PBS Lesson Series

Math: Grade 8, Lesson 8, Writing an Equation for a Linear Function from Two Points

Lesson Focus: Interpreting a Linear Function
Practice Focus: Students will focus on developing strategies for writing an equation for a linear function when given two ordered pairs.
Objective:

- Students will recognize that you can choose the ordered pairs from a table of value or from a graph of the function.
- Students will write the equation for a linear function using two ordered pairs.

Key Vocabulary:

- Slope/Rate of Change – the change over an interval in the height of a linear function on a graph or the change over an interval of any value. Slope can be visualized as rise over run or calculated from two points on the line (found in a table or on a graph) by this formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

- Y-intercept/Initial Value - the point where the graph of the linear function crosses the y-axis or the value when *x* is zero.
- Ordered Pairs

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

Note: There are several graphs and tables in lessons this week. They will need to be prepared in a way to show to students.

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 children are welcome to tune in. This lesson is the eighth 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**	Students get materials ready for the 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 about Writing an Equation for a Linear Function from Two Points 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**
- **A calculator not required but may be used to check calculations.**
- **This is optional but helpful: Graph Paper**

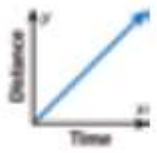
Ok, let's begin!

Intro (3 min)

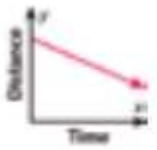
Today, we are going to develop strategies writing equations for linear functions using ordered pairs, but we will also continue practicing our interpretation of the linear function in context like we've been doing this week.

Let's connect back to some prior learning by doing a quick inquiry – what is the same and what is different here? [show each of the following – Box A is a simple time/distance graph at 45 degrees without any unit or axis markings. Box B is a time/distance graph with a decreasing rate of change]

A



B



C

Time	Distance
0	20
1	18
2	16

D

Time	Distance
0	0
1	5
2	8

Let's think about how these could be grouped and identified. [Pause]

Did you see any of these? Let's think aloud together. [point to each box as you describe the variance]

Students are thinking about the ways the tables of values and graphs are similar and different and recalling things they know about linear functions and relationships in tables of values.

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- **Every box shows a relationship between distance and time.**
- **Boxes A, B, and C represent constant rates of change over time.**
- **Box A and D represent positive rates of change and have an initial value of zero.**
- **Boxes B and C represent negative rates of change.**
- **Did you notice that Box D doesn't have a constant rate of change?**

Awesome! Let's keep in mind today that linear functions can be modeled using graphs, tables of values, and equations.

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Teacher Model (11 minutes)
[give plenty of time to pause for students to work]

Objective 1: Recognizing Ordered Pairs/Connecting to Prior Learning/Examples

Let's look a little deeper at a table of values. [show the table from Box C again]

Time	Distance
0	**20**
1	**18**
2	**16**

Let's recall what we know about tables of values.
This table shows us the relationship between distance and time. The table groups the information into ordered pairs of time and distance.

If we look at the first row, we see that at time equal zero that the distance is 20. So, we can write this as an ordered pair like this: [teacher write and say the ordered pair]
(0, 20)

Now, you try. Write the other two sets of ordered pairs from the table of values.
[pause]

Let's see what you wrote. Did you write these? [teacher write and say each ordered pair]
(1, 18) and (2, 16)

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<td>Students will review how to identify and write ordered pairs in a table.</td>
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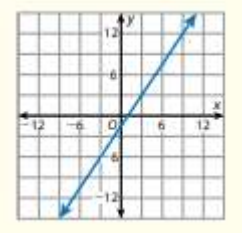
Great! Now, let's review this from reading a graph. We've done this on lessons earlier this week, but let's review briefly.

Students will review the ways to identify ordered pairs now on a graph.

Take a look at this graph [teacher show the prepared graph]



Let's look at the line placement to find a point of the graph. There are several, but look first for any clear integer values. I see one here.
[point to (1,1)]

This point on the line can be represented by the ordered pair (1,1) where the first 1 represents the horizontal shift and the second 1 represents the vertical shift.

Now, see if you can find at least one other point that can be represented by an integer ordered pair. I'll give you a minute to find it. [pause]

It's difficult to see these on graphs sometimes, but I saw at least two others. Did you find either one of these? [point to and write the following]
(9, 12) or (-3, -6)

Great! Now, you can easily identify ordered pairs from a table of values or from a graph. Now, let's use those ordered pairs to move to the next part of our lesson today.

Objective 2: Writing an Equation for a Linear Function from Two Points/Examples

Students will use their knowledge of identifying ordered pairs from a table and the methodology to calculate slope/rate of change along with the slope-intercept form of the equation to write a model of the linear function.

Let's look at a situation described in words and a tables of values, and just for some context for you, alpacas are grazing animals that are raised for their wool fiber like sheep. [show the words and graph and read the words aloud]

The Lima family owns 10 acres of land. They want to buy more land and start a ranch. The amount of land they need is a linear function of the number of grazing animals they plan to

Number of Alpaca	Land Needed (acres)
10	25
20	40
30	55

have. The family decides to raise alpaca. The tables gives the number of acres they need for different number of alpaca.	

Now, let's think about a couple questions together.

We want to write an equation to model the data in the table. We know that we can use the slope-intercept form of a linear equation to do that. Recall that we are talking about the y = mx + b form [teacher write y = mx + b] **where m is the slope or rate of change and the b is the initial value or y-intercept.**

So, since we have a table of values, we can write ordered pairs like we did at first. Take a minute to look again at the table and write all of the ordered pairs. [pause]
I wrote down these three. Did you? [write and show the following]
(10, 25) and (20, 40) and (30, 55)
Great!

Student Responds

Now recall that we can use those ordered pairs to calculate the slope or rate of change. We only need two. You can pick which ever two you want to work with.

Remember that this is what that looks like [write or show the slope formula]

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

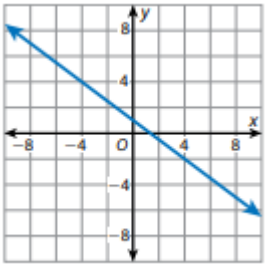
In this case, I'll use the points (10, 25) and (30, 55).
The slope would calculate like this. [write or show the solution path]

Slope $= \frac{55-25}{30-10} = \frac{30}{20} = 1.5$

How did you do?
[pause]

Student compares answer

Awesome! Now what does this mean in context of the problem?
[pause]
Right! It means that for every acre of land, you can increase the number of alpaca by 1.5. Now, no rancher is going to increase their flock or herd by a half an animal, but we know

that the mathematics is here to model the situation as a whole. **Since we've found the rate of change, how can we find the initial value or y-intercept? Sometimes, the table of values will give us that number, but in this case, the table doesn't tell us.** **So, we can find the initial value by substituting the rate of change which was 1.5 and one pair of values from the table into the slope intercept form of a linear equation. You can use any one of the ordered pairs that you want to.** **I'll walk you through this one to find the initial value.** **Let's use (10, 25). So,** [teacher write and speak the solution path] $$y = mx + b$$ $$25 = 1.5(10) + b$$ $$25 = 15 + b$$ $$25 - 15 = 15 - 15 + b$$ $$10 = b$$ **Did you follow the pathway? Now, we know that the rate of change or slope is 1.5 and the initial value or y-intercept is 10. We can write the equation of the linear function this way.** [teacher write and speak the equation] **Y = 1.5x + 10.** **Let's try another one: This time we'll use a graph.** [teacher show the graph]  **Take a minute and see if you can identify at least two integer points on the line on this graph.** [pause] **Here are the ones I found. Compare them to the ones you found:** **(-4, 4) and (4, -2)** **You might have thought you found a couple others. Graphs are often more difficult to read for specific points. They are**	Students will use their knowledge of identifying ordered pairs from a graph and the methodology to calculate slope/rate of change along with the slope-intercept form of the equation to write a model of the linear function.

very good at showing us general trends, but for individual points, we usually like something else. **So, now let's use these two points to help us write the equation of the line.** **What's the first thing we need to do?**[pause] **Right! Calculate the rate of change or slope.** **Slope** $= \frac{-2-4}{4--4} = \frac{-6}{8} = -\frac{3}{4}$ **Now, what's next?** [pause] **Right again! We need to find the initial value or y-intercept. Now use one of the ordered pairs and the slope to substitute into the y = mx + b form of a linear equation to find b. You try this for a minute.** [pause] **I used the ordered pair (-4,4) and the rate of change.** [teacher write and speak the solution path] $$\boldsymbol{y = mx + b}$$ $$\boldsymbol{4 = -\frac{3}{4}(-4) + b}$$ $$\boldsymbol{4 = 3 + b}$$ $$\boldsymbol{4 - 3 = 3 - 3 + b}$$ $$\boldsymbol{1 = b}$$ **So, now what is our final equation of the linear function?** [teacher write and speak the solution] $$\boldsymbol{y = -\frac{3}{4}x + 1}$$ **Are you getting the hang of this? I know you are! Let's do just a little more practice.**	
<u>Guided Practice</u> (10 minutes) [You may need to use the additional problem, but Just be sure to give plenty of time for students to try their work] **I'll get you started with another problem. Let's see how far you can get.** [write or show the table and description]	Guided Practice: Students will work through a sample using a table and will be given additional time at various points to explore the responses independently. They are continuing

The cost of a craft project is the function of the number of bundles of yarn (alpaca!) that it requires. The table shows the cost of projects that use different amounts of yarn.	**Bundles of Yarn** / **Cost of Project** **5** / **$11.25** **8** / **$13.50** **12** / **$16.50**

Take a minute to think about what you need and what you can learn from the table in order to write the equation of the linear function that models this situation. [pause]

Did you identify at least two sets of ordered pairs?[pause]
I'm sure you did. There are three in table, and they are [teacher write and speak]
(5, 11.25) and (8, 13.50) and (12, 16.50).

We are ready to calculate the rate of change. Pick two of the ordered pairs – any two will work as long as your arithmetic is correct! Take a minute and calculate the rate of change. [pause]

So, you should have come up with a rate of change of ¾ or 0.75. If you didn't, go back and check your arithmetic. This is what one pathway looks like: [teacher write and speak]

Slope/Rate of Change = $\frac{16.50-13.50}{12-8} = \frac{3}{4} = 0.75$ **or 75 cents for every bundle of yarn.**

We're almost there! Now, use one of the ordered pairs and the rate of change to find the initial value or y-intercepts. [pause]

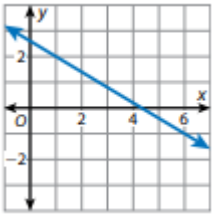
I used (8, 13.50) and got this: [teacher write and speak]

$$y = mx + b$$
$$13.50 = 0.75(8) + b$$
$$13.50 = 6 + b$$
$$13.50 - 6 = 6 - 6 + b$$
$$7.50 = b$$

So, our last step is to put it all together into a final equation model of the linear function. Take a minute to write down your final equation. [pause]

Did you get y = 0.75x + 7.5? Great!

to identify or calculate rate of change and initial value in context along with writing an equation to model the linear function.

Take one last minute to think about this in context. What does this model tell us? [pause] **We can say that that the initial cost of a project is $7.50 without using any yarn, but for every yarn bundle we use to add to the project, the price will increase by 75 cents.** **I think we might be ready to give this a try on your own!** <u>Additional Problems (if Needed):</u> **Let's consider this graph.** [show the graph]  **If we want to model this linear function with an equation, we will need to find two points on the line. Take a minute and write down the points you find.** [pause] **You should have found these:** [teacher write and speak] **(1,2) and (6, -1)** **Remember that graphs can be very tricky to see clearly where the line touches integer values.** **So, let's calculate the rate of change. Take a minute and work through that process.** [pause] **You're getting good at this! This is was I came up with.**[teacher write and speak] **Slope/Rate of Change** $= \frac{-1-2}{6-1} = \frac{-3}{5} = -\frac{3}{5}$ **Now, we need to find the initial value. Choose one of the two ordered pairs to work with along with the rate of change. Take another minute.** [pause] **I used (1, 2). You should get the same end result if you use (6,-1).** [teacher write and speak] $$y = mx + b$$ $$2 = -\frac{3}{5}(1) + b$$ $$2 = -\frac{3}{5} + b$$ $$2 + \frac{3}{5} = -\frac{3}{5} + \frac{3}{5} + b$$ $$2\frac{3}{5} = b$$	Students will work through a sample using a graph of a linear function and will be given additional time at various points to explore the responses independently. They are continuing to identify or calculate rate of change and initial value in context along with writing an equation to model the linear function.

Now put it all together in to the equation model. [pause] **Check yours against mine.** [write or show and speak] $$y = -\frac{3}{5}x + 2\frac{3}{5}$$ **How did you do on that one? Do you feel ready for that independent practice? I think you are ready! Let's go!**	
Independent Practice (1 min) **Terrific work today, students! Today, we explored strategies for Writing an Equation for a Linear Function from Two points in mathematics. After this lesson, you will have a few problems to practice on your own using graphs, tables, and descriptions of linear functions in context. 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, www.tn.gov/education.** [Teacher shows student practice page under document camera or camera zooms in on student practice page.] **Good luck and do your best!**	
Closing (1 min) **I enjoyed exploring the writing of equations for a linear function from two points 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!**	