Math: Grade 8, Lesson 6, Using Functions to Model Linear Relationship

Lesson Focus: Using Functions to Model Linear Relationships
Practice Focus: Students will focus on practicing writing equations and identifying input and output values in order to model linear functions.
Objective: Students will use functions to model linear relationships with a focus on contextual problems.
Key Vocabulary:

- Slope-intercept form of an Equation

TN Standards: 8.F.B.4
Teacher Materials:

- Whiteboard and Markers, Graph Paper if available
- Student Practice Packet

Student Materials:

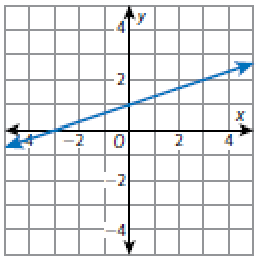
- Paper and a pencil, and a surface to write on
- Calculator not required but may be used to check calculations.
- Optional but helpful: Graph Paper

Teacher Do	Student Do
Opening (1 min) **Hello! Welcome to Tennessee's At Home Learning Series for math! Today's lesson is for all our 8th graders out there, though all students are welcome to tune in. This lesson is the sixth in our series.** **My name is ____ and I'm a ____ grade teacher in Tennessee schools! I'm so excited to be your teacher for this lesson! Welcome to my virtual classroom!** **If you didn't see our previous lesson, you can find it on the TN Department of Education's website at www.tn.gov/education. If you don't already have the student packet for this lesson, you can find it online at www.tn.gov/education. You can still tune in to today's lesson if you haven't see any of our others. But, it might be more fun if you first go back and watch our other lessons since we'll be talking about things we learned previously.** **Today we will be learning Using Functions to Model Linear Relationships in mathematics! Before we get started, to participate fully in our lesson today, you will need:** • **Paper and a pencil, and a surface to write on** • **Calculator is not required but may be used to check calculations.** • **Optional but helpful: Graph Paper**	Students get materials ready for the lesson.

Ok, let's begin!	
Intro (2 min) **Do you like pizza? I know I do! What is your favorite pizza topping? Do you like cheese only or do you like pepperoni? What about pineapple? Did you know that the most common pizza toppings in the United States are pepperoni, mushrooms, onions, sausage, bacon, and extra cheese?** **We are going to start today by exploring some situations that can be modeled by a linear function - like the cost of a pizza depending on the number of toppings.** **Here are a couple of things we need to remember in today's lesson: *y = mx + b* is the slope intercept form of an equation where *m* represents the rate of change or slope of the equation or function and *b* represents the constant or initial value (where x = 0) of the equation or function. The point b is also the "y-intercept" when in represented graphically. The equation can be stated as "the variable y is a function of the variable x** **Identifying the rate of change and initial value in the description of a linear situation can help you construct a linear function to model the situation.** **Are you ready?** [Pause] **Let's get started by reviewing some things you have already learned.**	Students are thinking about their favorite pizza toppings and recalling what they should know about slope-intercept form of a linear equation.
Teacher Model (10-12 min) Objective 1: Review & Tying to Previous Learning **Let's look at four equations that are in the form *y = mx + b*. You probably learned about this form earlier this year.** [Write or show these four equations] A. **y = 2x + 1** B. **y = 2x + 3** C. **y = -5x + 1** D. **y = -x + 3** **Which two have the same slope or rate or change?** [Pause] **You're right! A and B because they both have 2 as the slope or rate of change.** [point to each of the appropriate equations]	Student identifies the equations t that have the same slope, negative slope, and y-intercepts.

Which ones have a negative slope? [Pause] **You're right again! C and D because they have -5 and -1 as slopes or rate of change.** [point to each of the appropriate equations] **Which ones of the same y-intercept or initial value?** [Pause] **Great! A and C both have initial values or y-intercepts of 1. B and D have initial values or y-intercepts of 3.** [point to each of the appropriate equations]	
<u>Objective 2: Tying to Previous Learning & Explicit Instruction</u> **Let's look at a couple more examples:** [write or show the following] **A. y = x** **B. 3y = 12x +21** **C. 4x + y = 100** **Which equation is in slope-intercept form?** [Pause] **Right! Only A.** **So, what would we need to do to equation B to get it into slope-intercept form?** [Pause] **Right! Divide by three. So, it would look like this:** [write or show] $\frac{3y}{3} = \frac{12x}{3} + \frac{21}{3}$ **Y = 4x + 7** **What about equation C? What would we need to do to get it into slope-intercept form?** [Pause]	Students will identify equations not in slope-intercept form and will problem solve how to transform the equation into slope-intercept form.
Right! We would need to move the term 4x to the other side of the equation. So, it would look like this: [write or show] **4x – 4x + y = 100 – 4x** **Y = 100 – 4x (or y = 100 + -4x)** **Y = -4x + 100**	Students will visually inspect a graph looking for the y-intercept and the slope of the line. Students will write the equation of the line in slope-intercept form.

Now, let's explore a graph to see if we can get the slope-intercept form from a graph. Let's take a look at this graph:
[show and pause]



What can we see? What is the y-intercept of the graph or the y-value when x equals 0?
[Pause}

I hope you could see it! It is one.
[point to (0,1) on the graph]

What about the rate of change or slope? From one point to the next, how far up and how far over to you have to go?[Pause]

Can you see it? To get to the next integer values on the graph, you move one block up [move up from (0,1)] **and three over to the right** [move from (1,2) to (3,2)]. **So, the rate of change or slope is $\frac{1}{3}$.**

Let's write the equation in *y = mx + b* form where you will remember that b is the constant or initial value and on a graph is where the line crosses the y-axis AND m is the rate of change or slope of the graph. Give it a try.
[Pause]

Does your equation look like this? [show]

$$\boldsymbol{y = \frac{1}{3}x + 1}$$

Great! You will have a problem like this to solve on your independent practice today.

<u>Objective 3: Explicit Instruction & Example</u>
Now, let's go back to our conversation about pizza.
Let's think about a local pizza shop that sells pizzas like this:
[Show the graphic]

Objective 3:
Students will use the information in the table and the contextual problem to follow along with the teacher and to identify the slope or

Small Pizza $8.00	Large Pizza $12.00
Additional Toppings $1.50	Additional Toppings $2.00

rate of change and y-intercept values in context.

A customer can use the menu to call in a pizza order. The customer will choose a size and add toppings. The graphs and equations model the prices of the two sizes of pizzas.

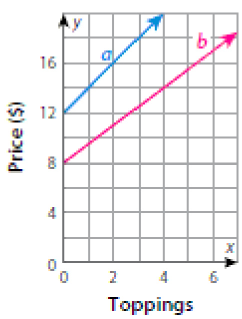
Remember to define your variables:
Let x be the number of toppings and let y be the total cost of the pizza.

Y = 1.5x + 8
Y = 2x + 12

Which equation models the prices of small pizza?
[Pause]

Yes! The first one does. The eight [point at the 8 in the first equation] **represents the initial value or cost of the pizza, and the 1.5** [point at the 1.5 in the first equation] **represents the $1.50 per topping which is the rate of change of the price.**

Now, let's look at a graphical model of these two equations.
[Show the following graphic]



Students will visually inspect a graph to identify which line represents each of the two contextual situations.

Which line represents the price of the large pizza?
[Pause]

Right! Line *a* does! [point at line a] **because it shows the initial value as twelve** [point at the line where it starts at (0,12)] **and for every one topping, the price increases by $2.** [point at the location (1,14) and then (2,16) on the line].

Which form do you prefer? The equation or the graphical model? [Pause]

Student thinks about which form of the linear model that they prefer and why.

Good thinking! No matter which one you prefer, if you know how they are connected, then you can easily convert your work between the two. However, you might notice that the

graph might require more estimation than the equation does if we are just reading it. **Let's work together on answering some additional questions:** [transition to guided practice]	
<u>Guided Practice </u>(10-12 min) **Which equation and graph represent the price of each size pizza? How do you know?** [Pause] **The graphs and equations are linear models because the model, or represent, linear functions.** **If a linear function has a constant rate of change, what do the rates of change represent in this situation?** [Pause] **What did you decide?** [Pause] **The rate of change is the cost of each additional topping.** **The initial value of each function is the value of y when x = 0. What do the initial values represent in this situation?** [Pause] **Right! That is the price of the pizza with no toppings.** **What quantities do the variables x and y represent in this situation?** [Use the phrase *is a function of* to describe the relationship between these quantities.] [Pause] **Let me help you out with this one a little bit. Let's see if you can fill in the blanks in these statements:** [Write or show the statements] • ***X* represents the number of ____________.** • ***Y* represents the total __________ of a __________.** • **The total ____________ of a ___________ is a function of the number ___________.** [Pause] **Did you fill it in something like this?** • ***X* represents the number of <u>toppings</u>.** • ***Y* represents the total <u>cost (or price)</u> of a <u>pizza</u>.**	Student begins by identifying what the rate of change is in the problem. This was actually stated during the lesson. Students should be able to recall this from the earlier model. Student identifies the initial value an what it represents in the contextual problem. Students thinks about how to phrase the relationship between the variables and uses the scaffold of the fill in the blank statements.

• **The total <u>cost (or price)</u> of a <u>pizza</u> is a function of the number <u>toppings</u>.**	
Great! Did you know that some people think that the graph or equation can only tell you the total cost of the pizza? However, if you know the total cost of the pizza, you can also find out the number of toppings that you should have as well! **Do you want to try that?** [Pause] **Of course you do! Let's give this a whirl.** **If Andrea spent $9.50 on a small pizza, how much many toppings did she get?** [Pause] **Did you figure out that she has one topping? Did you use the equation, the graphic model, or your own understanding of the problem to figure that out?** [Pause] **Awesome work!** **Here's another situation.** **If Mitch spent $18.00 on a large pizza, how many toppings did he get?** [Pause] **So, did you figure out that if the pizza costs $12.00 and each additional topping is $2 on the large pizza, then Mitch got three toppings? Great!**	Students recall that linear equations and graphs can also help you find other unknowns. In this case, students are challenges to find the number of toppings instead of the total cost of the pizza.
<u>Additional Problems (if Needed):</u>	
Here's another example using the same form of the equation. **Mechanical engineers use functions to solve problems involving the motion of objects. A function can be used to relate the final speed of a car after the driver applies constant acceleration over a set amount of time when the initial speed is known. This function is modeled by $v = at + r$, where v is the final speed, a is the constant acceleration, t is time, and r is the initial speed of the car.**	Student explores the additional problem related to speed of a vehicle.

What would this equation look like if the car was traveling at a rate of 20 miles per hour and the driver accelerates the car 3 miles per hour per second.[Pause] **This might be a little tricky, but the constant rate is 20 and the rate of change is 3 so the equation would look like this:** • ***V = 3t + 20*** [Write or show the equation] **What would be the speed of the car if the driver accelerates for 10 seconds?** [Pause] **Did you solve it this way?**[write or show equation] • ***V = 3 mph/second(10 seconds) + 20 mph*** • ***V = 30 mph + 20mph*** • ***V = 50 miles per hour*** **This function reveals the car is now traveling at a speed of 50 miles per hour.**	
<u>Independent Practice</u> (1 min) **Terrific work today, students! Today, we explored the Using Functions to Model Linear Relationships in mathematics. I hope you are making connections between the linear equation and the graphic representation of the functions we are modeling. After this lesson, you will have a few problems to practice on your own. I will show you the independent practice problems now, or you can find them in the student practice for this lesson posted on our website, <u>www.tn.gov/education</u>.** [Teacher shows student practice page under document camera or camera zooms in on student practice page.] **Good luck and do your best!**	
<u>Closing</u> (1 min) **I enjoyed reviewing Using Functions to Model Linear Relationships in mathematics with you! Thank you for inviting me into your home. I look forward to seeing you in our next lesson in Tennessee's At Home Learning Series! Bye!**	