Math 9

Overarching Question: What lessons can we learn from science and math that can help us live mino bimaadiziwin?

Overarching Challenge: Use Indigenous knowledge and western knowledge to develop a guide that includes helpful advice for living mino bimaadiziwin. (For example, communicate five important tips or lessons in the format of your choice.)

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Lesson Challenge: Use a line of best fit, a table, and a description of an equation to best match the graph and to make a prediction.

Lesson Summary: In this lesson, you will explain how well an equation describes the line of best fit and the trend in the data. You will use the equation to make a prediction.

Big Idea: Mathematical representations, such as equations and graphs, make data more understandable.

Materials: calculator

Lesson Grouping: These lessons are best completed in the following order:

1. Which graph best describes the trend in fish and seafood consumption over time?
2. Which best describes the trend in the data: a line of best fit or a curve of best fit?
3. How well does an equation match a line of best fit, a table, and a description in words?

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Lesson Challenge: Use a line of best fit, a table, and a description of an equation to best match the graph and to make a prediction.

Start Your Thinking

An environmentalist is analyzing the historical data for fish and seafood consumption in Canada from limited data over different intervals of time. They are using equations that describe lines of best fit as a simple way to make predictions based on trends in data. They have been given an equation, a table of values, and a description of the trend, but are not sure whether the equation effectively describes the line of best fit.

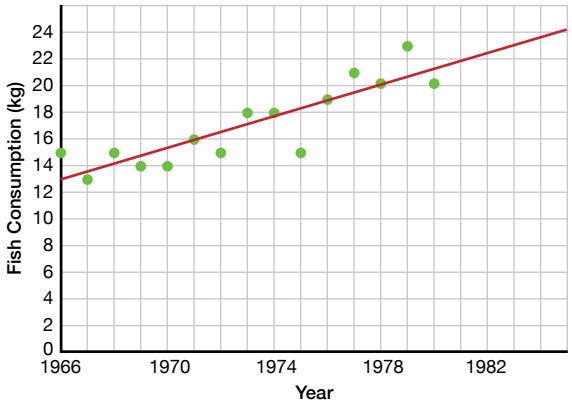
The equation they were given is $C = 2n + 13$, where C represents the mass of fish consumed per person and n is the year that the fish was consumed.

The table of values below represents the line of best fit.

Year	n	Fish Consumption (kg)	Description
1966	0	13.0	Based on data recorded between 1966 and 1980, fish consumption in kilograms is increasing at a steady rate. In 1966, the consumption was just over 13.0 kg, and by 1980, consumption had grown to 21.4 kg.
1967	1	13.6	
1968	2	14.2	
1969	3	14.8	
1970	4	15.4	
1971	5	16.0	
1972	6	16.6	
1973	7	17.2	
1974	8	17.8	
1975	9	18.4	
1976	10	19.0	
1977	11	19.6	
1978	12	20.2	
1979	13	20.8	
1980	14	21.4	

The graph below shows the line of best fit (the green dots represent the raw data).

Fish Consumption (kg) Over Time



To help the environmentalist decide how well the equation describes the line of best fit, look at the graph and compare it to the table of values and its description.

What do you notice is the same about all three ways to describe the line of best fit? **List your thoughts here:**		
Graph:	**Table:**	**Description:**

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Did you think about the following properties of line graphs (linear relations)?	
☐ The *y*-intercept	• The *y*-intercept is the initial value on the graph or table. It is where the graph intersects with or crosses the *y*-axis, and where *x* (the independent variable) is equal to 0.
☐ The rate of change	• The rate of change is how much *y* (dependent variable) changes in response to a change in *x* (independent variable). It can be written as $\frac{\text{Change in } y}{\text{Change in } x} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$ • The rate of change can be positive, negative, or zero (no change).
☐ The direction of change	• The direction of change can be increasing, decreasing, or unchanging.

Now, go back to your list of similarities on page 3, and see if you need to add or modify the ideas on your list.

Given these similarities, how well do you think the equation describes the line of best fit? Place an X on the scale to show your thinking.

I think the equation is

because…

Think About the Lesson Challenge

In this lesson, you will justify how well an equation describes the line of best fit and the trend in the data. You will then use that equation to predict fish consumption in Canada in 2030.

Before moving on to the next part of the lesson, pause and think about how you can use the *x*- and *y*-values in the table to check the effectiveness of the line of best fit on the graph. Remember that for a given *x*-value, there is a corresponding *y*-value on the graph or in the equation. So, if you substitute an *x*-value into the equation, the resulting *y*-value should be the same as the one in the table.

For example, the table of values below describes the equation $y = 4x - 3$.

x	*y*
–2	–11
–1	–7
0	–3
1	1

So, if you choose $x = -2$ from this table and substitute this value into the equation,

$$\begin{aligned} y &= 4x - 3 \\ &= 4(-2) - 3 \\ &= -8 - 3 \\ &= -11 \end{aligned}$$

you will get a resulting *y*-value of –11. You can see this value of *y* matches the one in the table of values above.

Choose a different x-value from the table. Check by substituting the value into the equation $y = 4x - 3$. Do you get a result that matches the table of values?

$$\begin{aligned} y &= 4x - 3 \\ &= 4(\square) - 3 \\ &= \square - 3 \\ &= \square \end{aligned}$$

Grow Your Thinking

Remember that the equation of a line is represented by the equation

$$y = mx + b$$

where m is the rate of change and b is the y-intercept.

You can use this understanding to help you compare a given equation to a table of values, a description, and a graph. To determine how well an equation fits the line graph, the table of values, and the description, you will need to be a sound thinker:

- Use what you know and understand to be mathematically true about graphs, tables of values, and the equation for a linear relationship. For example:
  - What do you know and understand to be true about the y-intercept and the constant term in an equation?
  - What do you know and understand to be true about the steepness of a graph and the magnitude of the rate of change in an equation?
  - What do you know and understand to be true about the sign of the rate of change in an equation and the direction of the line on a graph?
- Pay attention to the most useful/important details in the graph and equation for a linear relationship. For example:
  - Does the y-intercept match the constant term in the equation?
  - Does the steepness of the graph fit with the magnitude of the rate of change in the equation?
  - Does the sign of the rate of change in the equation match the direction of the line on the graph?

You can use these criteria to help you decide how well an equation fits a line graph, a table of values, and a description in the three examples on pages 7 to 12. The first example has been done for you as a model.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Example 1:

How well does the equation fit the line graph, the table of values, and the description shown?

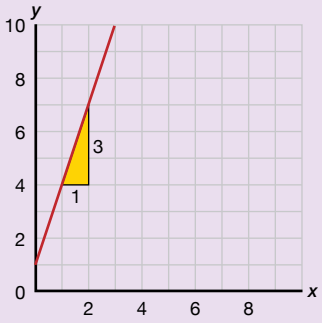
	What is the *y*-intercept?	What is the rate of change?	What is the direction of change?
Equation: $y = 3x + 5$ Remember that the algebraic form of the equation is $y = mx + b$.	$b = 5$	$m = 3$	m is (☑ + or ❑ –), so y is ☑ increasing ❑ decreasing ❑ not changing when x is ☑ increasing ❑ decreasing ❑ not changing
Graph:  	$b = 1$	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $= \frac{3}{1}$ $= 3$	m is (☑ + or ❑ –), so y is ☑ increasing ❑ decreasing ❑ not changing when x is ☑ increasing ❑ decreasing ❑ not changing
Table: x | y | Change in x | Change in y 0 | 1 | 1 – 0 = 1 2 – 1 = 1 | 4 – 1 = 3 7 – 4 = 3 1 | 4 2 | 7	$b = 1$	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $= \frac{3}{1}$ $= 3$	m is (☑ + or ❑ –), so y is ☑ increasing ❑ decreasing ❑ not changing when x is ☑ increasing ❑ decreasing ❑ not changing

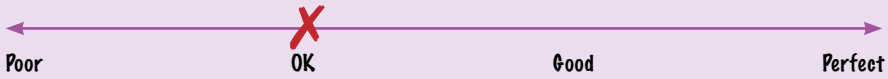
Table continued on next page.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

How well does the equation fit the line graph, the table of values, and the description shown?			
	What is the *y*-intercept?	**What is the rate of change?**	**What is the direction of change?**
Description: *y increases* by 3 units when *x increases* by 1 unit. The line graph begins at 1 and slopes upward to the right.	$b = 1$	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $= \frac{3}{1}$ $= 3$	m is (☑ + or ❑ –), so y is ☑ increasing ❑ decreasing ❑ not changing when x is ☑ increasing ❑ decreasing ❑ not changing
Compare the information that you gathered about the equation, graph, table, and description.	The *y*-intercept is ❑ very ❑ somewhat ☑ a little similar because the *y*-intercept in the equation is 5, but it is 1 in the graph, table, and description.	The rate of change is ☑ very ❑ somewhat ❑ a little similar because the rate of change is the same in all three.	The direction of change is ☑ very ❑ somewhat ❑ a little similar because the direction of change is the same in all three.

Make a final decision

I think the equation is



because the rate of change and direction of change are the same. The *y*-intercept is off by a small amount.

Based on the information that you have gathered, rewrite the equation to best reflect the table of values, description, and line of best fit:

$y = 3x + 1$

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Example 2:

How well does the equation fit the line graph, table of values, and description shown?

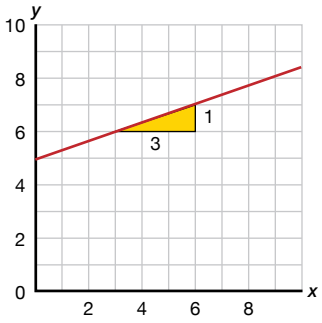
	What is the *y*-intercept?	What is the rate of change?	What is the direction of change?
Equation: $y = 2x + 5$ Remember that the algebraic form of the equation is $y = mx + b$.	$b =$ ____	$m =$ ____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Graph:  	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Table: x | y | Change in x | Change in y 0 | 5 | 3 – 0 = 3 3 | 6 | 6 – 3 = 3 6 | 7 | 9 – 6 = 3 9 | 8 | 6 – 5 = 1 7 – 6 = 1 8 – 7 = 1	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing

Table continued on next page.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

How well does the equation fit the line graph, table of values, and description shown?			
	What is the *y*-intercept?	**What is the rate of change?**	**What is the direction of change?**
Description: *y increases* by 1 unit when *x increases* by 3 units. The line graph has a *y*-intercept of 5 and slopes upward to the right.	b = ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is ☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Compare the information that you gathered about the equation, graph, table, and description.	The *y*-intercept is ☐ very ☐ somewhat ☐ a little similar because…	The rate of change is ☐ very ☐ somewhat ☐ a little similar because…	The direction of change is ☐ very ☐ somewhat ☐ a little similar because…

Make a final decision

I think the equation is

Poor — OK — Good — Perfect

because…

Based on the information that you have gathered, rewrite the equation to best reflect the table of values, description, and line of best fit:

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Example 3:

How well does the equation fit the line graph, table of values, and description shown?

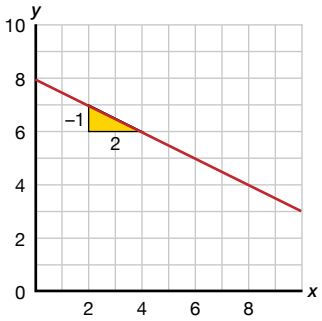
	What is the *y*-intercept?	What is the rate of change?	What is the direction of change?
Equation: $y = \frac{1}{2}x + 8$ Remember that the algebraic form of the equation is $y = mx + b$.	$b =$ ____	$m =$ ____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Graph:  	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Table: x | y | Change in x | Change in y 0 | 8 | 2 – 0 = 2 4 – 2 = 2 | 7 – 8 = –1 6 – 7 = –1 2 | 7 4 | 6	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing

Table continued on next page.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

How well does the equation fit the line graph, table of values, and description shown?			
	What is the *y*-intercept?	**What is the rate of change?**	**What is the direction of change?**
Description: *y decreases* by 1 unit when *x increases* by 2 units. The line graph has a *y*-intercept of 8 and slopes downward to the right.	b = ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is ☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Compare the information that you gathered about the equation, graph, table, and description.	The *y*-intercept is ☐ very ☐ somewhat ☐ a little similar because…	The rate of change is ☐ very ☐ somewhat ☐ a little similar because…	The direction of change is ☐ very ☐ somewhat ☐ a little similar because…

Make a final decision

I think the equation is

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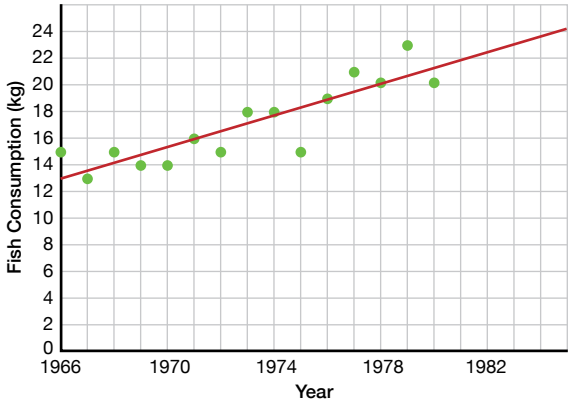
because…

Based on the information that you have gathered, rewrite the equation to best reflect the table of values, description, and line of best fit:

Pull Your Thinking Together

Now, return to the example at the beginning of the lesson. Use the criteria to determine how well the equation fits with the graph, table, and description.

Fish Consumption (kg) Over Time



Year	*n*	Fish Consumption (kg)	Description
1966	0	13.0	Based on data recorded between 1966 and 1980, fish consumption in kilograms is increasing at a steady rate. In 1966, the consumption was just over 13.0 kg, and by 1980, consumption had grown to 21.4 kg.
1967	1	13.6	
1968	2	14.2	
1969	3	14.8	
1970	4	15.4	
1971	5	16.0	
1972	6	16.6	
1973	7	17.2	
1974	8	17.8	
1975	9	18.4	
1976	10	19.0	
1977	11	19.6	
1978	12	20.2	
1979	13	20.8	
1980	14	21.4	

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

How well does the equation fit the line graph, table of values, and description shown?			
	What is the *y*-intercept?	**What is the rate of change?**	**What is the direction of change?**
Equation: $C = 2n + 13$	$b =$ ____	$m =$ ____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Graph	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $=$ _____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Table	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $=$ _____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing

Table continued on next page.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

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Description	$b =$ ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ $=$ _____	m is ☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Compare the information that you gathered about the equation, graph, table, and description.	The *y*-intercept is ☐ very ☐ somewhat ☐ a little similar because…	The rate of change is ☐ very ☐ somewhat ☐ a little similar because…	The direction of change is ☐ very ☐ somewhat ☐ a little similar because…

Make a final decision

I think the equation is

Poor — OK — Good — Perfect

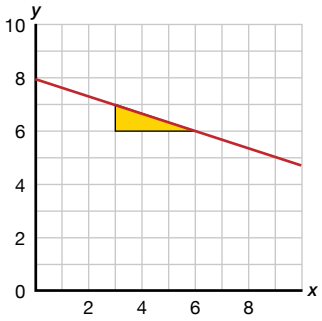
because…

Based on the information that you have gathered, rewrite the equation to best reflect the table of values, description, and line of best fit:

Practise the Thinking

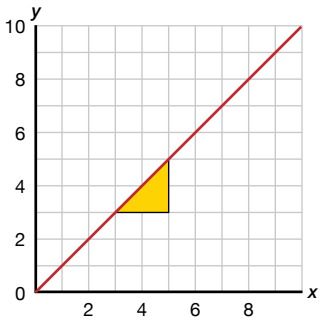
Practise what you have learned in this lesson by using the criteria to write the equations that fit the given graphs, tables of values, and description shown.

Practice 1

	What is the *y*-intercept?	What is the rate of change?	What is the direction of change?
Graph:  	b = ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Table: x | y | Change in x | Change in y 0 | 8 | 3 – 0 = 3 6 – 3 = 3 | 7 – 8 = –1 6 – 7 = –1 3 | 7 6 | 6	b = ____	m = ____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Description: *y decreases* by 1 unit when *x increases* by 3 units. The line graph has a *y*-intercept of 8 and goes down to the right.	b = ____	m = ____	m is (☐+ or ☐–), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Write the equation (in the form $y = mx + b$) that fits the graph, table of values, and description:			

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

Practice 2

	What is the *y*-intercept?	What is the rate of change?	What is the direction of change?
Graph:  	b = ____	$m = \frac{\text{Change in } y}{\text{Change in } x}$ = _____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Table: x | y | Change in x | Change in y 1 | 1 | 3 – 1 = 2 5 – 3 = 2 | 3 – 1 = 2 5 – 3 = 2 3 | 3 5 | 5	b = ____	m = ____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Description: *y increases* by 2 units when *x increases* by 2 units. The line graph has a *y*-intercept of 0 and rises to the right.	b = ____	m = ____	m is (☐ + or ☐ –), so y is ☐ increasing ☐ decreasing ☐ not changing when x is ☐ increasing ☐ decreasing ☐ not changing
Write the equation (in the form $y = mx + b$) that fits the graph, table of values, and description:			

Reflect on Your Thinking

Think About the Lesson Challenge

Did you get $C = 0.60n + 13.00$ as your corrected equation on page 15? If not, go back and review your work. Now, use the corrected equation to make a prediction for fish consumption in Canada in 2030. Use the year, n, to solve for C.

I think fish consumption in Canada will be…

Think About the Overarching Challenge

If you completed the launch lesson ("What lessons can we learn from science and math that can help us live mino bimaadiziwin?"), you probably started a Thoughtbook. In this Thoughtbook, you began thinking about ways to respond to the challenge: **Begin creating helpful advice for living mino bimaadiziwin.**

After you've finished the math lessons, you'll use what you've learned to respond to that challenge. You can use the format of your choice—a song, a traditional art form, photographs, a poem, whatever you think would be best—to describe the actions we can take to live in a good way with the land.

Revisit your Thoughtbook now, and think about what you've learned in this lesson:

- What actions would you add to your Thoughtbook?
- Would you change any of the ideas that you already have in your Thoughtbook?

If you haven't already started a Thoughtbook, you can answer these questions on page 20.

Lesson Question: How well does an equation match a line of best fit, a table, and a description in words?

To complete this lesson, take a moment to reflect on your learning.

Success Criteria	How well am I doing?
I use what I know to be mathematically true about graphs, tables of values, and the equation for a linear relationship (slope and *y*-intercept, direction of change) to decide how well an equation describes the trend in the data.	 Examples that support my rating:
I pay attention to the most useful/ important details in the graph and equation for a linear relationship.	 Examples that support my rating:

My Thoughtbook: What lessons can we learn from science and math that can help us live mino bimaadiziwin?

Use words, symbols, or pictures to describe three pieces of helpful advice that we can learn from science and math that could help us live mino bimaadiziwin.