

M101: Linear Equations - Concepts and Skills

Post-Badge Task

Teacher Scoring Guide

Reflecting on Badge Learning

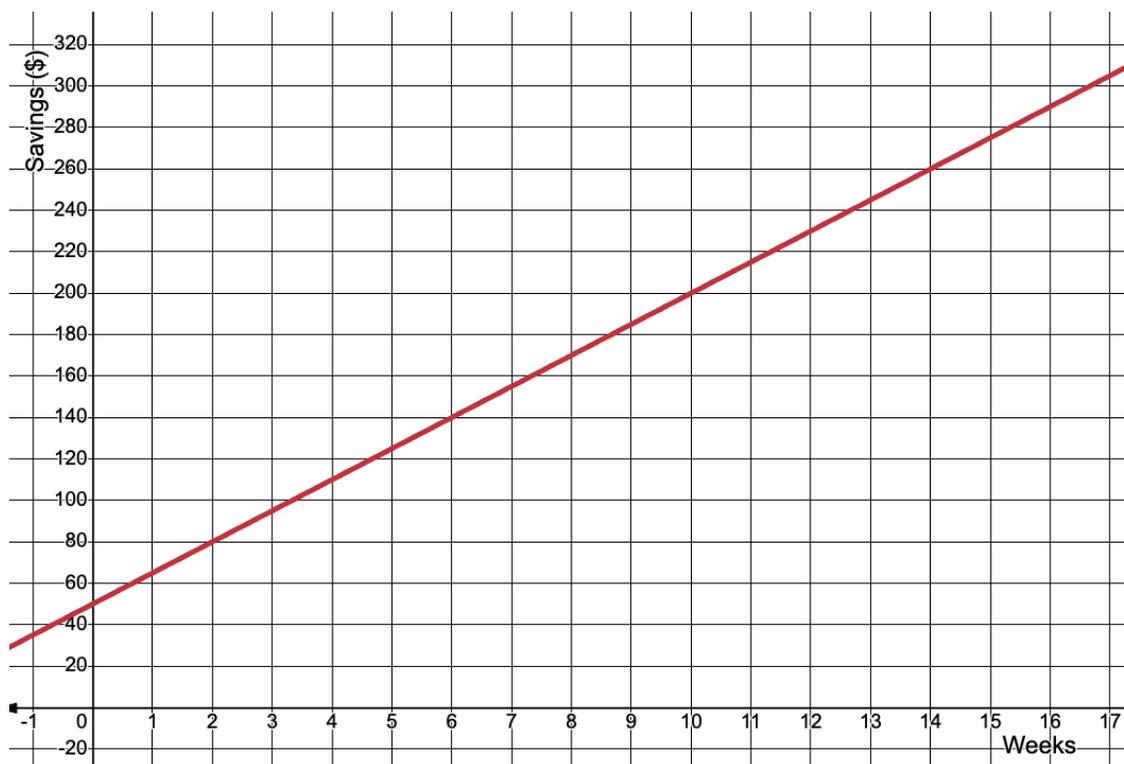
Now that you have learned more about linear functions and their characteristics, respond to the questions that follow. These are the same questions you responded to before the start of this badge.

The Task

Luka and his friend, Raquel, are both saving for new e-bikes.

Luka currently does not have any money, but is going to start saving \$20 a week.

Raquel's savings are shown on this graph:



The following pages include sample student responses in **blue font**, as well as additional scoring comments in **red font**.

QUESTION 1 This task is about e-bikes. Do some research! Report on the following questions:

- What is an e-bike?
- What is the cost of some of the most expensive e-bikes?
- What is the cost of some of the least expensive e-bikes?
- Do you notice any significant differences between the very expensive e-bikes and the less expensive e-bikes? What are they?
- Did you find an e-bike that you might want to purchase? If so, what did you like about it?



Answers will vary. Possible student responses:

- What is an e-bike? An e-bike is bicycle equipped with an electric motor that assists you when you're pedaling. The motor gets its power from a rechargeable battery mounted on the bike. To classify as an e-bike, the motor has to help you rather than propel you on its own.
- What is the cost of some of the most expensive e-bikes? I found a couple extremely expensive e-bikes. The Porsche eBike Cross Performance EXC Mamba Green lists for \$15,899.99. The Domane+ SLR 9 lists for \$12,999.99.
- What is the cost of some of the least expensive e-bikes? The least expensive e-bikes I found were on Amazon: Qlife Racer Electric Bike for Adults - 21-Speed Mountain Lightweight for \$239.99 and Cityone Electric Bike for Adults 26" Step-Through Ebike for \$264.99.
- Do you notice any significant differences between the very expensive e-bikes and the less expensive e-bikes? Yes! What are they?
The more expensive e-bikes:
 - can be customized to fit the rider for better comfort and performance
 - are made with lighter and stronger materials like carbon fiber or high-grade aluminum
 - typically have advanced features like GPS, Bluetooth connectivity, and sophisticated display systems
 - have better suspension and disc braking systems (often hydraulic)
 - have motors that are more powerful and last longer
 - the batteries capacities are higher (1000Wh vs 250 Wh) and last longerThe cheaper e-bikes:
 - made with lower quality and heavier materials
 - low battery capacities and shorter life
 - smaller hub motors
 - don't have good warranties or service
 - mechanical disc braking system
- Did you find an e-bike that you might want to purchase? If so, what did you like about it? Yes, I found one on sale right now. The Xpress 750 High-Step eBike for \$1299. It features an upgraded TC•Eighty front suspension fork, a 7-speed drivetrain, hydraulic disc brakes, and 27.5 x 2.1-inch city tires. It also comes with a larger seat for comfort, and a headlight, phone mount, and bike lock.

QUESTION 2 Write an equation to represent Luka's savings over time. Describe what the variables you choose in your equation represent in the context of this problem.



$S = 20w$ where S represents the total amount of savings and w represents the number of weeks since Luka begins saving.

OR

$y = 20x$ (y is the total amount of savings and x is the number of weeks)

The form and choice of variables for the equation can vary, but it should be a linear equation

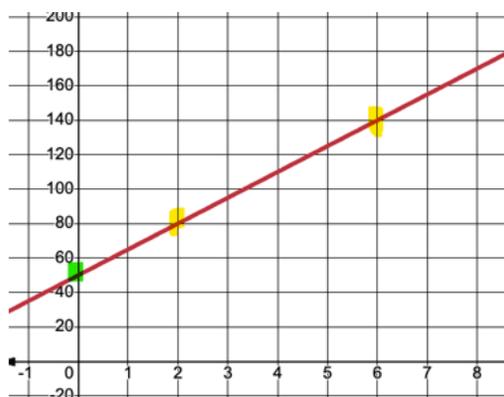
QUESTION 3 How much money will Luka have after 3 weeks? How do you know?



Luka will have \$60 after 3 weeks, because using the formula $S = 20w$, and substituting 3 in for weeks, I get $20(3) = 60$.

Students don't have to show their equation or work in order to adequately answer this question. The key is they explain how they determined that \$60 is the answer.

QUESTION 4 How much money does Raquel save each week? How do you know?



Raquel saves \$15 each week.

I looked at the graph and determined two points where the grid lines intersected. (2, 80) and (6, 140). By these two points, Raquel saved \$60 in 4 weeks. So, $60/4$ is \$15.

OR

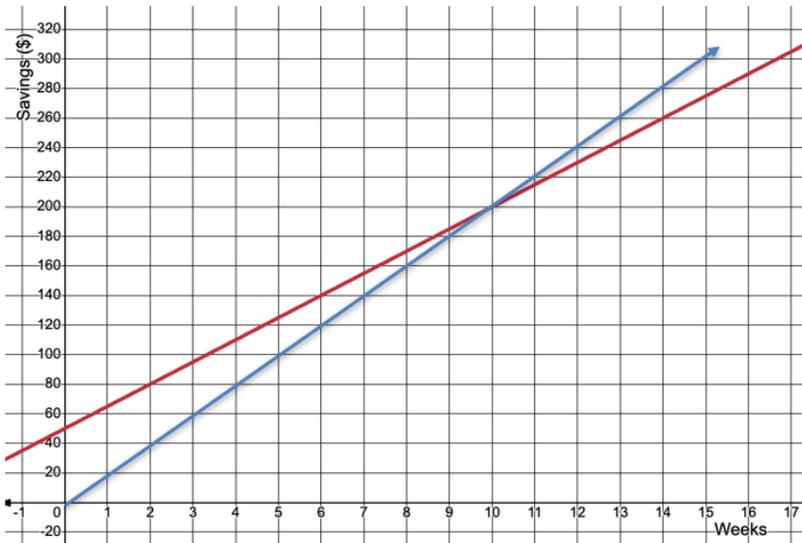
Raquel started with \$50. At 2 weeks, it appears she has \$80. So, she saved \$30 in two weeks. That is \$15 per week.

Students are not likely to include a graph with their answer, but they may use points as shown in the sample response above. Again, the key is that students include an explanation as to how they determined \$15 per week, with or without showing work

QUESTION 5 Luka tells Raquel that they are saving at the same rate because after 10 weeks, they will both have \$200. Do you agree or disagree with Luka? Graph Luca's savings and use the graph to justify your answer.



No, I do not agree with Luka. I graphed the equation that represents Luka's savings ($S = 20w$) and it crosses Raquel's graph at 10 weeks. That's where they both have \$200 in savings. But Luca will have more money after 10 weeks because he is saving at a higher rate than Raquel. Raquel started with \$50 and is saving \$15 per week. Luka started with \$0, but is saving \$20 each week...which is a higher rate.



Students should at least show the graph of Luka's savings (blue line), even if they don't include Raquel's graph with it. Students need to realize that Luka's rate is higher than Raquel's rate, and the fact that they have the same amount at 10 weeks doesn't mitigate that difference.

QUESTION 6 After how many weeks will each person be able to afford an e-bike that costs \$300?



According to the graph, Luka will have \$300 at 15 weeks and Raquel will have \$300 at $16\frac{2}{3}$ weeks. Specifically, when I substitute 300 for S in Luka's equation, I get 15 for the number of weeks. $300 = 20w$, $300/20 = w$, $15 = w$

Raquel's equation is $S = 15w + 50$. Substituting 300 for S , I get $16\frac{2}{3}$ weeks.

$300 = 15w + 50$, $250 = 15w$, $250/15 = w$, $w = 16\frac{2}{3}$

Students are likely to answer 15 weeks for Luka, because it comes out evenly, but may state "over 16 weeks" for Raquel, which is acceptable. A student might also express the weeks for Raquel in decimal form: 16.667.

QUESTION 7 If you were going to start saving for a new bike, which one would you choose? How much does it cost? What math would you use to plan? Why?



Answers will likely vary widely, depending on the cost of the e-bike they choose. Teachers may have to prompt students to show some math which supports a plan for saving for the cost of an e-bike. Possible student responses:

The e-bike that I want costs about \$1300. I don't have any savings right now, but I could possibly save \$25 per week starting now. If I use the equation $S = 25w$, it will take 52 weeks (a full year) to save for the e-bike.

$$1300 = 25w, 1300/25 = w, 52 = w \qquad \text{OR}$$

The e-bike that I want costs about \$1300. I have \$400 in savings right now and I could save \$20 per week from my job from this point on. Using the equation $S = 20w + 400$, it will take 45 weeks to save for the e-bike.

$$1300 = 20w + 400, \quad 900 = 20w, 900/20 = w, 45 = w$$

QUESTION 8

- What is an example of a question you could ask where you would find Raquel's graph more useful to answer it than Luka's equation?
- What is an example of a question you could ask where you would find Luka's equation more useful to answer it than Raquel's graph?
- Are there any questions you could ask where it wouldn't matter to you whether you had a graph or an equation?



a. How much savings did Raquel have before she starting saving for an e-bike?
This question is easily answered because it's the y-intercept on the graph.

b. How much money has Luka saved in 6 weeks?
Since Luka's equation is $S = 20w$, the answer is easy to answer by substituting 6 in for w and solving for S . The answer is \$120.

c. When will you have enough money to buy the e-bike you want?
I could use an equation or graph (depending on how many weeks it would take) to answer this question. If the e-bike I want costs less than \$300, the graph works as easily as the equation.

Answers will vary and do not need include any mention of Luka or Raquel. The idea is to answer whether a graph or equation or either a graph or equation would be most useful for answering their questions.

QUESTION 9 What else did you learn that was not reflected in Questions 1-8?



Answers will likely vary widely, including some students not being able to produce a response at all. This question is meant to allow students to share what else they learned that may be of interest to them. Some possible student responses:

I learned that the price of an e-bike can vary greatly, and some are more affordable than I thought.

I learned that different e-bikes are built for specific purposes (commuting, off-roading, etc.).

I learned that when you save the same amount of money over a particular time period, you can write a linear equation to model the savings plan.

QUESTION 10 Compare your answers to these questions now to your answers from the earlier attempt. What do you notice about your progress?



Answers will vary. Look for students to explain what they know now compared to what they knew when responding to the pre-test.