of data.

The following are examples of functions.

\[
\begin{array}{c|c}
X & Y \\
\hline
-1 & 4 \\
0 & 3 \\
1 & 2 \\
2 & 1 \\
3 & 0 \\
\end{array}
\]

What are some conclusions that we can make about functions?

Every \( x \) or input has only 1 output.
Vertical Line Test:

Not a Function

Function

Function

Using the vertical line test state if the following is a function or not.

Finding the Domain and Range:

What is the domain and range of the following functions?

a) \{(10, 8), (13, 7), (16, 6), (17, 7)\}

Domain: \{6, 7, 13, 16, 17\}

Range: \{6, 7\}

b) \[
\begin{array}{c|c}
  X & Y \\
  \hline
  -1 & 4 \\
  0 & 3 \\
  1 & 2 \\
  2 & 1 \\
  3 & 0 \\
\end{array}
\]

Domain: \{-1, 0, 1, 2, 3\}

Range: \{0, 1, 2, 3\}

When finding the domain of a graph look for x values that do not fall on the graph. When finding the range look for y values that do not fall on the graph.
Work in your group to determine if the following relations are functions? Explain your answer using a complete sentence.

1) [Graph of a function]
   Function: Yes  No
   It is a function because it passes the vertical line test.

2) [Diagram of a function with inputs and outputs]
   Function: Yes  No
   It is a function because every input has exactly one output.

3) \{(0, 0), (1, 1), (2, 8), (3, 27)\}
   Function: Yes  No
   It is a function because every x value has exactly one y value.

4) | x | y |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>-1</td>
<td>4</td>
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<tr>
<td>-1</td>
<td>3</td>
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<tr>
<td>0</td>
<td>2</td>
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<tr>
<td>1</td>
<td>1</td>
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<tr>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>
   Function: Yes  No
   The x value -1 has two y values.

Ticket out the door: Write a paragraph in your class journal explaining what you learned about functions today. (Don't forget to incorporate the new vocabulary that you learned.)
Define the following. Sample answers

What are the differences and similarities between functions and relations?
All functions are relations, the difference is that a function have a rule that for every $x$ there is one and only one $y$-value.

What does the domain represent?
All of the inputs or $x$ values that are part of the relation/function.

What does the range represent?
All of the outputs or $y$ values that are part of the relation/function.

Put it into practice:

Determine if the following relations are functions. Explain the reasoning behind your answer.

1) Input Output
   
   
   
   Function: Yes No
   The input 20 has two outputs 2 and 6.

2) \{(2, 4), (3, 5), (4, 4), (5, 3)\}
   
   Function: Yes No
   It is a function because every $x$ value has only one $y$ value.
3) | X | Y |
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>-1</td>
<td>4</td>
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<td>3</td>
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<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Function: Yes  No

The x value -1 has two different y values.

What are the domain and range for the following functions?

5) X | Y
---|---
4  | -4
6  | -3
8  | -2
10 | -1
12 | 0

Domain: 4, 6, 8, 10, 12
Range: -4, -3, -2, -1, 0

6) {(1, 0), (4, 3), (7, 6), (10, 9)}

Domain: 1, 4, 7, 10
Range: 0, 3, 6, 9

7) Input | Output
Q    | A
R    | B
S    | C

Domain: a, b, c, s
Range: a, b, c

8) X | Y
---|---
4  | 0
6  | -1
8  | -1
10 | -3
12 | -4

Domain: 4, 6, 8, 10, 12
Range: -4, -3, -2, -1, 0
Appendix C: Day 2 Notes and Worksheet Solutions

**Guided Notes:** Finding the Rate of Change of a Function

Name: ____________________  Block: ____________  Date: ____________

**Vocabulary:**
- **Rate of Change:** A ratio that shows the change in variables, $\frac{\Delta y}{\Delta x}$, where $\Delta$ represents the change in the input (x-values).
- **Increasing:** The output (y-values) are getting larger. Positive ROC.
- **Decreasing:** The output (y-values) are getting smaller. Negative ROC.

**How to find the Rate of Change:**

Rate of change formula: \( ROC = \frac{y_2 - y_1}{x_2 - x_1} \)

<table>
<thead>
<tr>
<th>From a Table</th>
<th>From Ordered Pairs</th>
<th>From a graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Find the common difference of the range (y-values on right side)</td>
<td>1) Find the difference of the y-values</td>
<td>1) Find the slope of the graph</td>
</tr>
<tr>
<td>2) Find the common difference of the domain (x-values on left side)</td>
<td>2) Find the difference of the x-values</td>
<td></td>
</tr>
<tr>
<td>3) Plug into the rate of change formula</td>
<td>3) Plug the answers from 1 and 2 into the rate of change formula</td>
<td></td>
</tr>
</tbody>
</table>

If you have a Positive rate of change then the graph will be Rising, and if it has a Negative rate of change then the graph will be Falling (sometimes it is only for a given domain and sometimes it will be for the whole graph).
Find the rate of change:

1) Find the rate of change for the table below.

\[
\begin{array}{c|c}
X & Y \\
\hline
3 & 2 \\
4 & 6 \\
5 & 10 \\
6 & 14 \\
\end{array}
\]

\[
\frac{4 - 2}{1 - 3} = \frac{2}{-2} = -1
\]

2) Find the rate of change for the table below.

\[
\begin{array}{c|c}
X & Y \\
\hline
-2 & 21 \\
0 & 18 \\
2 & 15 \\
4 & 12 \\
\end{array}
\]

3) Find the rate of change between these two points (7, 0) and (13, 5)

\[
\frac{5 - 0}{13 - 7} = \frac{5}{6}
\]

4) Find the rate of change of the line that passes through the two points (-1, -4) and (5, -3)

\[
\frac{-3 - (-4)}{5 - (-1)} = \frac{1}{6}
\]

5) Find the rate of change of the graph below

\[
\frac{4}{3}
\]

6) Find the rate of change of the graph below

\[
\frac{9}{5}
\]
Which has the biggest rate of change?

7) \{ (2, 2), (3, 4), (4, 6), (5, 8) \} or

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>24</td>
</tr>
<tr>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

\[ \frac{2}{3} \]

or the line that passes through the points (4, 7) and (7, 14).

\[ \frac{3}{7} \]

\[ \frac{7}{3} \]

8)

or the line that passes through the points (4, 7) and (7, 14).

\[ \frac{3}{7} \]

\[ \frac{7}{3} \]

9) The line that passes through (5, 8) and (8, 9) or \{ (2, 4), (3, 7), (4, 10) \}

\[ \frac{-8}{9} = \frac{10}{3} \]

\[ \frac{3}{1} \]

\[ \frac{1}{3} \]
Rate of Change Activity  

Work with a partner to find the rate of change for the five different sections of the graph below.

1) What is the rate of change from 0 to 4 minutes? \( \frac{45}{4} \)

2) What is the rate of change from 4 to 9 minutes? \( \frac{10}{5} = 2 \)

3) What is the rate of change from 9 to 14 minutes? 0

4) What is the rate of change from 14 to 21 minutes? \( \frac{-8}{6} \)

5) What is the rate of change from 21 to 30 minutes? \( \frac{-15}{6} \)
Write a story to explain the graph above and that compares the rates of change. (Hint you can use someone driving.) Sample answer

Bob is going for a drive. He starts off at a fast pace. Then slows down and comes to a stop. He remembers that he forgot his wallet so he drives home. When he is almost home he sees a police car and slows down till he gets home.

Explain what the rate of change is telling us in the above graph. How is this helpful when looking at data? (Hint: Increasing and Decreasing) Sample answer

At first the rate of change tells us that our data is increasing quickly. Then it slows down till it eventually comes to a stop. It then decreases quickly then slows down till the end of the data.

This is helpful to know because it helps in explaining what is happening with the data.
Homework: Day 2

Finding the Rate of Change of a Function

Answer the following

1) How do you find the rate of change from a table of data?
   First find the common difference of the input and output. Then put common difference of the output in the numerator and common difference of the input in the denominator. Then simplify.

2) If a graph is increasing then it has what kind of rate of change? Positive

3) If a graph is decreasing then it has what kind of rate of change? Negative

Put into Practice

Find the rate of change for the following data and graphs.

4) \{(-3, 4), (1, 2), (5, 0), (9, -2)\}
   \[
   \frac{\Delta y}{\Delta x} = \frac{-2}{4} = -\frac{1}{2}
   \]

5) \[
   \begin{array}{c|c}
   X & Y \\
   \hline
   -10 & 13 \\
   -5 & 16 \\
   0 & 19 \\
   5 & 22 \\
   \end{array}
   
   \]

6) [Graph showing a line with a negative slope of -\frac{1}{2}]
List the rate of change from least to greatest for the following questions.

7) The line that passes through the points (-12, 4) and (-6, 8), {(-2, 2), (0, 2), (2, 2), (4, 2)}, and the table

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>7</td>
</tr>
</tbody>
</table>

8)

9) Looking at question 8 could you guess which graph has the smallest rate of change and which one has the largest? Explain why you could or could not see the order of the rate of change.

*Answers will vary*
Appendix D: Day 3 & $ Notes and Quiz Solutions

Guided Notes: Is it a Linear or Non-linear Function Name: Key ____________________
Block: __________ Date: ______

Vocabulary: Have students come up with

Linear Function: Is a function whose graph is a straight line.

Non-linear Function: Is any function whose graph is not a straight line.

How to determine if a function is linear or non-linear graphically.
The following graphs are non-linear. Look at both the equations and graph.

1) $y = x^2$

2) $y = x^3$

3) $y = \sqrt{x}$

4) $y = 2^x$

5) $y = \frac{1}{x}$

What are some conclusions that you can make about non-linear functions based on the graphs above? What are some conclusions that you can make about non-linear functions based on the equations? Answers will vary.
Here are some linear equations. Look at both the equations and the graphs.

7) \( y = -\frac{1}{3}x + 4 \)  
8) \( y = \frac{3}{4}x - 2 \)  
9) \( y = 4 \)

What are some conclusions that you can make about linear functions based on the graphs? What are some conclusions that you can make about linear functions based on the equations?

*Answers will vary*

Looking at the conclusions you have made about linear and non-linear functions, work with a partner to come up with a definition for linear and non-linear functions. Be prepared to share your definitions to the class. (Use the space below to brainstorm your ideas.)
Now you try:

Use your definition to decide which graphs are linear and which are non-linear. Explain your reasoning. (You can still work with your partner for this exercise)

1) [Graph]

- **Non-linear**
- *Because the graph is not a straight line.*

2) [Graph]

- **Linear**
- *Because the graph is a straight line.*

3) [Graph]

- **Non-linear**
- *Because the graph is not a straight line.*

4) [Graph]

- **Linear**
- *Because the graph is a straight line.*
Look at the following equations and try to determine if the equation is linear or non-linear. Explain your reasoning.

5) \( y = x^2 \)  
   Non-linear  
   \( x \) is raised to the 2nd power

6) \( y = \frac{1}{4} \sqrt{x} \)  
   Non-linear  
   The \( x \) is inside the radical

7) \( y = \frac{x}{2} \)  
   Linear  
   The \( x \) is not in a radical, in the denominator, or raised to any power

8) \( y = \frac{2}{x} \)  
   Non-linear  
   The \( x \) is in the denominator

9) \( y = \frac{5}{9} x - 1 \)  
   Linear  
   The \( x \) is not in a radical, in the denominator, or raised to any power

10) \( y = -5 - \frac{1}{4} x \)  
    Linear  
    The \( x \) is not in a radical, in the denominator, or raised to a power

Write in your class journal how to tell graphically if a function is linear or non-linear.
Make a table for a given equation to see if the equation is a linear or non-linear function.

1) \( y = \frac{1}{4}x + 2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1.5</td>
</tr>
<tr>
<td>-1</td>
<td>1.75</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>2.25</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Linear, the y values are increasing by \( \frac{1}{4} \) every time.

2) \( y = x^2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>4</td>
</tr>
<tr>
<td>-1</td>
<td>1</td>
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<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Non-Linear, the y values 4 and 1 repeat.

3) \( y = \frac{4}{x} + 2 \)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>0</td>
</tr>
<tr>
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<td>-2</td>
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<tr>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Non-Linear, there is no constant rate of change. There is no y value for 0.

4) \( y = x \)

<table>
<thead>
<tr>
<th>x</th>
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<tbody>
<tr>
<td>-2</td>
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<td>2</td>
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</tbody>
</table>

Linear, the y values are increasing by 1 every time.
Now that we have a basic idea of how to see if a function is linear or non-linear, work with your partner on the following activity in which you will be finding if the functions are linear or non-linear by either looking at the function graphically or algebraically (constructing a table of data and finding the rate of change). Explain if the function is linear or non-linear and why.

1)  
\[
\begin{array}{c|c}
 x & y \\
-2 & 4 \\
-1 & 3 \\
0 & 2 \\
1 & 1 \\
2 & 0 \\
\end{array}
\]

Linear  
The function has a constant rate of change.

2)  
\[
\begin{array}{c|c}
 x & y \\
-4 & 8 \\
-2 & 4 \\
0 & 0 \\
2 & 4 \\
4 & 8 \\
\end{array}
\]

Non-linear  
The function does not have a constant rate of change.

3)  
\[
\begin{array}{c|c}
 x & y \\
0 & 7 \\
1 & 4 \\
2 & 1 \\
3 & -2 \\
6 & -11 \\
\end{array}
\]

Linear  
There is a constant rate of change.

4)  
\[
\begin{array}{c|c}
 x & y \\
-7 & -3 \\
-5 & -4 \\
-3 & -5 \\
-1 & -6 \\
1 & -7 \\
\end{array}
\]

Linear  
There is a constant rate of change.
5) Non-linear
not a straight line

6) Linear
The function is a straight line

7) Non-linear
The function is not a straight line

8) Linear
The function is a straight line

9) Linear
The function is a straight line

10) Non-linear
The function is not a straight line
Determine if the following functions are linear or non-linear by making tables of data and determining if the functions have a constant rate of change or not.

11) \( y = 2x + 4 \) \textbf{linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

12) \( y = x^2 + 4 \) \textbf{non-linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>8</td>
</tr>
<tr>
<td>-1</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

13) \( y = -\frac{x}{4} \) \textbf{linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-( \frac{1}{2} )</td>
</tr>
<tr>
<td>-1</td>
<td>-( \frac{1}{4} )</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>-( \frac{1}{4} )</td>
</tr>
<tr>
<td>2</td>
<td>-( \frac{1}{2} )</td>
</tr>
</tbody>
</table>

14) \( y = x^3 - 2 \) \textbf{non-linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-10</td>
</tr>
<tr>
<td>-1</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

15) \( y = \frac{2}{x} \) \textbf{non-linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>-1</td>
<td>-2</td>
</tr>
<tr>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

16) \( y = \frac{4}{7}x + 2 \) \textbf{linear}  

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>( \frac{6}{7} )</td>
</tr>
<tr>
<td>-1</td>
<td>( \frac{10}{7} )</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>( \frac{18}{7} )</td>
</tr>
<tr>
<td>2</td>
<td>( \frac{22}{7} )</td>
</tr>
</tbody>
</table>
Quiz: Function Quiz 1

Name: Key

Block: Date:

1) What is a relation? A set of ordered pairs

2) What is a function? A relation where every input has exactly one output.

3) Explain one way to find the rate of change. Answers will vary

   Graphically: Find the slope of the line.
   From a table of data or table: find the common difference of both the input/ x values and output/ y values.

What is the domain and range of the following sets of data?

4) \{(2, 4), (3, 8), (4, 12), (5, 16)\}
   Domain: \{2, 3, 4, 5, 6\}
   Range: \{4, 8, 12, 16\}

5) \begin{array}{|c|c|}
    \hline
    x & y \\
    \hline
    -3 & 7 \\
    -2 & 4 \\
    -1 & 1 \\
    0 & -2 \\
    1 & -5 \\
    \hline
  \end{array}
  Domain: \{-3, -2, -1, 0, 1\}
  Range: \{-5, 0, 1, 4, 7\}

6) Find the rate of change for both questions 4 and 5.
   \[ \frac{4}{1} = 4 \]  \[ -\frac{3}{1} = -3 \]
**Lesson:** Creating a Linear Function Using Rate of Change and Y-intercept.

**Vocabulary:**

**Y-intercept:** The point at which the graph crosses the y-axis

**How to find the y-intercept.**

What do you think y-intercept means?

---

How to find the y-intercept when given...

<table>
<thead>
<tr>
<th>A table of data</th>
<th>A set of points on the line</th>
<th>A Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are looking to see when input is zero and the y-value at that point is the y-intercept.</td>
<td>When given a set of data (two or more points on a line) you need to find the rate of change and then you can either make a Table of data and fill it in till you find the y-intercept or graph the points and find the y-intercept.</td>
<td>Look for where the line crosses the y-axis and the y-value at the point is the y-intercept.</td>
</tr>
</tbody>
</table>

*Sometimes it is not given in the table. When that is the case you need to find the rate of change and extend your table till you are able to follow the instruction above.*
What is the y-intercept of the following functions.

1) \[(0, 4)\]

2) \[(0, -3)\]

3)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

6) The line that passes through the points (2, 7) and (3, 4).

ROC: \(-3\)

ROC: \(0, 13\)

7) The line that passes through the points (4, 9) and (-2, 3).

ROC: 1

ROC: \(0, 5\)
How to model a linear function.

When trying to model a linear function there are two things you need to know. One is y-intercepts and the second is the rate of change. Once you know that information, you can write a model for a linear function by filling in this equation: \( f(x) = mx + b \) where \( b \) is the y-intercept and \( m \) is the rate of change.

Let's try it. Write a model to represent the linear function.

8)  
Rate of Change: \( \frac{3}{4} \)  
Y-intercept: \(-2\)  
Model of the Function: \( f(x) = -\frac{3}{4}x - 2 \)

9)  
<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>
Rate of Change: \( \frac{2}{7} \)  
Y-intercept: \(-6\)  
Model of the Function: \( f(x) = 2x - 6 \)

10) What is the equation of the linear function that passes through these two points \((4, 6)\) and \((6, 6)\)?

\[
\frac{y - 6}{x - 4} = \frac{0 - 6}{4 - 6} = 3 \\
\begin{align*}
\text{model: } f(x) &= 3x + b \\
f(4) &= 6 \\
6 &= 3(4) + b \\
b &= -6 \\
\therefore f(x) &= 3x - 6
\end{align*}
\]
Now you try!

Match the following models with the linear functions that are either given as a graph, a table, or points.

<table>
<thead>
<tr>
<th>Models</th>
<th>$y = 3x + 2$</th>
<th>$y = 2x - 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$y = -2x + 1$</td>
<td>$y = \frac{1}{2}x + 6$</td>
</tr>
</tbody>
</table>

1) $\{(-1, 4), (4, 4), (9, 4)\}$

2)

3)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

ROC: $\frac{1}{2}$

$y = \frac{1}{2}x + 6$

4)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

ROC: $\frac{2}{3}$

$y = \frac{2}{3}x - 1$
What does it mean?

What is the y-intercept? The point at which the graph crosses the y-axis.

Explain in your own words one way to find a y-intercept when given points on a line.

Find the rate of change. Then make a table of data until you find x=0.

Write the model for the given linear functions.

1) \[ y = mx + b \]
   \[ m = \frac{4}{3} \]
   \[ b = 2 \]

2) \[ \text{ROC: } 0 = m \]
   \[ y - \text{int: } -3 = b \]
   \[ y = 0x - 3 \]
   \[ y = -3 \]

3) \[ \text{ROC: } \frac{y}{4} = 4 = m \]
   \[ y - \text{int: } 2 = b \]
   \[ y = 4x + 2 \]
4) \[ \begin{array}{c|c}
 x & y \\
-2 & 5 \\
-1 & 0 \\
0 & -5 \\
1 & -10 \\
2 & -15 \\
\end{array} \]

\[ y = mx + b \]
\[ m = \frac{-5}{1} = -5 \]
\[ b = -5 \]

5) \[ \begin{array}{c|c}
 x & y \\
-10 & 0 \\
-7 & 5 \\
-4 & 10 \\
-1 & 15 \\
2 & 20 \\
\end{array} \]

\[ y = mx + b \]
\[ m = \frac{5}{3} \]
\[ 0 = \frac{5}{3}(10) + b \]
\[ b = \frac{50}{3} \]
\[ b = -16.6 \]

6) Model the linear function that passes through the points (2, 5) and (4, 6)

\[ y = mx + b \]
\[ m = \frac{1}{2} \]
\[ 5 = \frac{1}{2}(2) + b \]
\[ 5 = 1 + b \]
\[ -1 = b \]
\[ y = \frac{1}{2}x + 4 \]

7) Model the linear function that passes through the points (5, 10) and (7, 12)

\[ y = mx + b \]
\[ m = 1 \]
\[ 10 = 5 + b \]
\[ -5 = b \]
\[ y = x + 5 \]
4) The table shows the values of \( x \) and \( y \) with the following coordinates:

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>5</td>
</tr>
<tr>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>-5</td>
</tr>
<tr>
<td>1</td>
<td>-10</td>
</tr>
<tr>
<td>2</td>
<td>-15</td>
</tr>
</tbody>
</table>

The slope \( m = -5 \) and the y-intercept \( b = -5 \) are given.

The equation of the line is:

\[
y = -5x - 5
\]

5) The table shows the values of \( x \) and \( y \) with the following coordinates:

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>0</td>
</tr>
<tr>
<td>-7</td>
<td>5</td>
</tr>
<tr>
<td>-4</td>
<td>10</td>
</tr>
<tr>
<td>-1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>

The slope \( m = \frac{5}{3} \) and the y-intercept \( b = \frac{50}{3} \) are given.

The equation of the line is:

\[
y = \frac{5}{3}x - 16.67
\]

Use the point \((-10, 0)\) to find \( b \):

\[
a = \frac{5}{3} (c) + b
\]

\[
0 = \frac{50}{3} + b
\]

\[
b = 16.67
\]

6) Model the linear function that passes through the points (2, 5) and (4, 6)

The slope \( m = \frac{1}{2} \) is given.

The equation of the line is:

\[
y = \frac{1}{2}x + 4
\]

7) Model the linear function that passes through the point \((5, 10)\) and \((7, 12)\)

The slope \( m = \frac{2}{2} = 1 \) is given.

The equation of the line is:

\[
y = x + 5
\]
Write a model for the following linear functions.

1) 

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.3</td>
</tr>
<tr>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td>3</td>
</tr>
<tr>
<td>-3</td>
<td>6</td>
</tr>
</tbody>
</table>

\[ y = -3x - 3 \]

Rate of Change: \[ \frac{3}{1} = m = -3 \]

Y-intercept: \[ a = -3 \]

2) 

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>-1</td>
</tr>
<tr>
<td>12</td>
<td>-4</td>
</tr>
<tr>
<td>16</td>
<td>-7</td>
</tr>
</tbody>
</table>

\[ y = \frac{3}{4}x + 5 \]

Rate of Change: \[ \frac{3}{4} = m \]

Y-intercept: \[ b = 5 \]

3) 

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-6</td>
</tr>
<tr>
<td>-1</td>
<td>-4</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>-3</td>
<td>0</td>
</tr>
<tr>
<td>-4</td>
<td>2</td>
</tr>
</tbody>
</table>

\[ y = -2x - 6 \]

Rate of Change: \[ \frac{2}{1} = m = -2 \]

Y-intercept: \[ a = -6 \]

4) 

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-4</td>
</tr>
<tr>
<td>2</td>
<td>-4</td>
</tr>
<tr>
<td>4</td>
<td>-4</td>
</tr>
</tbody>
</table>

\[ y = -4 \]

Rate of Change: \[ \frac{0}{2} = m = 0 \]

Y-intercept: \[ b = -4 \]
Appendix F: Day 6 & 7 Notes and worksheet solutions

**Lesson:** Create a Function and Graph it

**Name:** __________________________

**Block:** ___________ **Date:** __________

Make a prediction from the tables of data and linear function equations as to whether you think the linear function is increasing or decreasing. Graph the linear function to see if the prediction is correct.

1) $y = \frac{1}{2}x + 4$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>2</td>
</tr>
<tr>
<td>-2</td>
<td>3</td>
</tr>
<tr>
<td>-1</td>
<td>3.5</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

[Graph showing increasing line]

2) $y = -\frac{3}{4}x + 5$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>-1</td>
</tr>
<tr>
<td>12</td>
<td>-4</td>
</tr>
<tr>
<td>16</td>
<td>-7</td>
</tr>
</tbody>
</table>

[Graph showing decreasing line]

3) $y = -2x - 6$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>2</td>
</tr>
<tr>
<td>-3</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>-1</td>
<td>-4</td>
</tr>
</tbody>
</table>

[Graph showing decreasing line]
4) \[ \begin{array}{cc} x & y \\ -2 & -4 \\ 0 & -4 \\ 2 & -4 \\ 4 & -4 \end{array} \]

\[ y = -4 \]

Is it increasing, decreasing, or neither and where?

Look at the following functions. Tell where the function is increasing, decreasing, or neither by giving the domain for each.

5) 

A Robot drives around the parking lot

Increasing: \( 0 \leq x \leq 2 \cup 8 \leq x \leq 13 \)

Decreasing: \( 13 \leq x \leq 24 \)

Neither: \( 2 \leq x \leq 8 \)
Now you try

6)

Increasing: \(-1 \leq x\)

Decreasing: \(-12 \leq x\)

Neither: \(\text{NA}\)

7)

Increasing: \(4 \leq x \leq 5\)

Decreasing: \(4 \leq x \leq 8.7\)

Neither: \(5 \leq x \leq 8.7\)
**How to sketch a graph from a word problem.**

Steps to follow:

1) Read the problem and determine what the x and y axis will be representing.

2) Determine where your function is going to start and what it is going to do.

4) Sketch a graph.

Ex) You are tracking your workout for today in a graph. You start off walking, before moving up to jogging. Then you start to run, then drop back down to a jog and end with a walk. Your graph will show speed vs. time.
Ex2) Bill is running late for school. He runs to his bus stop in hopes of catching the bus. He stops and waits for the bus. When he realizes that he missed the bus he walks home and has his mom take him to school. Graph using distance vs. time.
Now you try:

For questions 8 and 9 graph as speed vs. time.

8) Alec decided that he wanted to be a runner so he started running. He found out that he was unfit and came to a stop gradually.

9) Raja was at a friend's house hanging out. When it was close to dinner time she walked home at a steady rate.
For questions 10 and 11 graph as distance from home vs. time

10) Sam was leaving for a road trip. He drove to the gas station and filled up his tank. He got back on the road and drove to the thruway where he realized he forgot to lock his front door and had to turn around and go home.

11) Tasha was going to the grocery store to buy snacks for her party. She drives her car to the store and parks. She goes shopping then gets back into her car and drives home at the same speed in which she drove to the store.
Homework: Day 6 and 7

Vocabulary Review:

Define the following terms.

1) Domain: All the x values that are true for the function.

2) Increasing: The y-values are getting larger as you read the graph from left to right.
   - or positive rate of change.

3) Y-intercept: Where the graph passes through the y-axis.

4) Rate of change: A ratio between changes in sets of data.

5) Decreasing: The y-values are getting smaller as you read the graph from left to right.
   - or negative rate of change.

Put it into practice.

For the following, determine if the function is increasing, decreasing, or neither. Explain your answer.

6) \{(-3, 4), (-1, 4), (1, 4)\}

\[
\begin{align*}
0 & = 0 \\
\text{Neither There is no slope}
\end{align*}
\]

7) \[
\begin{array}{c|c}
  x & y \\
  \hline
  0 & 5 \\
  3 & 7 \\
  6 & 9 \\
  9 & 11 \\
\end{array}
\]

\[
\begin{align*}
\frac{2}{3} & \\
\text{Increasing}
\end{align*}
\]
Describe the characteristic of the following graph.

8)

Increasing: \( 9 \leq x \leq 14 \)

Decreasing: \( 0 \leq x \leq 5 \)

Neither: \( 5 \leq x \leq 9 \)

Make a graph for the following word problems.

9) Hunter was getting ready to go to school. He leaves his house and walks to the bus stop where he waits for a few minutes. He gets on the bus which makes 3 other stops before arriving at school. Make a distance (from Hunter’s home) vs. time graph to represent the above information.
Appendix G: Test Solutions

Test: Function Unit

Grade: ___/95

Vocabulary:

Match the vocabulary words with their definition (2pts each).

1. Relation
   a) The input values of a function

2. Function
   b) The point at which the graph crosses the y-axis

3. Domain
   c) The output values of a function

4. Range
   d) The rate at which a linear equation is either increasing or decreasing.

5. Linear Function
   e) Every input has only one output

6. Rate of Change
   f) Is a function with a consistent rate of change.

7. Y-intercept
   g) Is any set of data points

State the domain and range of the following sets of data and state if it is a function or relation (4 pts each).

8) \{(3, 3), (3, 4), (3, 5)\}

   Domain: \{3, 3, 3\}

   Range: \{3, 4, 5\}

9) \[ \begin{array}{c|c}
   X & Y \\
   \hline
   -1 & 4 \\
   0 & 3 \\
   1 & 2 \\
   2 & 1 \\
   3 & 0 \\
   \end{array} \]

   Domain: \{-1, 0, 1, 2, 3\}

   Range: \{0, 1, 2, 3\}

10) \{(4, -2), (5, -3), (6, -2), (7, -1)\}

   Domain: \{4, 5, 6, 7\}

   Range: \{-2, -3, -2\}

   139
Find the rate of change of the following functions (3pts each).

11) 
\[
\begin{array}{|c|c|}
\hline
X & Y \\
\hline
4 & -4 \\
6 & -3 \\
8 & -2 \\
10 & -1 \\
12 & 0 \\
\hline
\end{array}
\]

\[ROC: \frac{1}{2}\]

12) \{ (1, 0), (4, 3), (7, 6), (10, 9) \}

\[ROC: \frac{2}{3} = 1\]

13) 
\[\frac{3}{2}\]

\[ROC: \frac{3}{2}\]

Make a table to determine if the following functions are linear or non-linear (6 pts each).

14) \(y = \frac{2}{3}x - 2\)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>(\frac{2}{3}(x)-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-3.33</td>
<td>(-\frac{10}{3})</td>
</tr>
<tr>
<td>-1</td>
<td>-2.66</td>
<td>(-\frac{8}{3})</td>
</tr>
<tr>
<td>0</td>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>-1.33</td>
<td>(-\frac{4}{3})</td>
</tr>
<tr>
<td>2</td>
<td>-1.66</td>
<td>(-\frac{2}{3})</td>
</tr>
</tbody>
</table>

\text{Linear}

15) \(y = x^3 + 2\)

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>((-2)^3+2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-5</td>
<td>((-1)^3+2)</td>
</tr>
<tr>
<td>-1</td>
<td>1</td>
<td>((-1)^3+2)</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>(2^3+2)</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>((2)^3+2)</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>((2)^3+2)</td>
</tr>
</tbody>
</table>

\text{Non-linear}
What is the y-intercept of the following? (4 pts each)

16)  
\[
\begin{array}{c|c|}
 x & y \\
\hline
-3 & 7 \\
-2 & 4 \\
-1 & 1 \\
0 & -2 \\
1 & -11 \\
\end{array}
\]

17)  
\[
\begin{array}{c|c|}
 x & y \\
\hline
-7 & -3 \\
-5 & -4 \\
-3 & -5 \\
-1 & -6 \\
1 & -7 \\
\end{array}
\]

18) \{(-2, 2), (0, 0), (2, 2), (4, 2)\}

19) Write a model for the linear function that passes through these points \{(-6, 7), (-3, 8), (0, 9)\} (5 pts)

\[
\begin{align*}
\text{Roc: } & \frac{3}{3} = 3 = m \\
\text{y-int: } & 9 = b \\
\Rightarrow y & = 3x + 9
\end{align*}
\]

20) Write a model for the linear function that passes through these two points (-1, 1) and (2, -2). (6 pts)

\[
\begin{align*}
\text{Roc: } & \frac{-3}{3} = -1 = m \\
\Rightarrow b & = 0 \\
\Rightarrow y & = -x
\end{align*}
\]
Graph the following word problems.

20) Seth is going skiing over winter break. He rides the ski lift to the top of the mountain where he gets off. He then waits for his friends to get off the lift. They decide to take the slow run down the mountain. Graph as a distance from the bottom vs. time. (5 pts)

22) Beth decided to take her dog (Spotty) for a run. They started out at a slow jog for a few minutes then started to run. At the end of the run they walked for a cool down before stopping. Graph as speed vs. time. (5 pts)
Remove this page of your test and take it home. This part of the test is due tomorrow by the end of the school day.

23) Type a one to two page essay on:
What you learned in this unit.
What was your favorite activity that we did and explain why.
What was your least favorite activity and explain why. (15pts)
References


