Lesson 2: Real-World Positive and Negative Numbers and Zero

Student Outcomes

- Students use positive and negative numbers to indicate a change (gain or loss) in elevation with a fixed reference point, temperature, and the balance in a bank account.
- Students use vocabulary precisely when describing and representing situations involving integers; e.g., an elevation of −10 feet is the same as 10 feet below the fixed reference point.
- Students choose an appropriate scale for the number line when given a set of positive and negative numbers to graph.

Classwork

Opening Exercise (5 minutes)

Display a number line without a scale labeled. Pose the following questions to the whole group, and allow students 3 minutes to discuss their responses in pairs. Record feedback by labeling and relabeling the number line based on different responses.

Questions for Discussion:

- Explain how you would show 150 on a number line.
  - I would start at zero and move to the right 150 units.

- What strategy would you use to number the number line in order to show 150?
  - Answers may vary. I would locate (place) zero as far to the left as possible and use a scale of 10.

- If you want to have zero and 150 on the given number line, what scales would work well (what should you count by)?
  - Answers may vary. I could count by fives, tens, or twenty-fives. I could also label the first tick mark 140 and count by ones.

Scaffolding:
For kinesthetic learners, provide students with whiteboards and markers to create their number lines. Ask them to hold up their boards, and select a few students to explain their diagrams to the class.

MP.4
Common Misconceptions

Teacher should explain to students how to choose an appropriate scale. Pay careful attention to student graphs and address common misconceptions, such as:

- Unequal intervals – Intervals should be equal from one mark to the next. This usually happens when students stop skip counting in order to make the numbers fit on the diagram (e.g., 5, 10, 15, 20, 50, 100, 150).
- Miscounting – This is usually the result of students rushing and not paying attention to details. Students should always check their scales for accuracy before plotting points.
- Always starting at zero – The problem should determine the appropriate start and end point for a number line. Help struggling students by counting the number of tick marks (lines) first, in order to determine a starting point.
- Not using the entire number line diagram – Spacing should be evenly distributed throughout a number line. This usually happens when students are counting by a value that is too large (e.g., counting by tens instead of twos).

Example 1 (10 minutes): Take It to the Bank

The purpose of this example is for students to understand how negative and positive numbers can be used to represent real-world situations involving money. Students will be introduced to basic financial vocabulary – deposit, credit (credited), debit (debited), withdrawal, and change (gain or loss) throughout the example. Teacher should access prior knowledge by having students independently complete the first two columns of the KWL graphic organizer in their student materials. Monitor student responses and select a few students to share out loud.

Example 1: Take it to the Bank

For Tim’s 13th birthday, he received $150 in cash from his mom. His dad took him to the bank to open a savings account. Tim gave the cash to the banker to deposit into the account. The banker credited Tim’s new account $150 and gave Tim a receipt. One week later, Tim deposited another $25 that he had earned as allowance. The next month, Tim asked his dad for permission to withdraw $35 to buy a new video game. Tim’s dad explained that the bank would charge $5 for each withdrawal from the savings account and that each withdrawal and charge results in a debit to the account.

Read Example 1 silently. In the first column, write down any words and definitions you know. In the second column, write down any words you do not know.

<table>
<thead>
<tr>
<th>Words I Already Know</th>
<th>Words I Want to Know</th>
<th>Words I Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank account – place where you put your money</td>
<td>Credited</td>
<td></td>
</tr>
<tr>
<td>Receipt – ticket they give you to show how much you spent</td>
<td>Debit</td>
<td></td>
</tr>
<tr>
<td>Allowance – money for chores</td>
<td>Fee</td>
<td></td>
</tr>
<tr>
<td>Charge – something you pay</td>
<td>Deposit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Withdraw</td>
<td></td>
</tr>
</tbody>
</table>

In the third column, write down any new words and definitions that you learn during the discussion.
Exercises 1–2 (7 minutes)

This exercise asks students to number the events of the story problem in order to show how each action can be represented by an integer and modeled on a number line. Record the events in the diagram below.

The teacher leads the whole group through Exercise 1, precisely defining vocabulary to describe each situation as an integer and modeling the integer on a number line. Pose the following questions throughout the exercise. Point out that zero represents the balance before each transaction in the story problem.

Questions for Discussion:

- Tim receives $150 for his birthday. Do you think this will be a positive or negative number for Tim’s money? Explain.
  - Positive; $150 is a gain for Tim’s money. Positive numbers are greater than 0.

- How much money is in the account when Tim opened it? What does this number represent in this situation?
  - The account has $0 in it because Tim had not put in or taken out any money. Zero represents the starting account balance.

- The $150 that Tim gives the banker is called a deposit. A deposit is the act of putting money into a bank account. To show the amount of money in Tim’s savings account, would this deposit be located to the left or right of zero on the number line?
  - This deposit is located to the right of zero because it increases the amount of money in the savings account.

- The bank credited the account $150. A credit is when money is deposited into an account. The account increases in value. How would you represent a credit of $150 as an integer? Explain.
  - Since a credit is a deposit, and deposits are written as positive numbers, then positive 150 represents a credit of $150.

- Tim makes another deposit of $25. Would this be a positive or negative number for Tim’s savings account, and how would you show it on a number line?
  - A deposit increases the amount of money in the savings account, so 25 is positive. I would place the point 25 units to the right of zero.

- The bank creates a debit of $5 for any withdrawal. What do you think the word debit means in this situation?
  - A debit sounds like the opposite of a credit. It might be something taken away. Taking money out of the savings account is the opposite of putting money in.
A debit means money paid out of an account. It is the opposite of a credit. Are debits represented as positive or negative numbers on the number line for the amount of money in a savings account?

- A debit is represented as a negative number to the left of zero on a number line because debits are the opposite of credits, which are positive numbers.

The bank charges a $5 service fee for any withdrawal on a savings account. A charge, also called a fee, is the amount of money a person has to pay for something. Can you name a situation where you would have to pay a charge?

- I would have to pay a charge at an amusement park, a concert, a basketball game, or a doctor’s office. (Answers may vary.)

How would you represent a charge of $5 for Tim’s savings account on the number line?

- A charge of $5 would be $\text{-}5$ because money is being taken out of the account. I would find positive five on the number line by starting at 0 and moving 5 units to the right. Then, I would count 5 units going left from zero to end on $\text{-}5$.

Tim withdrew $35 from his account. Based on the story problem, what is the meaning of the term withdraw?

- Since Tim wanted to buy something, he took money out of the account. I think withdraw means to take money out of an account.

To withdraw money is to take money out of an account. How would you represent the $35 for the video game as an integer for Tim’s savings account?

- The money was taken out of Tim’s account; it would be represented as $\text{-}35$.

2. Write each individual description below as an integer. Model the integer on the number line using an appropriate scale.

<table>
<thead>
<tr>
<th>EVENT</th>
<th>INTEGER</th>
<th>NUMBER LINE MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open a bank account with $0.</td>
<td>0</td>
<td><img src="image" alt="Number Line Model for Open a bank account with $0." /></td>
</tr>
<tr>
<td>Make a $150 deposit.</td>
<td>150</td>
<td><img src="image" alt="Number Line Model for Make a $150 deposit." /></td>
</tr>
<tr>
<td>Credit an account for $150.</td>
<td>150</td>
<td><img src="image" alt="Number Line Model for Credit an account for $150." /></td>
</tr>
<tr>
<td>Make a deposit of $25.</td>
<td>25</td>
<td><img src="image" alt="Number Line Model for Make a deposit of $25." /></td>
</tr>
<tr>
<td>A bank charge of $5.</td>
<td>$\text{-}5$</td>
<td><img src="image" alt="Number Line Model for A bank charge of $5." /></td>
</tr>
<tr>
<td>A withdrawal of $35.</td>
<td>$\text{-}35$</td>
<td><img src="image" alt="Number Line Model for A withdrawal of $35." /></td>
</tr>
</tbody>
</table>
Example 2 (7 minutes): How Hot, How Cold?

This example gives students practice reading thermometers in both Fahrenheit and Celsius scales. Students will write temperatures as integers and describe how temperature could be modeled on a vertical number line.

Example 2: How Hot, How Cold?

Temperature is commonly measured using one of two scales, Celsius or Fahrenheit. In the United States the Fahrenheit system continues to be the accepted standard for non-scientific use. All other countries have adopted Celsius as the primary scale in use. The thermometer shows how both scales are related.

a. The boiling point of water is 100°C. Where is 100 degrees Celsius located on the thermometer to the right?

   *It is not shown because the greatest temperature shown in Celsius is 50°C.*

b. On a vertical number line, describe the position of the integer that represents 100°C.

   *The integer is 100, and it would be located 100 units above zero.*

c. Write each temperature as an integer.
   i. The temperature shown to the right in °F:

      *100*

   ii. The temperature shown to the right in °C:

      *38*

   iii. Freezing point of water in Celsius:

      *0*

d. If someone tells you your body temperature is 98.6°, what scale are they using? How do you know?

   *Since water boils at 100°C, they must be using the Fahrenheit scale.*

e. Does the temperature 0 degrees mean the same thing on both scales?

   *No, 0°C corresponds to 32°F and 0°F corresponds to approximately –18°C.*

Teacher should address the common misconception on how to describe negative temperatures. –10 can be read as “negative ten degrees Celsius.” It can also be read as “ten degrees below zero.” However, it should not be read as “negative ten degrees below zero.”

Temperatures that are above zero can be stated as their numerical value. For example, describing a fever of 102°F can be simply stated as “one hundred and two degrees.”
Exercises 3–5 (7 minutes)

The following problems provide students additional practice with real world positive and negative numbers and zero. Give students time to share responses to the whole group.

<table>
<thead>
<tr>
<th>Gain</th>
<th>Loss</th>
<th>Deposit</th>
<th>Credit</th>
<th>Debit</th>
<th>Charge</th>
<th>Below Zero</th>
<th>Withdraw</th>
<th>Owe</th>
<th>Receive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Number</strong></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>Loss</td>
<td>Deposit</td>
<td>Credit</td>
<td>Debit</td>
<td>Charge</td>
<td>Below zero</td>
<td>Withdraw</td>
<td>Owe</td>
<td>Receive</td>
</tr>
<tr>
<td><strong>Negative Number</strong></td>
<td></td>
<td></td>
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</tbody>
</table>

4. Write an integer to represent each of the following situations:
   a. A company loses $345,000 in 2011. \(-345,000\)
   b. You earned $25 for dog sitting \(25\)
   c. Jacob owes his dad $5. \(-5\)
   d. The temperature at the sun’s surface is about 5,600°C. \(5,600\)
   e. The temperature outside is 4 degrees below zero. \(-4\)
   f. A football player lost 10 yards when he was tackled. \(-10\)

5. Describe a situation that can be modeled by the integer \(-15\). Explain what zero represents in the situation.

   I owe my best friend $15. In this situation, 0 represents my owing nothing to my best friend.

Closing (2 minutes)

- How did we represent debit and credit on a number line?
  - A debit is represented as a negative number, located to the left of zero. A credit is represented as a positive number, located to the right of zero.
- Can a temperature of \(-9\) degrees be described as “Negative nine degrees below zero?” Why or why not?
  - No, because “below zero” already means that the temperature is negative.

Exit Ticket (7 minutes)
Lesson 2: Real-World Positive and Negative Numbers and Zero

Exit Ticket

1. Write a story problem that includes both integers $-8$ and $12$.

2. What does zero represent in your story problem?

3. Choose an appropriate scale to graph both integers on the vertical number line. Label the scale.

4. Graph both points on the vertical number line.
Exit Ticket Sample Solutions

1. Write a story problem that includes both integers $-8$ and $12$.
   
   (Answers may vary.) One boxer gains 12 pounds of muscle to train for a fight. Another boxer loses 8 pounds of fat.

2. What does zero represent in your story problem?
   
   Zero represents no change in the boxer's weight.

3. Choose an appropriate scale to graph both integers on the vertical number line. Label the scale.
   
   I chose a scale of 1.

4. Graph both points on the vertical number line.

Problem Set Sample Solutions

1. Express each situation as an integer in the space provided.

   a. A gain of 56 points in a game. $56$
   
   b. A fee charged of $2.50. $-2.50$
   
   c. A temperature of 32 degrees below zero. $-32$
   
   d. A 56 yard loss. $-56$
   
   e. The freezing point of water in Celsius. $0$
   
   f. A $12,500 deposit. $12,500$
For questions 2–5, use the thermometer to the right.

2. Each sentence is stated incorrectly. Rewrite the sentence to correctly describe each situation.
   a. The temperature is \(-10\) degrees Fahrenheit below zero.
      
      Correct: The temperature is \(-10^\circ F\).
      or
      The temperature is 10 degrees below zero Fahrenheit.

   b. The temperature is \(-22\) degrees Celsius below zero.
      
      Correct: The temperature is \(-22^\circ C\).
      or
      The temperature is 22 degrees below zero Celsius.

3. Mark the integer on the thermometer that corresponds to the temperature given.
   a. \(70^\circ F\)
   b. \(12^\circ C\)
   c. \(110^\circ F\)
   d. \(\,-4^\circ C\)

4. The boiling point of water is \(212^\circ F\). Can this thermometer be used to record the temperature of a boiling pot of water? Explain.
   
   No, it cannot because the highest temperature in Fahrenheit on this thermometer is \(120^\circ\).

5. Kaylon shaded the thermometer to represent a temperature of 20 degrees below zero Celsius as shown in the diagram. Is she correct? Why or why not? If necessary, describe how you would fix Kaylon’s shading.
   
   She is incorrect because she shaded a temperature of \(\,-20^\circ F\). I would fix this by marking a line segment at \(\,-20^\circ C\) and shade up to that line.