

Using Dot Plots to Answer Statistical Questions

Goals

- Compare and contrast (orally and in writing) dot plots that represent two different data sets measuring the same quantity, paying attention to the “center” and “spread” of each distribution.
- Critique or justify (orally and in writing) claims about the center of a distribution represented on a dot plot.

Learning Targets

- I can use a dot plot to represent the distribution of a data set and answer questions about the real-world situation.
- I can use center and spread to describe data sets, including what is typical in a data set.

Access for Students with Diverse Abilities

- Representation (Activity 2)

Access for Multilingual Learners

- MLR8: Discussion Supports (Activity 2)

Lesson Narrative

In this lesson, students continue to use dot plots to develop their understanding of center and spread by informally identifying values to describe the center and spread, comparing centers and spreads of different distributions, and making use of the structure of the distributions to understand them in the context of situations.

Student Learning Goal

Let's use dot plots to describe distributions and answer questions.

Lesson Timeline

5
min

Warm-up

10
min

Activity 1

15
min

Activity 2

10
min

Lesson Synthesis

Assessment

5
min

Cool-down

Warm-up

Packs on Backs

5 min

Activity Narrative

In this lesson, students begin informally connecting center and spread to the word “typical.” They consider a value that could be typical or characteristic of a data set by thinking about two good options and reasonings. They continue to interpret a dot plot in the context of a situation. Students also have a chance to critique the arguments of Clare and Tyler.

Launch

Arrange students in groups of 2. Give students 2 minutes of quiet work time and a minute to share their responses with a partner. Follow with a whole-class discussion.

During the partner discussion, identify students who agree with Clare or Tyler to share during the whole-class discussion.

Student Task Statement

This dot plot shows the weights of backpacks, in kilograms, of 50 sixth-grade students at a school in New Zealand.

- The dot plot shows several dots at 0 kilograms. What could a value of 0 mean in this context?
Sample response: A value of 0 could represent students who don't use backpacks.
- Clare and Tyler studied the dot plot.
 - Clare says, “I think we can use 3 kilograms to describe a typical backpack weight of the group because it has the greatest frequency.”
 - Tyler disagrees and says, “I think 3 kilograms is too low to describe a typical weight. There are some values much greater than 3 and that should make the typical value greater.”Do you agree with either of them? Explain your reasoning.
Sample response:
 - I agree with Clare. There are more backpacks that are 3 kilograms than any other weights, and half of the dots are around 3 kilograms (between 2 and 4 kilograms).
 - I agree with Tyler. Half of the values are 3 or less and half are 4 or more, but because the distribution goes all the way up to 16, it seems like that should move the typical value to greater than 3.

Student Workbook

LESSON 5

Using Dot Plots to Answer Statistical Questions

Let's use dot plots to describe distributions and answer questions.

Packs on Backs

This dot plot shows the weights of backpacks, in kilograms, of 50 sixth-grade students at a school in New Zealand.

1. The dot plot shows several dots at 0 kilograms. What could a value of 0 mean in this context?

2. Clare and Tyler studied the dot plot.

- Clare says, “I think we can use 3 kilograms to describe a typical backpack weight of the group because it has the greatest frequency.”
- Tyler disagrees and says, “I think 3 kilograms is too low to describe a typical weight. There are some values much greater than 3 and that should make the typical value greater.”

Do you agree with either of them? Explain your reasoning.

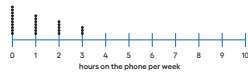
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GRADE 6 • UNIT 8 • SECTION B | LESSON 5

Student Workbook

On the Phone

Twenty-five sixth-grade students were asked to estimate how many hours a week they spend talking on the phone. This dot plot represents their reported number of hours of phone usage per week.



- What percentage of the students reported not talking on the phone?
- What percentage of the group reported talking on the phone for 3 hours?
- How many hours would you say that these 25 students typically spend talking on the phone?

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Activity Synthesis

Ask the selected students—one who agrees with Clare and another who agrees with Tyler—to share their reasoning. Ask if anyone disagrees with both students, and if so, what value they would consider a better description of the center of the data.

Students should have a reasonable explanation for each argument they favor, but it is not necessary to confirm one way or another at this point.

Activity 1

On the Phone

10 min

Activity Narrative

In this activity, students continue to analyze distributions in terms of where most of the data cluster and try to identify and interpret the **center** and **spread** of a distribution that is not symmetric. The two distributions used here allow students to contrast a narrow spread and a wide spread and develop a deeper understanding of variability.

As students work, notice how students identify a general location for the center of a data set and the descriptions that they use to talk about the spread, using terms such as “wide,” “narrow,” or “something in between.”

Launch



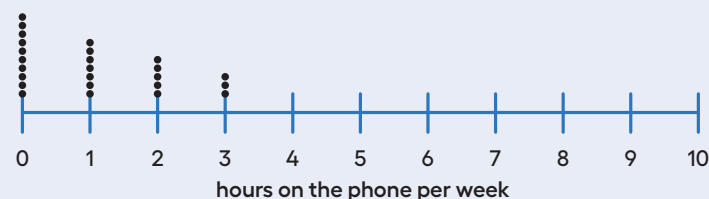
Arrange students in groups of 2. Give students 3–4 minutes of quiet work time for the first three questions, and another 4–5 minutes to share their responses and discuss the last question with a partner.

Students are asked to find a percentage. If necessary, briefly review how to find a percentage.

Identify students who connect the size of a spread to how different or alike the data points are. Ask them to share later. Additionally, identify students who measure spread as the range of the entire data as well as those who use the distance to the center.

Student Task Statement

Twenty-five sixth-grade students were asked to estimate how many hours a week they spend talking on the phone. This dot plot represents their reported number of hours of phone usage per week.



- What percentage of the students reported not talking on the phone?
40% of the group reported not using the phone.

2. What percentage of the group reported talking on the phone for 3 hours?
12% of the students reported talking on the phone for this amount of time.

3. How many hours would you say that these 25 students typically spend talking on the phone? 1 hour

4. a. How would you describe the spread of the data? Would you consider these students' amounts of time on the phone to be alike or different? Explain your reasoning.

Sample response: The spread is pretty small. The hours reported span from 0 to 3, with a little more than half of the values being either 0 or 1, and the rest being 2 or 3. I think the phone usage is fairly different between those who don't talk on the phone at all (40% of the group) and those who talk for 2 or 3 hours a week (40% of the group).

b. Here is the dot plot from an earlier activity. It shows the number of hours per week the same group of 25 sixth-grade students reported spending on homework.

Overall, are these students more alike in the amount of time they spend talking on the phone or in the amount of time they spend on homework? Explain your reasoning.

Words per Minute	Number of Students
20	2
21	3
22	4
23	3
24	2
25	1
26	3
27	2
28	3
29	2
30	2
31	1
32	2
33	1
34	1

Sample response: The students are more alike in their phone usage than in the time they spend on homework. The spread of the data is much larger on the homework time dot plot, which means there is much more variability in the time they spend doing homework than the time they spend on the phone.

Activity Synthesis

The purpose of the discussion is to help students find good ways to describe a distribution based on center and spread.

Select a few students to share the values that they find typical for the number of hours spent on the phone. Ask students how their values relate to what they might consider the center of the distribution.

Ask students how they thought about the spread of the data. If possible, select students who thought of spread as the range of the entire data and those who thought of it as an interval around the center. Ask students to share their interpretation of what the spread means in the context of using the phone. Make sure to include previously identified students who connect spread to how alike or different the data points are.

Tell students that distributions are generally described using the center and spread. There are multiple ways to understand the center of a distribution as well as how the spread can be described. Select a few students to describe the distributions of the two data sets shown in this activity.

Student Workbook

On the Phone

Twenty-five sixth-grade students were asked to estimate how many hours a week they spend talking on the phone. This dot plot represents their reported number of hours of phone usage per week.

Hours on the Phone	Number of Students
0	4
1	4
2	3
3	3
4	1

1. What percentage of the students reported not talking on the phone?

2. What percentage of the group reported talking on the phone for 3 hours?

3. How many hours would you say that these 25 students typically spend talking on the phone?

Student Workbook

On the Phone

a. How would you describe the spread of the data? Would you consider these students' amounts of time on the phone to be alike or different? Explain your reasoning.

b. Here is the dot plot from an earlier activity. It shows the number of hours per week the same group of 25 sixth-grade students reported spending on homework.

Hours on Homework	Number of Students
1	2
2	3
3	2
4	2
5	2
6	1
7	2
8	1
9	1

Overall, are these students more alike in the amount of time they spend talking on the phone or in the amount of time they spend on homework? Explain your reasoning.

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Access for Multilingual Learners (Activity 2, Student Task)

MLR8: Discussion Supports.

Display a sentence frame to support understanding of the context: “A person’s typing speed increases when they type (more or fewer) words per minute because ...”.

Advances: Conversing, Representing

Building on Student Thinking

Some students might find it challenging to tell where the center of a distribution could be just by looking at a single dot plot. The idea of center might be more apparent when presented in comparative terms. For example, ask them to describe in their own words how the distribution of the first dot plot differs from that of the second dot plot. Students are likely able to say that, compared to the first dot plot, the group of dots in the second dot plot is overall farther to the right on the number line. Ask them if there is a location on each dot plot around which data points seem to be grouped.

Student Workbook

Click-Clack

1. A keyboarding teacher wonders: “Do typing speeds of students improve after taking a keyboarding course?” Explain why her question is a statistical question.

2. The teacher records the number of words that her students can type per minute at the beginning of a course and again at the end. The two dot plots show the two data sets.

beginning of course

end of course

Based on the dot plots, do you agree with each of the following statements about this group of students? Be prepared to explain your reasoning.

a. Overall, the students’ typing speed does not improve. They type at the same speed at the end of the course as they did at the beginning.

b. 20 words per minute is a good estimate for how fast, in general, the students typed at the beginning of the course because it is near the center of the distribution.

Activity 2

Click-Clack

15
min

Activity Narrative

In this activity, students continue to practice finding reasonable values for centers of data and describing variability. The focus is on making use of the structure of distributions to compare groups in those terms and interpreting their analyses in the context of a situation.

By comparing distributions, seeing how center and spread for the same population could change, and making sense of what these changes mean, students deepen their understanding of these concepts before learning about more formal measures of center and variability.

Launch



Give students a brief overview on keyboarding courses. Explain that these are classes designed to help people improve their typing speed and accuracy, which they may need for their jobs. Typing proficiency is usually measured in terms of number of words typed per minute; the more words typed correctly per minute, the faster or more proficient one’s typing is.

Keep students in groups of 2. Give them 5–6 minutes of quiet time to work on the first two questions, and then 2–3 minutes to discuss their responses and complete the last question together.

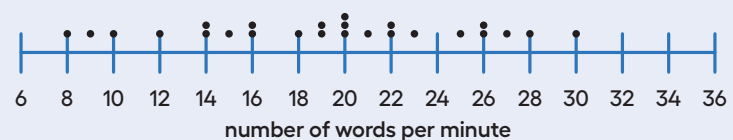
Student Task Statement

1. A keyboarding teacher wonders: “Do typing speeds of students improve after taking a keyboarding course?” Explain why her question is a statistical question.

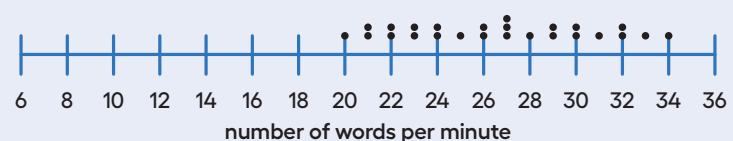
The question is a statistical question because data are needed to answer it, and we can expect it to have variability.

2. The teacher records the number of words that her students can type per minute at the beginning of a course and again at the end. The two dot plots show the two data sets.

beginning of course



end of course



Based on the dot plots, do you agree with each of the following statements about this group of students? Be prepared to explain your reasoning.

a. Overall, the students’ typing speed does not improve. They type at the same speed at the end of the course as they did at the beginning.

Sample response: Disagree. The set of dots were, as a group, placed lower on the number line at the beginning of the course and higher at the end, which means that, as a class, they were typing more words per minute or typing faster.

b. 20 words per minute is a good estimate for how fast, in general, the students typed at the beginning of the course because it is near the center of the distribution.

Sample response: Agree. At the beginning, 20 is more or less in the middle of the set of dots. It is reasonable to use this value to describe the set in general. (Or: Disagree. There are quite a few data points that are much lower or higher than 20. It doesn’t seem that 20 is a good estimate of the set.)

c. 20 words per minute is a good description of the center of the data set at the end of the course.

Sample response: Disagree. Almost all students were typing more than 20 words a minute, so 20 would not be a good description of the group’s typing speed at the end of the course.

d. There is more variability in the typing speeds at the beginning of the course than at the end, so the students’ typing speeds are more alike at the end.

Sample response: Agree. The spread in the first dot plot is wider, which means the speeds of the students were quite different or more variable. The dots on the second dot plot are closer together, or the spread is narrower, which means at the end of the course the typing speeds were less variable.

3. Overall, how fast would you say that the students type after completing the course? What would you consider the center of the end-of-course data?

Sample response: I would consider the center of the data to be about 26. In general, the group of students were typing at about 26 words per minute after taking the course.

Are You Ready for More?

Use one of these suggestions or make up your own. Research to create a dot plot with at least 10 values. Then, describe the center and spread of the distribution.

- Points scored by your favorite sports team in its last 10 games
- Length of your 10 favorite movies (in minutes)
- Ages of your favorite 10 celebrities

Answers vary.

Student Workbook

Click-Click

1 A keyboarding teacher wonders, “Do typing speeds of students improve after taking a keyboarding course?” Explain why her question is a statistical question.

2 The teacher records the number of words that her students can type per minute at the beginning of a course and again at the end. The two dot plots show the two data sets.

beginning of course

end of course

Based on the dot plots, do you agree with each of the following statements about this group of students? Be prepared to explain your reasoning.

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Click-Click

c. 20 words per minute is a good description of the center of the data set at the end of the course.

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Are You Ready for More?

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Access for Students with Diverse Abilities (Activity 2, Synthesis)
Representation: Internalize Comprehension.

Use color coding and annotations to highlight connections between representations in a problem. For example, color code the distinctions between the distributions such as changes in center or spread, and note connections to the context.

Supports accessibility for: Visual-Spatial Processing

Activity Synthesis

The purpose of the discussion is for students to deepen their understanding of distributions and use the descriptions to compare two groups.

Focus the whole-class discussion on two ideas:

- The distinctions between the two distributions: Students should see that, overall, the cluster of data points have both shifted up toward a greater number of words per minute (moving its center up) and become more compressed in its spread by the end of the course. Because the center moved up in location, the value we use to describe that center would also increase.
- What the changes in the center and spread tell us in this situation: Students should recognize that a higher center means that, overall, the group has improved in their typing speed. They should see that a narrower spread at the end of the course suggests that there's now less variability in the typing speeds of different students (compared to a much larger variability initially).
- The comparison of distributions is useful for overall trends, but does not describe individual patterns well. For example, there could be a student who typed 30 words per minute at the beginning of the course and 20 words per minute at the end. Overall, the students in the class tended to improve because the center went up, but every student doesn't necessarily follow the trend.

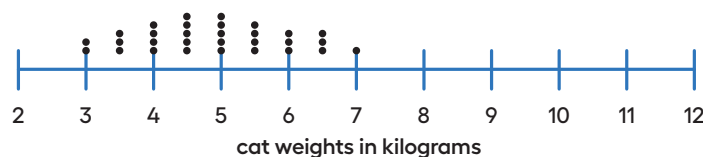
Lesson Synthesis

Use *Stronger and Clearer Each Time* to give students an opportunity to revise and refine their response to “What are the center and spread of a distribution? What do they tell us about a typical value for the distribution?” In this structured pairing strategy, students bring their first draft response into conversations with 2–3 different partners. They take turns being the speaker and the listener. As the speaker, students share their initial ideas and read their first draft. As the listener, students ask questions and give feedback that will help their partner clarify and strengthen their ideas and writing.

If time allows, display these prompts for feedback:

- “_____ makes sense, but what do you mean when you say ... ?”
- “Can you describe that another way?”
- “How do you know ... ? What else do you know is true?”

Close the partner conversations, and give students 3–5 minutes to revise their first draft. Encourage students to incorporate any good ideas and words they got from their partners to make their next draft stronger and clearer.

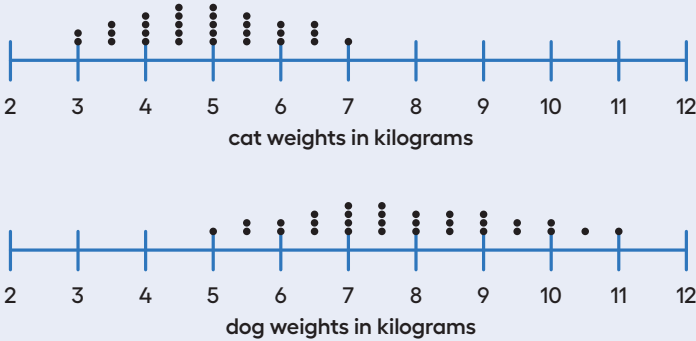


Display the dot plot and ask how students see the center and spread in the display.

Lesson Summary

One way to describe what is typical or characteristic for a data set is by looking at the **center** and **spread** of its distribution.

Let’s compare the distribution of cat weights and dog weights shown on these dot plots.



The collection of points for the cat data is further to the left on the number line than the dog data is. Based on the dot plots, we may describe the center of the distribution for cat weights to be between 4 and 5 kilograms and the center for dog weights to be between 7 and 8 kilograms.

We often say that values at or near the center of a distribution are typical for that group. This means that a weight of 4–5 kilograms is typical for a cat in the data set, and a weight of 7–8 kilograms is typical for a dog.

We also see that the dog weights are more spread out than the cat weights are. The difference between the heaviest and lightest cats is only 4 kilograms, but the difference between the heaviest and lightest dogs is 6 kilograms.

A distribution with greater spread tells us that the data have greater variability. In this case, we could say that the cats are more similar in their weights than the dogs are.

Student Workbook

5 Lesson Summary

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We also see that the dog weights are more spread out than the cat weights are. The difference between the heaviest and lightest cats is only 4 kilograms, but the difference between the heaviest and lightest dogs is 6 kilograms.

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Responding To Student Thinking

More Chances

Students will have more opportunities to understand the mathematical ideas addressed here. There is no need to slow down or add additional work to the next lessons.

Cool-down

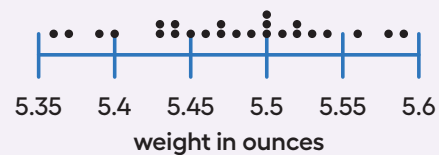
Packing Tomatoes

5
min

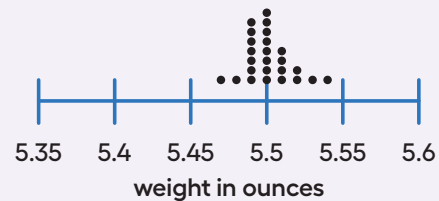
Student Task Statement

A farmer sells tomatoes in packages of ten. She would like the tomatoes in each package to all be about the same size and close to 5.5 ounces in weight. The farmer is considering two different tomato varieties: Variety A and Variety B. She weighs 25 tomatoes of each variety. These dot plots show her data.

Variety A



Variety B



1. What would be a good description for the center of the distribution of weights of Variety A tomatoes, in general? What about for the weight of Variety B tomatoes?

In general, Variety A tomatoes are about 5.49 ounces and Variety B tomatoes are about 5.5 ounces.

2. Which tomato variety should the farmer choose? Explain your reasoning.

She should choose Variety B.

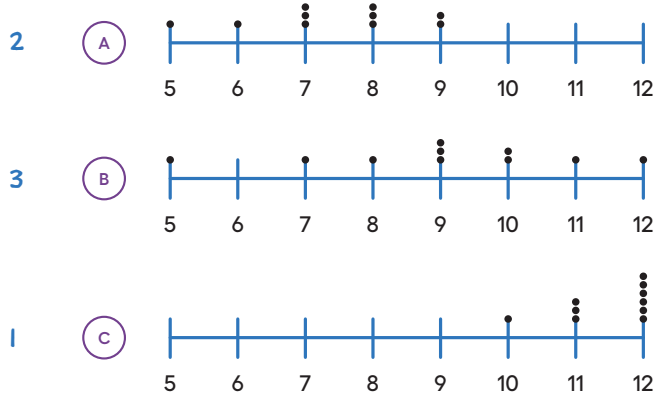
Sample reasoning: The two varieties of tomatoes have about the same center of their distributions, but there is much less variability in Variety B tomato weights. The weights are much more consistent than the weights for Variety A, so the tomatoes are more likely to be the same size and closer to 5.5 ounces in weight.

Practice Problems

4 Problems

Problem 1

Three sets of data about ten sixth-grade students were used to make three dot plots. The person who made these dot plots forgot to label them. Match each dot plot with the appropriate label.

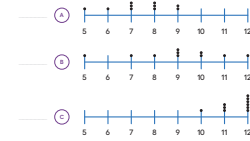


1. Ages in years
2. Numbers of hours of sleep on nights before school days
3. Numbers of hours of sleep on nights before non-school days

Student Workbook

LESSON 5
PRACTICE PROBLEMS

Three sets of data about ten sixth-grade students were used to make three dot plots. The person who made these dot plots forgot to label them. Match each dot plot with the appropriate label.



1. Ages in years
2. Numbers of hours of sleep on nights before school days
3. Numbers of hours of sleep on nights before non-school days

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GRADE 4 • UNIT 4 • SECTION 4 • LESSON 5

Student Workbook

Practice Problems

The dot plots show the time it takes to get to school for ten sixth-grade students from the United States, Canada, Australia, New Zealand, and South Africa.

United States

travel time in minutes

Canada

travel time in minutes

Australia

travel time in minutes

New Zealand

travel time in minutes

South Africa

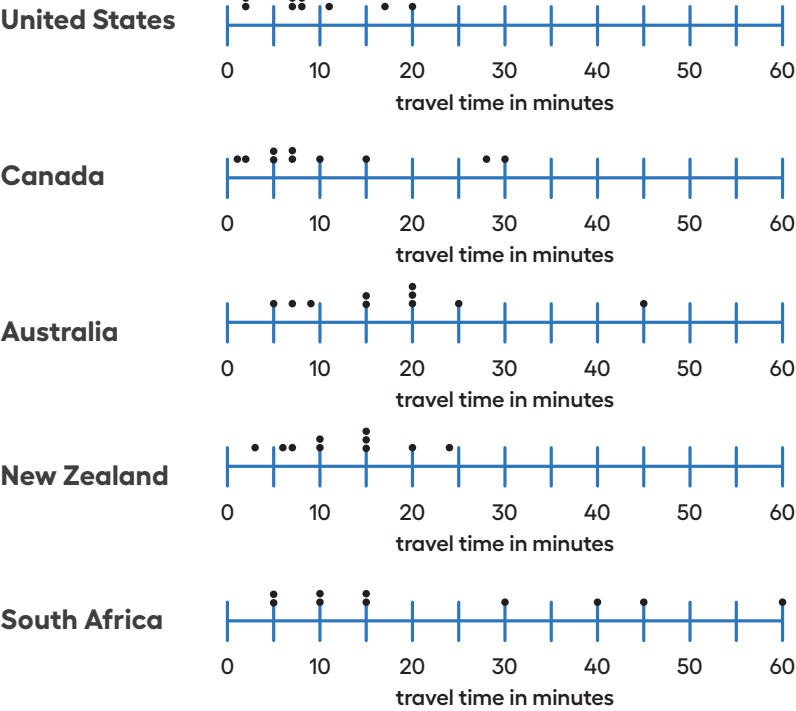
travel time in minutes

a. List the countries in order of the center of the distributions (means), from shortest to longest.

b. List the countries in order of the spread of the distributions (MAD), from the least variability to the greatest.

Problem 2

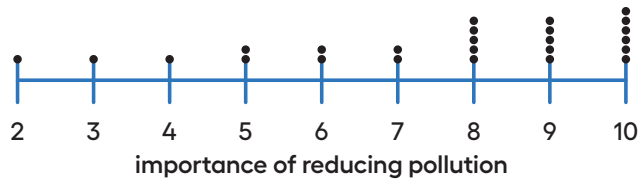
The dot plots show the time it takes to get to school for ten sixth-grade students from the United States, Canada, Australia, New Zealand, and South Africa.



- a. List the countries in order of the center of the distributions (means), from shortest to longest.
- U.S., Canada, New Zealand, Australia, South Africa
- The centers for Canada and New Zealand are close, so students may have trouble ordering them.
- b. List the countries in order of the spread of the distributions (MAD), from the least variability to the greatest.
- U.S., New Zealand, Australia, Canada, South Africa
- The spreads for the U.S. and New Zealand and the spreads for Canada and Australia are close, so students may have trouble ordering them.

Problem 3

Twenty-five students are asked to rate how important it is to reduce pollution on a scale of 0 to 10. A rating of 0 means “not at all important” and a rating of 10 means “very important.” Here is a dot plot of their responses.



Explain why a rating of 6 is not a good description of the center of this data set.

Sample response: Although 6 is halfway between the largest and the smallest numbers in the data set, most of the values in the data set are larger than 6. Only 7 of the 25 values are less than or equal to 6, but 20 of the data values are greater than or equal to 6.

Problem 4

from Unit 7, Lesson 10

Tyler wants to buy some cherries at the farmer’s market. He has \$10, and cherries cost \$4 per pound.

- a. If c is the number of pounds of cherries that Tyler can buy, write one or more inequalities or equations describing c .

Sample response: The inequality $c < 2.5$, or $c = 2.5$, says that Tyler cannot spend more than \$10 for the cherries. The inequality $c > 0$ means that Tyler actually buys some cherries.

- b. Can 2 be a value of c ? Can 3 be a value of c ? What about -1? Explain your reasoning.

Yes, 2 can be a solution because 2 pounds of cherries cost \$8. No, 3 could not be a solution because Tyler could not buy 3 pounds of cherries as they would cost \$12 and he has only \$10. No, -1 could not be a solution because it does not make sense for Tyler to buy -1 pounds of cherries.

- c. If m is the amount of money, in dollars, Tyler can spend, write one or more inequalities or equations describing m .

Sample response: $m < 10$ or $m = 10$ (Tyler can spend \$10 or less), and $m > 0$ (Tyler spends some money).

- d. Can 8 be a value of m ? Can 2 be a value of m ? What about 10.5? Explain your reasoning.

Yes, 8 and 2 can both be values of m . The value 8 means Tyler buys 2 pounds of cherries ($2 \cdot 4 = 8$), and 2 means he buys $\frac{1}{2}$ pound of cherries ($\frac{1}{2} \cdot 4 = 2$). No, 10.5 cannot be a value of m in this case. Even though 10.5 is greater than 0, m must also be 10 or less.

Student Workbook

Practice Problems

Twenty-five students are asked to rate how important it is to reduce pollution on a scale of 0 to 10. A rating of 0 means “not at all important” and a rating of 10 means “very important.” Here is a dot plot of their responses.

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From Unit 7, Lesson 10

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b. Can 2 be a value of c ? Can 3 be a value of c ? What about -1? Explain your reasoning.

GRADE 4 • UNIT 4 • SECTION 4 • LESSON 5

Student Workbook

Practice Problems

c. If m is the amount of money, in dollars, Tyler can spend, write one or more inequalities or equations describing m .

d. Can 8 be a value of m ? Can 2 be a value of m ? What about 10.5? Explain your reasoning.

Learning Targets

- I can use a dot plot to represent the distribution of a data set and answer questions about the real-world situation.
- I can use center and spread to describe data sets, including what is typical in a data set.

GRADE 4 • UNIT 4 • SECTION 4 • LESSON 5