**Instructional Design**

**Model with Functions**

**By: Lance Kruse**

**Rationale**

Mathematics, particularly the study of linear functions, can make sense of many real-life situations that are intriguing to students. When studying functions in real-world contexts, students may better “make sense of the underlying mathematical concepts and foster an appreciation of these concepts” (NCTM, 2000, p. 297). However, when functions are taught without any relevance to meaningful contexts, the subject matter attracts an abstract and seemingly useless ambiance. Through problem solving in the mathematics classroom, “students can experience the power and utility of mathematics” (NCTM, 2000, p. 256). The true power of mathematics is not understood until it is used to begin to organize and explain our incredibly complex and profound world. Through understanding functions, students can understand their world and thus appreciate the value of mathematics.

This sub-unit will be constructed of lesson plans following the Basic Lesson Planning Model and incorporate a blended philosophical approach to learning (Chiarelott, 2006). The Basic Lesson Planning model is highly adaptable and allows for flexibility in this sub-unit. Throughout this sub-unit, the instructional activities are important to set the stage for the real-world context of the mathematics scenario being investigated. At some points, direct instruction is required so students understand the expectations for the day before they work independently. Additionally, concluding activities are important so that students can reflect on their learning for the day and it allows for me to check their understanding before moving on to the next day’s lesson. If students struggled to complete the tasks for the day, then revisions will be made to the next day’s lesson.

This sub-unit will build upon all their previous knowledge learned in previous sub-units regarding functions by asking them to model with functions. The students will be presented with a real-world problem regarding two different cell-phone plans. Students will be asked to analyze these two plans and to determine which one would be better based on their individual needs. Students will have opportunities to apply the knowledge they learned in pervious sub-units to create functions, graphs, and use it to answer questions. This follows the behaviorist model of learning in which the teacher designs the learning activities and structures to maximize student learning (Chiarelott, 2006). However, as mentioned earlier, this sub-unit will follow a blended approach to learning.

This sub-unit also allows for students to create their own ideas and present solutions while also critically analyzing their peer’s ideas. In this sub-unit, students will create two different cell phone plans that account for data usage and talking minutes. They will have to answer a series of questions about their plans pointing out the benefits of each plan. The next day, students will evaluate their peer’s plans and will provide their own insight into which plan is the best based on their individual needs. Not only does this engage the highest levels of Bloom’s taxonomy (Kelley, 1999), but it also fosters critical thinking and problem solving from the students. These lessons follow the constructivist model of learning by allowing the students to be in control of their learning. The teacher sets up the framework of the environment but allows the students to do the majority of their work without there being any one correct answer (Chiarelott, 2006). Through this blended approach, the students will learn mathematics along with other important skills.

As a result of this sub-unit, students will learn how to model real world scenarios using functions and how to answer questions using those models. Students will foster their critical thinking and problem-solving abilities while also working on communication and collaboration with their peers. This sub-unit features high quality mathematics instruction that is rooted in problem solving skills contextualized to the real world, which follows the contextualized teaching and learning principles (NCTM. 2000). It is crucial that students learn the applicability of mathematics to the real world in order to foster a deeper understanding and appreciation of mathematics.

**Sub-Unit Intended Learning Outcomes (Functions)**

**Sub-Unit 4: Model with Functions**

* 1. Students will be able to construct a linear function to model a real-world scenario (Applying).
	2. Students will be able to identify properties of the linear function and analyze them in context of the model (Analyzing).
	3. Students will be able to evaluate the accuracy of a linear function as a model to a real-world scenario by using properties of the function as justification (Evaluating).
	4. Students will be able to qualitatively evaluate the functional relationship between two quantities by analyzing a graph (Evaluating).
	5. Students will be able to sketch a graph that exhibits the qualitative features of a function that has been described qualitatively (Creating).
	6. Students will be able to create their own function (algebraically, graphically, and numerically in tables) to model a real-world scenario and apply the model to answer questions about the scenario (Creating).

**Pre-Assessment of Model with Functions**

**Directions:** Circle the number that best resembles your knowledge of the following.

**1 – never seen 2 – below average 3 – average 4 – above average 5 – expert**

1. Mathematical Models 1 2 3 4 5

2. Creating mathematical models for the real-world 1 2 3 4 5

3. Analyze properties of functions 1 2 3 4 5

4. Use models to answer real-world questions 1 2 3 4 5

5. Evaluating accuracy of models 1 2 3 4 5

6. Evaluate in writing two functions 1 2 3 4 5

7. Evaluating orally two functions 1 2 3 4 5

8. Sketch graphs for verbal descriptions 1 2 3 4 5

9. Sketch graphs from written descriptions 1 2 3 4 5

10. Create own function algebraically 1 2 3 4 5

11. Create own function graphically 1 2 3 4 5

12. Create own function in tables 1 2 3 4 5

13. Identifying the zeros of a function 1 2 3 4 5

14. Identifying the intersection of two functions 1 2 3 4 5

15. Analyzing systems of equations 1 2 3 4 5

16. Persuading peers using mathematical argument 1 2 3 4 5

17. Analyzing peer’s argument 1 2 3 4 5

18. Pose questions to a peer’s argument 1 2 3 4 5

19. Mathematical dispute orally 1 2 3 4 5

20. Mathematical dispute in writing 1 2 3 4 5

**Directions:** Answer the following questions to the best of your ability. Please show your work.

1. What is a mathematical model?

2. Provide an example of a mathematical model. Why is this considered a mathematical model?

3. Identify the zeros of the function ­*y=2x +6.* How did you do it?

4. This function represents the scores on exams (*y)* in relation to how many hours students studied prior to the exam (*x*) according to Columbia University. What does the function tell you about exam scores and hours students studied?

*y=12x+40*

5. Graph the function from Question 4. What does the graph tell you about exam scores and hours students studied?



6. This function below represents the scores on exams (*y)* in relation to how many hours students studied prior to the exam (*x*) according to Case Western University. What does the function tell you about exam scores and hours students studied?

*y=5x+60*

7. Graph the function from Question 6. What does the graph tell you about exam scores and hours students studied?



8. Function (a) is from Columbia University and function (b) is from Case Western University. Compare and contrast the two functions. What do the similarities and differences tell you about exam scores and hours studied?

1. *y=12x+40*
2. *y=5x+60*

9. Graph function (a) and function (b) from Question 8 on the same graph below. What does this tell you in relation to hours studied and exam scores?



10. How many hours do you normally study for a test? (Round to the nearest hour please).

11. Suppose you wanted to justify to your parents/guardians that you were studying long enough for your tests. Your parents/guardians disagree and insight you study longer. Which function (i.e. research from Columbia or Case Western University) would you show them to help justify your studying habits? Why would you chose this function/research?

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| **Talk or Text?** |
| **Your Name** | Lance Kruse | **Date** | 10/12/15 |
| **Subject/ Course**  | Mathematics | **Grade** | 8th |
| **Sub-Unit Topic**  | Model with Functions | **# of Students** | 20 |
| **Class Length** | 50 minutes | Day 1 of 3 | **Unit Topic** | Functions |
| **Central Focus/Concept, Essential Question, or Enduring Understanding**  |
| **Central Focus:** Creating and evaluating mathematical models |
| **Common Core State Standards for Mathematics** |
| * CCSS.MATH.CONTENT.8.F.B.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.
 |
| **Learning Objectives** |
| * Students will be able to construct a linear function to model a real-world scenario (Applying).
* Students will be able to identify properties of the linear function and analyze them in context of the model (Analyzing).
* Students will be able to qualitatively evaluate the functional relationship between two quantities by analyzing a graph (Evaluating).
 |
| **Planned Assessments** |
| * Pre-assessment: This is the sub-unit pre-assessment provided prior to this sub-unit. The pre-assessment asks students to rate their familiarity with the topics to be covered in this sub-unit. Additionally, the questions include topics from previous learned units and asking them to apply them to the topics in this sub-unit.
* Formative Assessment: This lesson’s formative assessment will include as students work in their small groups, observations will be taken by the teacher to see to what extent students are understanding the key concepts. Questions will be asked (as identified below) to assess their understanding. The sub-units formative assessment will be analyzing their worksheet for understanding before moving on to the next day’s lesson.
* Summative Assessment: The lesson’s summative assessment will be students handing in their worksheets from the day which will be analyzed for student understanding. The sub-unit summative assessment will be the final post-assessment.
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| **List Resources** |
| * SmartBoard/Projector
* Information about current cell phone plans from Verzion, T-Mobile, and AT&T.
* Talk or Text Activity Sheet
* Talk or Text Answer Key

Lesson adapted from:Hendrickson, K. (n.d.). Talk or text. *National council teachers of mathematics: Illuminations.* Retrieved from <https://illuminations.nctm.org/Lesson.aspx?id=2850>  |
| **THE LESSON** |
| **1. MOTIVATION Allotted Time: 5 minutes*** Have Smart Board open.
* Begin by addressing students “This weekend, I was watching TV and saw a commercial from Verizon Wireless that was promoting a new cell-phone plan. They even compared it other companies such as AT&T and T-Mobile. Has anyone else seen that commercial?”
* Change to next slide that has a picture from the Verizon commercial
* “Well, it got me thinking – which plan really is better? Do you think we could answer that question? Yes, we probably can. However, these plans are incredibly complex. So, I found two simplified versions of the plans and I want to see which of these plans is better.”

**2. LESSON PROCEDURE Allotted Time: 30 minutes*** Change to next slide that has the details of the simplified plans.
* Address students, “So, imagine that you are allotted $25 a month to pay for your cell-phone plan. You have two different plan options from which to choose. You will be answering a series of questions to help you determine while plan option is the best option for you.”
* Pass out student worksheets.
* Change to next slide that has student expectations listed.
* Address students, “While you are working, I expect each person to be doing their work on their paper. You may discuss concepts with your group members as long as you do your work as well. Realize that your answers might differ from your peer’s and that’s okay! You will have 30 minutes to complete this worksheet.”
* Start timer for 30 minutes.
* As students work on the worksheet, the teacher should talk with groups about their work. The teacher needs to ensure students answer question 5 correctly and that they know what the equation means in relation to the problem. Some sample questions to ask are:
	+ Under what circumstances is each cell phone plan better? (Plan A is better when you talk on the phone more. Plan B is better when you send text messages more.)
	+ What does this equation represent? (The number of texts and minutes that cost exactly $25).
	+ How did you go about creating each equation (Cost for text goes with *x* variable and cost for minutes goes with *y* variable).
	+ How do you graph them? (Must change them into slope-intercept form which is *­y=mx+b* where *m* is the slope and *b* is the y-intercept).
	+ How did you identify what to label your *x* and *y* axis? (Since *x* s texts that is horizontal axis. Since *y* is minutes that is vertical axis).
	+ What does the graph of each equation represent? (Combinations of texts and minutes that cost exactly $25.)
	+ 3. What does the space underneath the graph of the line represent? (Combinations of texts and minutes that cost less than $25.)
	+ 4. What does the space above the graph of the line represent? (Combinations of texts and minutes that cost more than $25.)
	+ 5. Can you use quadrant II, III, or IV? (No, because you cannot have negative minutes or negative text messages.)
	+ 6. What other factors might you consider when choosing a cell phone plan? (Answers will vary, but student comments may include activation fees, mobile-to-mobile minutes, weekend or evening minutes, cell phones available, or "extras" like voice mail and ring tones.)
* Ensure students understand the equations before allowing them to move on to graphing the equations.
* As students are working they should be working on their own papers while also discussing ideas with their peers. Students should raise their hand if they have any question that a peer cannot answer. Note, students should not be copying off of each other but should have their own work on their paper. Students should pull from their own preferences to answer the questions about which plan is better for them.
* As students finish up the worksheet, ensure students have accurately represented graphs (see answer key) as well as a thorough and concise argument for question 8. Students will be sharing their answers for Question 8 to the class.

**3. CLOSURE Allotted Time: 15 minutes*** Once timer goes off (or if students finished early) call attention by raising your hand and stop talking and have students follow suit.
* Address class, “Wow! I saw a lot of great work, ideas, and answers. Let’s go ahead and review some of these concepts before getting to the last question!”
* Go through each question from the work sheet on the Smart Board (template is already made with the answers). Ensure student’s work matches the answer key.
* DO NOT ANSWER QUESTION 8.
* Once your reach question 8, ask the students to share their thoughts. Call on a student to come to the front of the class and use the graphs of the equations to answer which plan they would choose. Push students to use correct mathematically precise vocabulary and arguments.
* Once student shares his/her idea, ask the class if anyone else chose the same plan? If so, ask if they had a reason different from the first student? If so, invite them up to share.
* Ask if a student chose the other plan. Invite them up to share their ideas.
* Ask students to turn-in their worksheet.
* Address the class “How does this question relate to the real-world? Back to the Verizon, AT&T and T-Mobile plans?” Students will most likely answer that it does not account for data usage – a big concern with plans now.
* Address the class “Well, tonight for homework, I want you to research two plans, each from a different company that compare data usage and minutes. Bring these details with you to class.”
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| **Design Your Own Plan** |
| **Your Name** | Lance Kruse | **Date** | 10/13/15 |
| **Subject/ Course**  | Mathematics | **Grade** | 8th |
| **Sub-Unit Topic**  | Model with Functions | **# of Students** | 20 |
| **Class Length** | 50 minutes | Day 2 of 3 | **Unit Topic** | Functions |
| **Central Focus**  |
| **Central Focus:** Creating and evaluating mathematical models to answer real world questions |
| **Common Core State Standards for Mathematics** |
| * CCSS.MATH.CONTENT.8.F.B.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.
* CCSS.MATH.CONTENT.8.F.B.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.
 |
| **Learning Objectives** |
| * Students will be able to evaluate the accuracy of a linear function as a model to a real-world scenario by using properties of the function as justification (Evaluating).
* Students will be able to create their own function (algebraically, graphically, and numerically in tables) to model a real-world scenario and apply the model to answer questions about the scenario (Creating).
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| **Planned Assessments** |
| * Pre-assessment: This lesson’s pre-assessment is the previous day’s worksheet. If students understand the concepts in the worksheet then they are ready for the day.
* Formative Assessment: This lesson’s formative assessment is made through observations while they are working.
* Summative Assessment: The lesson’s summative assessment will be students handing in their worksheets from the day which will be analyzed for student understanding.
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| **List Resources** |
| * SmartBoard/Projector
* Create your own plan worksheets
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| **THE LESSON** |
| **1. MOTIVATION Allotted Time: 5 minutes*** Have Smart Board open.
* Begin by addressing students “For homework you all found two different plans from different companies. Take two minutes and share with your group your plan – does anyone in your group have the same plan?”
* Call attention by raising your hand and having the class follow suit.
* Address the students, “Great! I heard a lot of different plans and a couple of the same too. Hopefully this shows you how incredibly complex the plans are for these companies! Today, you will be using these plans as a foundation to create your own cell-phone plans. You will create two different plans that someone else would have the option of chosing!”

**2. LESSON PROCEDURE Allotted Time: 35 minutes*** Change to next slide that has the details of the activity.
* Address students, “So, you will be creating two different cell-phone plans. As we discussed yesterday, the two big concerns are data-usage and talking minutes. You will create your own plan using these two factors as variables in your plan. You will be doing this with your group. While you work with your group to devise the plans, you each should have your own work.”
* Pass out student worksheets.
* Change to next slide that has student expectations listed.
* Address students, “While you are working, I expect each person to be doing their work on their paper. You may discuss concepts with your group members as long as you do your work as well. You will have 30 minutes to complete this worksheet.”
* Start timer for 30 minutes.
* As students work on the worksheet, the teacher should talk with groups about their work. The teacher needs to ensure students answer providing reasonable answers to the questions and that their equations are correct. Some sample questions to ask students are:
	+ How did you choose how much your plans would cost?
	+ How did you choose how much you would charge per gb?
	+ How did you choose how much you would charge per minute?
	+ How did you come up with your equation for each plan?
	+ How did you get the equation into slope-intercept form?
	+ Is this a function? (yes)
	+ Why is it a function? (For each input there is only one output – it is linear).
	+ What is the slope? (value in front of the *x*).
	+ What is the y-intercept? (The constant number being added to the *x*).
	+ Which plan favors the usage of more gb? How do you know?
	+ Which plan favors the usage of more min? How do you know?
* Ensure students understand the equations before allowing them to move on to graphing the equations.
* As students are working they should be working on their own papers while also discussing ideas with their peers. Students should raise their hand if they have any question that a peer cannot answer. Note, students should not be copying off of each other but should have their own work on their paper.
* As students finish up the worksheet, ask them to write their table from Question 4 on the SmartBoard.

**3. CLOSURE Allotted Time: 10 minutes*** Once timer goes off (or if students finished early) call attention by raising your hand and stop talking and have students follow suit.
* Address class, “Wow! I saw a lot of great work, ideas, and answers. Each group has written their two different plans on the board. What are general ideas we notice about these plans?”
* Students should identify total prices of each plan per month. Are the prices close to each other? Are some drastically different? Ask students to share their ideas and ask the groups questions for why they chose that price for the plan.
* Student should also identify the price per gb and per minute that each plan chose. While an in depth analysis should NOT occur at this point, noticing if these prices are similar or different can be interesting for the next day’s lesson.
* After a short discussion, ask each group to identify which of the plans they would personally choose based on their own plans they created. Each student should write this at the bottom of their worksheet.
* Collect student’s worksheets.
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**Create Your Own Plan**

**Directions**: You will work with your group to devise two different cell-phone plans that consider the amount of data used, *x*, and the number of talking minutes allowed, *y*. Follow the step by step directions below to create your own plan and answer the questions. Remember, you want your plans to be competitive where some people might want Plan A while others want Plan B. Each group member will be turning in their own worksheet.

1. **Using your research of real plans from companies, how much money per month will both plans charge?**

 The plans will charge \_\_\_\_\_\_\_\_\_\_\_\_ per month.

1. **Identify how much each gigabyte (gb) of data costs for each plan (note these should be different).**

 Plan A will charge \_\_\_\_\_\_\_\_\_\_\_\_ per gb of data.

 Plan B will charge \_\_\_\_\_\_\_\_\_\_\_\_ per gb of data.

1. **Identify how much each minute (min) of talking time costs for each plan (note these should be different).**

 Plan A will charge \_\_\_\_\_\_\_\_\_\_\_\_ per minute of talking time.

 Plan B will charge \_\_\_\_\_\_\_\_\_\_\_\_ per minute of talking time.

1. **Use the information from Questions 1, 2, and 3 to fill in the table below.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Data Usage (gb)** | **Minutes Usage (min)** | **Total Cost of Plan** |
| **Plan A** | $ /gb | $ /min |  |
| **Plan B** | $ /gb | $ /min |

1. **Use the information in questions 1, 2, and 3 to write an equation for each plan. Be sure to identify all the variables.**

 Plan A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Plan B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Explain what the equation represents for each plan.**

 Plan A:

 Plan B:

1. **Write each equation in slope-intercept form. (Show your work on how you wrote it in slope-intercept form).**

 Plan A:

 Plan B:

1. **Graph the equations below on the same graph below. Ensure to label the axis**.



1. Describe what each graph tells you about each plan?
2. Using this graph as a reference, what type of person would want to choose Plan A?
3. Using this graph as a reference, what type of person would want to choose Plan B?

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| **Analyzing Plans**  |
| **Your Name** | Lance Kruse | **Date** | 10/14/15 |
| **Subject/ Course**  | Mathematics | **Grade** | 8th |
| **Sub-Unit Topic**  | Model with Functions | **# of Students** | 20 |
| **Class Length** | 50 minutes | Day 3 of 3 | **Unit Topic** | Functions |
| **Central Focus**  |
| **Central Focus:** Analyze and evaluate models for different cell-phone plans |
| **Common Core State Standards for Mathematics** |
| * CCSS.MATH.CONTENT.8.F.B.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.
* CCSS.MATH.CONTENT.8.F.B.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.
 |
| **Learning Objectives** |
| * Students will be able to create their own function (algebraically, graphically, and numerically in tables) to model a real-world scenario and apply the model to answer questions about the scenario (Creating).
 |
| **Planned Assessments** |
| * Pre-assessment: This lesson’s pre-assessment is the previous day’s worksheet. If students understand the concepts in the worksheet then they are ready for the day.
* Formative Assessment: This lesson’s formative assessment is made through observations while they are working.
* Summative Assessment: The lesson’s summative assessment will be students handing in their worksheets from the day which will be analyzed for student understanding.
 |
| **List Resources** |
| * SmartBoard/Projector
* Choose your own plan worksheet
 |
| **THE LESSON** |
| **1. MOTIVATION Allotted Time: 10 minutes*** Have Smart Board open.
* Begin by addressing students “Yesterday you all made different plans with your groups and answered questions about them. We began to look at some of these plans yesterday. Here they are again.”
* Change slide to display all the group’s plans.
* Say, “Can someone look at this tell me in each pair of plans, which one is the best?” Allow students to share their ideas, however, note that no student should be answer to answer this without graphing it. Do not allow students to graph it.
* Say “Well, we today you are going to figure out which of each pair of plans is the best plan for you!”

**2. LESSON PROCEDURE Allotted Time: 20 minutes*** Say, “Group 1, you will be analyzing group 2’s plans. Group 2, you will analyze group 3’s plans. Group 3, you will analyze group 4’s plans. Group 5, you will analyze group 1’s plans.”
* Pass out Chose your own plan worksheet.
* Say “Each group, please write down the plans that you are evaluating on your worksheet.”
* Change to next slide that has the details of the activity.
* Address students, “So, you will analyzing both of these plans and identifying which is best for you.”
* Change to next slide that has student expectations listed.
* Address students, “While you are working, I expect each person to be doing their work on their paper. You may discuss concepts with your group members as long as you do your work as well. You will have 15 minutes to complete this worksheet.”
* Start timer for 15 minutes.
* As students work on the worksheet, the teacher should talk with groups about their work. The teacher needs to ensure students are on task and are on the right path for the equations. Some sample questions to ask students are:
	+ How do these two plans differ from your own plans?
	+ How did you come up with those equations?
	+ What does each variable represent?
	+ How did you write it in slope-intercept form?
	+ What does the graph tell you?
	+ Why did you chose this plan?
	+ Which plan do you like the best overall (between yours and theirs)?
* Ensure students understand the equations before allowing them to move on to graphing the equations.
* As students are working they should be working on their own papers while also discussing ideas with their peers. Students should raise their hand if they have any question that a peer cannot answer. Note, students should not be copying off of each other but should have their own work on their paper.

**3. CLOSURE Allotted Time: 20 minutes*** Once timer goes off (or if students finished early) call attention by raising your hand and stop talking and have students follow suit.
* Address class, “Wow! I saw a lot of great work, ideas, and answers. Each of you should have chosen which plan you liked better. Take two minutes and share with your group which plan you chose and see what the rest of your group members thought.”
* Allow students to share with group members which plan they liked more.
* Call attention by raising your hand.
* Say, “Now, I want each group to report out to which plan they chose. If some of you choose Plan A and some choose Plan B, I want to hear from both sides. Your argument should be clear and concise – no longer than 60 seconds.”
* Allow each group to report out their ideas. Identifying any common themes.
* Collect student’s worksheets.
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**Choose Your Own Plan**

**Directions**: You will work independently to identify which of the two plans are best for you. You may work with your group members if you have questions but each person should have their own work recorded on the worksheet.

1. **Copy down the details of the two plans of the group you are analyzing:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Data Usage (gb)** | **Minutes Usage (min)** | **Total Cost of Plan** |
| **Plan A** | $ /gb | $ /min |  |
| **Plan B** | $ /gb | $ /min |

1. **Use the information in the table above, write an equation for each plan. Be sure to identify what each variable represents.**

 Plan A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Plan B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Explain what the equation represents for each plan.**

 Plan A:

 Plan B:

1. **Write each equation in slope-intercept form. (Show your work on how you wrote it in slope-intercept form).**

 Plan A:

 Plan B:

1. **Graph the equations below on the same graph below. Ensure to label the axis**.



1. **Describe what each graph tells you about each plan?**
2. **Using this graph as a reference, what type of person would want to choose Plan A?**
3. **Using this graph as a reference, what type of person would want to choose Plan B?**
4. **Which plan would you chose? Why?**
5. **Think back to the two plans you created yesterday. Which plan of yours did you chose? Compare your chosen plan that you created to the chosen plan in Question 9. How do these two plans compare? Which of the two would you chose? Why?**

**Post-Assessment of Model with Functions**

**Directions:** Circle the number that best resembles your knowledge of the following.

**1 – never seen 2 – below average 3 – average 4 – above average 5 – expert**

1. Mathematical Models 1 2 3 4 5

2. Creating mathematical models for the real-world 1 2 3 4 5

3. Analyze properties of functions 1 2 3 4 5

4. Use models to answer real-world questions 1 2 3 4 5

5. Evaluating accuracy of models 1 2 3 4 5

6. Evaluate in writing two functions 1 2 3 4 5

7. Evaluating orally two functions 1 2 3 4 5

8. Sketch graphs for verbal descriptions 1 2 3 4 5

9. Sketch graphs from written descriptions 1 2 3 4 5

10. Create own function algebraically 1 2 3 4 5

11. Create own function graphically 1 2 3 4 5

12. Create own function in tables 1 2 3 4 5

13. Identifying the zeros of a function 1 2 3 4 5

14. Identifying the intersection of two functions 1 2 3 4 5

15. Analyzing systems of equations 1 2 3 4 5

16. Persuading peers using mathematical argument 1 2 3 4 5

17. Analyzing peer’s argument 1 2 3 4 5

18. Pose questions to a peer’s argument 1 2 3 4 5

19. Mathematical dispute orally 1 2 3 4 5

20. Mathematical dispute in writing 1 2 3 4 5

**Directions:** Answer the following questions to the best of your ability. Please show your work.

1. What is a mathematical model?
2. Provide an example of a mathematical model. Why is this considered a mathematical model?
3. Identify the zeros of the function ­*y=10x - 2.* How did you do it?
4. Columbia University is deciding to look into another research idea that connects the number of hours of sleeping to academic performance. Below is a sample of the results that the researched obtained from a survey given to an 8th grade class.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Classmates | Lucas | Susan | Tiu | Mario | Deja | Juan | Dominic | Shae | Katarina |
| Average Hours of Sleep | 6 | 5 | 8 | 7 | 5 | 6 | 9 | 6 | 7 |
| Overall Grade in class | 81 | 68 | 91 | 85 | 67 | 73 | 94 | 78 | 83 |

Use your knowledge about modeling with functions to create a function for this data set.

5. Graph the function from Question 4. What does the graph tell you about exam scores and hours students sleep? Be sure to label the axis.



6. Explain how this model accurately represents the data from the research study.

7. Case Western University is releasing their own data about a similar research study. Their data is as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Classmates | Sharon | Tracy | Jonathan | Gabriel | Dawn | Kandy | Bruce | Mike | Beth |
| Average Hours of Sleep | 5 | 6 | 9 | 5 | 8 | 9 | 7 | 8 | 9 |
| Overall Grade in class | 67 | 74 | 97 | 63 | 86 | 95 | 79 | 89 | 92 |

Use your knowledge about modeling with functions to create a function for this data set.

5. Graph the function from Question 4. What does the graph tell you about exam scores and hours students sleep? Be sure to label the axis.



6. Explain how this model accurately represents the data from the research study.

7. Graph both functions on the graph below. Compare and contrast the two functions – what do they tell you about the studies?



8. How many hours do you normally sleep each night? (Round to the nearest hour please).

9. Suppose you wanted to justify to your parents/guardians that you were sleeping long enough. Your parents/guardians disagree and insight you to go to bed earlier. Which function (i.e. research from Columbia or Case Western University) would you show them to help justify your sleeping habits? Why would you chose this function/research?

References

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