Lesson 13

Median

Goals

- Comprehend that the "median" is another measure of center, which uses the middle of all the values in an ordered list to summarize the data.
- Identify and interpret the median of a data set given in a table or on a dot plot.
- Informally estimate the center of a data set and then compare (orally and in writing) the mean and median with this estimate.

Learning Targets

- I can find the median for a set of data.
- I can say what the median represents and what it tells us in a given context.

Lesson Narrative

In this lesson, students consider another measure of center, the **median**. They make use of the structure of the data set to see that the median partitions the data into two halves: One half of the values in the data set has that value or smaller values, and the other half has that value or larger. Students learn how to find the median for data sets with both an even and an odd number of values.

Students interpret the median of a distribution in context and recognize the difference in meaning between the median and mean of a distribution.

Student Learning Goal

Let's explore the median of a data set and what it tells us.

Access for Students with Diverse Abilities

- Representation (Activity 2)

Access for Multilingual Learners

- MLR1: Stronger and Clearer Each Time (Activity 1)

Instructional Routines

- MLR1: Stronger and Clearer Each Time

Required Materials

Materials to Gather

- Index cards: Lesson
- Index cards: Activity 2

Required Preparation

Lesson:
For the "Finding the Middle" activity, each student will need an index card.

Lesson Timeline

Warm-up	Activity 1	Activity 2	Lesson Synthesis	Assessment: Cool-down
5 min	15 min	15 min	10 min	5 min

Warm-up

The Plot of the Story

5 min

Activity Narrative

This *Warm-up* reinforces students' understanding about the relationship between the mean absolute deviation (MAD) and the spread of data. In the given scenarios, the number of people attending the two events and their mean age are the same, but the MADs are different. Students are asked to interpret these measures in context and then draw their own dot plot with given conditions.

As students work and discuss, identify several students who drew dot plots that correctly meet the criteria in the second question. Ask students with different dot plots to share during a whole-class discussion.

Students may need more time to make sense of how to generate their own dot plot for the second question. If it is not possible to give students additional time, consider presenting the second question at a different time.

Launch

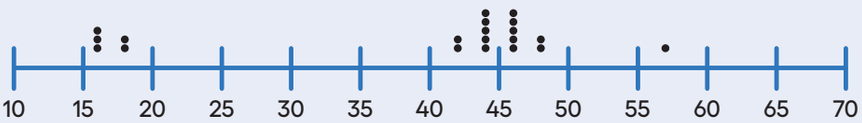
Arrange students in groups of 2. Give students 1 minute of quiet think time for the first question, and then 2–3 minutes to work on the second question with a partner. Display the following questions for all to see. Ask students to think about and discuss them before drawing their dot plots:

- *"How many data points should be on the dot plot?"*
- *"How would the mean help us place the data points?"*
- *"How would the MAD help us place the data points?"*
- *"How should our dot plot compare to the dot plots of Data sets A and B?"*

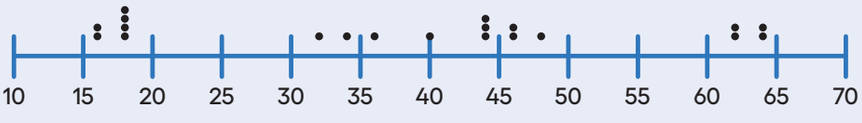
Student Task Statement

1. Here are two dot plots and two stories. Match each story with a dot plot that could represent it. Be prepared to explain your reasoning.

data set A

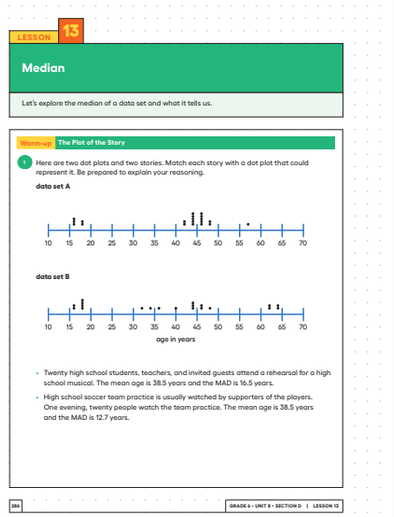


data set B



age in years

Student Workbook


LESSON 13

Median

Let's explore the median of a data set and what it tells us.

Warm-up The Plot of the Story

1. Here are two dot plots and two stories. Match each story with a dot plot that could represent it. Be prepared to explain your reasoning.

data set A

10 15 20 25 30 35 40 45 50 55 60 65 70

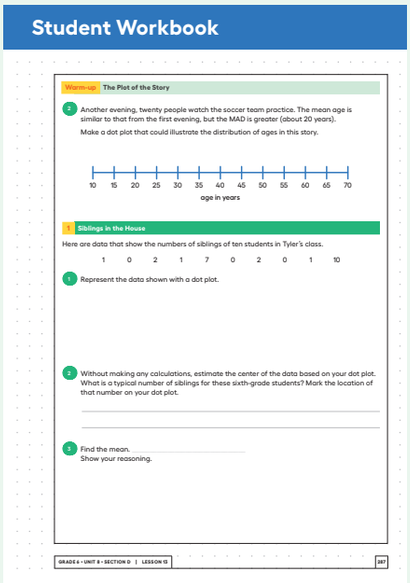
data set B

10 15 20 25 30 35 40 45 50 55 60 65 70

age in years

- Twenty high school students, teachers, and invited guests attend a rehearsal for a high school musical. The mean age is 38.5 years and the MAD is 16.5 years.
- High school soccer team practice is usually watched by supporters of the players. One evening, twenty people watch the team practice. The mean age is 38.5 years and the MAD is 12.7 years.

Student Workbook


Warm-up The Plot of the Story

2 Another evening, twenty people watch the soccer team practice. The mean age is similar to that from the first evening, but the MAD is greater (about 20 years).
Make a dot plot that could illustrate the distribution of ages in this story.

10 15 20 25 30 35 40 45 50 55 60 65 70
age in years

1 Siblings in the House

Here are data that show the numbers of siblings of ten students in Tyler's class.

1 0 2 1 7 0 2 0 1 10

1 Represent the data shown with a dot plot.

2 Without making any calculations, estimate the center of the data based on your dot plot. What is a typical number of siblings for these sixth-grade students? Mark the location of that number on your dot plot.

3 Find the mean.
Show your reasoning.

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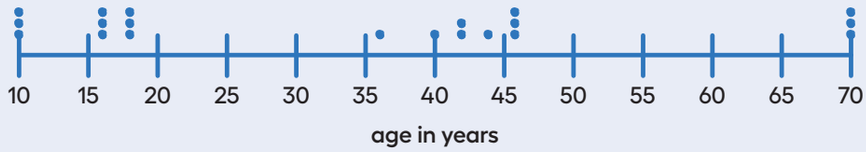
- Twenty high school students, teachers, and invited guests attend a rehearsal for a high school musical. The mean age is 38.5 years and the MAD is 16.5 years.
- High school soccer team practice is usually watched by supporters of the players. One evening, twenty people watch the team practice. The mean age is 38.5 years and the MAD is 12.7 years.

Data set A goes with the high-school soccer practice story. Data set B goes with the musical performance story. Sample explanation: The data points in data set B are more spread out, so the MAD for that data set would be larger.

2. Another evening, twenty people watch the soccer team practice. The mean age is similar to that from the first evening, but the MAD is greater (about 20 years).

Make a dot plot that could illustrate the distribution of ages in this story.

Sample dot plot:



Activity Synthesis

Invite students to share their response to the first question. Ask a student to explain how they matched one context to its dot plot and another student to explain the second matching context and dot plot. Record and display their responses for all to see. If possible, record their responses directly on the dot plots.

Ask selected students to share their dot plots for the second question and their reasoning. To involve more students in the conversation, consider asking some of the following questions:

- *"What was the first piece of information you used to draw your dot plot? Why?"*
- *"How did you decide where to place your dots?"*
- *"How is your dot plot the same or different from the one representing the first evening of soccer practice?"*
- *"Do you agree or disagree with this representation of the context? Why?"*
- *"Do you have any questions to ask the student who drew the dot plot?"*

Activity 1
Siblings in the House

15 min

Activity Narrative

The aim of this activity is to expose the limits of the mean in summarizing a data set that has gaps and values far from the center, and to motivate a need to have another measure of center. Students first use a table of values and a dot plot to estimate a typical value for a data set. Then they calculate the mean and notice that it does not lie near the center of the data. A closer look helps them see that when a data set contains values that are far away from the bulk of the data, or when there are gaps in the data set, the mean can be a little or a lot higher or lower than what we would consider typical for the data.

Launch

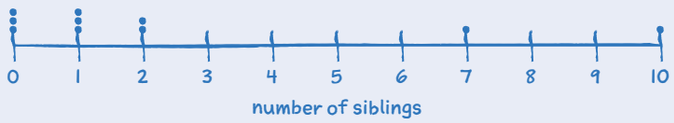
Arrange students in groups of 2. Give students 7–8 minutes of quiet work time and then 3–4 minutes to discuss their responses with a partner. If there are disagreements, ask them to discuss them until they reach agreement. Follow with a whole-class discussion.

Student Task Statement

Here are data that show the numbers of siblings of ten students in Tyler's class.

1 0 2 1 7 0 2 0 110

1. Represent the data shown with a dot plot.



2. Without making any calculations, estimate the center of the data based on your dot plot. What is a typical number of siblings for these sixth-grade students? Mark the location of that number on your dot plot.

Sample response: I'd estimate the center to be between 1 and 2 siblings.

3. Find the mean. Show your reasoning.

The mean is 2.4 siblings. $\frac{1+0+2+1+7+0+2+0+1+10}{10} = \frac{24}{10} = 2.4$

4. a. How does the mean compare to the value that you marked on the dot plot as a typical number of siblings? (Is it a little larger, a lot larger, exactly the same, a little smaller, or a lot smaller than your estimate?)

Sample response: The mean is a little larger than my estimate.

Instructional Routines

MLR1: Stronger and Clearer Each Time

ilclass.com/r/10695479

Please log in to the site before using the QR code or URL.

Access for Multilingual Learners (Activity 1)

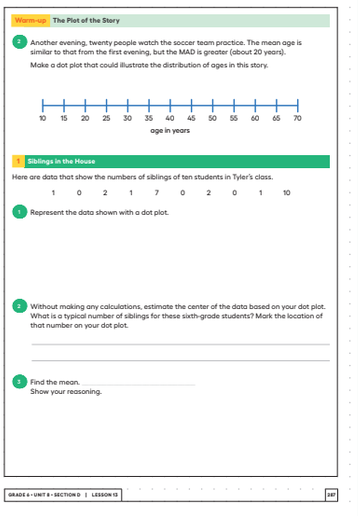
MLR1: Stronger and Clearer Each Time.

This activity uses the *Stronger and Clearer Each Time* math language routine to advance writing, speaking, and listening as students refine mathematical language and ideas.

Building on Student Thinking

Because previous lessons have used the mean as the best way to find a typical value, some students may go directly to that method from the beginning. Although this is valid at this stage, encourage them to look at the dot plot and think about what a typical value should be.

Student Workbook


Warm-up The Plot of the Story

2 Another evening, twenty people watch the soccer team practice. The mean age is similar to that from the first evening, but the MAD is greater (about 20 years). Make a dot plot that could illustrate the distribution of ages in this story.

10 15 20 25 30 35 40 45 50 55 60 65 70
age in years

1 Siblings in the House

Here are data that show the numbers of siblings of ten students in Tyler's class.

1 0 2 1 7 0 2 0 1 10

1 Represent the data shown with a dot plot.

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3 Find the mean. Show your reasoning.

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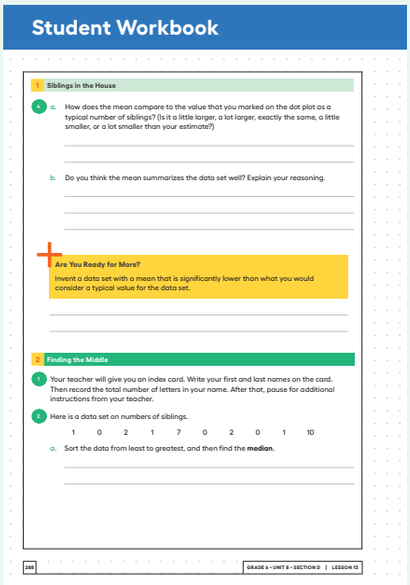
Student Workbook

1 Siblings in the House

a. How does the mean compare to the value that you marked on the dot plot as a typical number of siblings? (Is it a little larger, a lot larger, exactly the same, a little smaller, or a lot smaller than your estimate?)

b. Do you think the mean summarizes the data set well? Explain your reasoning.

Are You Ready for More?

Invent a data set with a mean that is significantly lower than what you would consider a typical value for the data set.

2 Finding the Middle

1. Your teacher will give you an index card. Write your first and last names on the card. Then record the total number of letters in your name. After that, pause for additional instructions from your teacher.
2. Here is a data set on numbers of siblings.

1 0 2 1 7 0 2 0 1 10

a. Sort the data from least to greatest, and then find the **median**.

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b. Do you think the mean summarizes the data set well? Explain your reasoning.

Sample response: I don't think the mean summarizes the data very well. Eight out of 10 of the data points are below the mean, and more than half of the students have either no siblings or only 1 sibling, so to say that 2.4 is a typical number of siblings is not accurate.

Are You Ready for More?

Invent a data set with a mean that is significantly lower than what you would consider a typical value for the data set.

Sample response: The data could have most values close to or equal to 8 and a small number of much lower values: 0, 0, 1, 7, 8, 8, 8, 9, 9, 10. The mean of this data set is 6, while we might say that 8 is typical.

Activity Synthesis

Select a few students to share their estimate for a typical number of siblings. Consider asking students:

- *"When you looked at the table of values, what was your sense of a typical number of siblings for the ten students in Tyler's class?"*

  Around 2 because most students have 0, 1, or 2 siblings, but there are a couple of students with a lot.

- *"When you looked at the dot plot, did your estimate change?"*

  It was easier to see where most of the data are.

Use *Stronger and Clearer Each Time* to give students an opportunity to revise and refine their response to "Do you think the mean summarizes the data set well?" 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.

After *Stronger and Clearer Each Time*, discuss how the calculated mean compared to their estimates. Draw students' attention to the idea that the mean may not always represent a typical value for a data set. Discuss:

- *"We have learned that the mean is a way to measure the center of a distribution. How did your calculated mean compare to your estimate of what was typical for the data set?"*

  The mean is greater than my estimate for a typical value.

"*Why do you think the mean was higher than your estimate?*"

Only two of the points are above the mean of 2.4 and both are quite far above it, and seven points are below 2.4, so the mean might not paint an accurate picture of what is typical in this situation.

"*If the mean does not always reflect what is typical in a data set, should we always rely on it as the best way to describe the center? If not, in what other ways might we measure the center of a data set?*"

Maybe we could look for the most common values or pick a number close to where most of the data are.

Activity 2

Finding the Middle

15 min

Activity Narrative

This activity introduces students to the term **median.** They learn that the median describes the middle value in an ordered list of data, and that it can capture what we consider typical for the data in some cases.

Students learn about the median through a kinesthetic activity. They line up in order of the number of letters in their name. Then, those at both ends of the line count off and sit down simultaneously until one or two people in the middle remain standing. If one person remains standing, that person has the median number of letters. If two people remain standing, the median is the mean or the average of their two values.

Students then practice identifying the median of other data sets, by analyzing both tables of values and dot plots.

Launch

Explain to students that, instead of using the mean, sometimes we use the middle value in an ordered list of data set as a measure of center. We call this the median. Guide students through the activity:

- Give each student an index card. Ask them to write their first and last names on the card and record the total number of letters in their name. Display an example for all to see.
- Ask students to stand up, holding their index cards in front of them, and arrange themselves in order based on the number of letters in their name. (Consider asking students to do so without speaking at all to encourage collaboration.) Look for the student whose name has the fewest letters and ask that student to be the left end of the line. Ask the student with the longest full name to be the right end of the line. Students who have the same number of letters should stand side-by-side.
- Tell students that, to find the median or the middle number, we will count off from both ends at the same time. Ask the students at the two ends of the line say "1" at the same time and then to sit on the floor, and the students next to them to say "2" and then to sit down, and so on. Have students count off in this fashion until only one or two students are standing.

Access for Students with Diverse Abilities (Activity 2, Student Task)

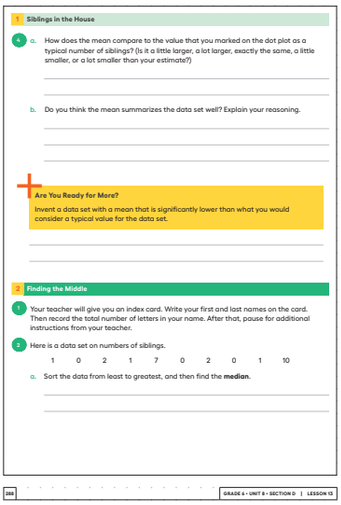
Representation: Develop Language and Symbols.
Maintain a display of important terms and vocabulary. Invite students to suggest language or diagrams to include that will support their understanding of distributions. Terms may include "median."

Supports accessibility for: Conceptual Processing, Language

Building on Student Thinking

When determining the median, students might group multiple data points that have the same value and treat it as a single point, instead of counting each one separately. Remind them that when they lined up to find the median number of letters in their names, every student counted off, even if their name had the same number of letters as their neighbor's name.

Student Workbook


1 Siblings in the House

a. How does the mean compare to the value that you marked on the dot plot as a typical number of siblings? (Is it a little larger, a lot larger, exactly the same, a little smaller, or a lot smaller than your estimate?)

b. Do you think the mean summarizes the data set well? Explain your reasoning.

Are You Ready for More?

Invent a data set with a mean that is significantly lower than what you would consider a typical value for the data set.

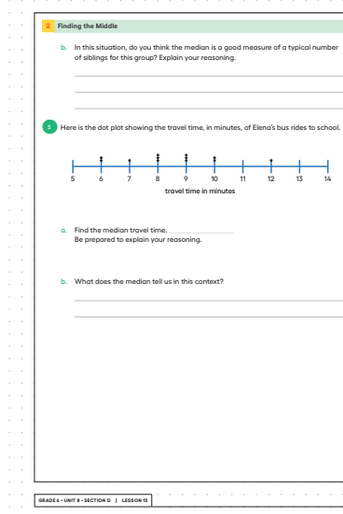
2 Finding the Middle

1. Your teacher will give you an index card. Write your first and last names on the card. Then record the total number of letters in your name. After that, pause for additional instructions from your teacher.
2. Here is a data set on numbers of siblings.

1 0 2 1 7 0 2 0 1 10

a. Sort the data from least to greatest, and then find the **median.**

Student Workbook


2 Finding the Middle

b. In this situation, do you think the median is a good measure of a typical number of siblings for this group? Explain your reasoning.

3. Here is the dot plot showing the travel time, in minutes, of Elena's bus rides to school.

5 6 7 8 9 10 11 12 13 14

travel time in minutes

a. Find the median travel time. _____
Be prepared to explain your reasoning.

b. What does the median tell us in this context?

- If the class has an odd number of students, one student will remain standing. Tell the class that this student's number is the median. Give this student a sign that says "median" If the class has an even number of students, two students will remain standing. The median will be the mean, or average, of their numbers. Ask both students to hold the sign that says "median."
- Explain that the median is the value that divides the data into 2 halves. Half of the data values are the same size or less than it and fall to the left of it on the number line, and half are the same size or greater than it and fall to the right.
- Ask students to find the median a couple more times by changing the data set (for example, ask a few students to leave the line or adding new people who are not members of the class with extremely long or short names). Make sure that students have a chance to work with both odd and even numbers of values.
- Collect the index cards and save them because they will be used again in the lesson on box plots.

Ask students to complete the rest of the questions on the task statement.

Student Task Statement

1. Your teacher will give you an index card. Write your first and last names on the card. Then record the total number of letters in your name. After that, pause for additional instructions from your teacher.

No answer required.

2. Here is a data set on numbers of siblings.

1 0 2 1 7 0 2 0 1 10

a. Sort the data from least to greatest, and then find the **median.**

The numbers of siblings in order: 0, 0, 0, 1, 1, 1, 2, 2, 7, 10 has median 1. The median is the average of the fifth and sixth values.

b. In this situation, do you think the median is a good measure of a typical number of siblings for this group? Explain your reasoning.

Sample response: Yes, I think the median is a good measure, because 1 sibling is in the middle of where most of the points in the data set are. Almost a third of the students have 1 sibling.

3. Here is the dot plot showing the travel time, in minutes, of Elena's bus rides to school.

a. Find the median travel time. Be prepared to explain your reasoning.

The median length of travel is 8.5 minutes. It is the average of the sixth and seventh data points, which are 8 and 9 minutes.

b. What does the median tell us in this context?

Sample response: The median tells that half of her trips to school took 8.5 minutes or less and the other half took 8.5 minutes or more.

Activity Synthesis

Select a few students to share their responses to the questions about number of siblings and Elena's travel times. Focus the discussion on the median as another measure of the center of a data set and whether it captures what students would estimate to be a typical value for each data set.

Emphasize to students that the median is a value and not an individual. For example, if the last person standing in the class has 10 letters in their name, the median is the number 10 and not the person standing. If there is another student who has 10 letters in their name, they might have switched places with the last person standing when lining up initially. Although the person standing could change, the median remains the same value of 10.

At this point, it is unnecessary to compare the mean and the median. Students will have many more opportunities to explore the median and think about how it differs from the mean in the upcoming activities.

Lesson Synthesis

In this lesson, we learn about another measure of center called the **median.** The discussion should focus on what the median is, how to find it, and why it is useful.

- *"What is the median?"*

  The number in the middle of an ordered list of data.

- *"How can we find it?"*

  We order the data values from least to greatest and find the value in the middle.

- *"Is the median always one of the values in the data set? If not, when is it not?"*

  No. When the number of values in a data set is even, there will be two middle values. The median is the number exactly between them which may not be a value in the data set.

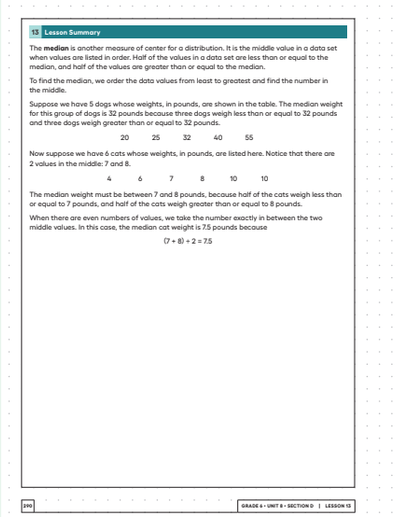
- *"What does the median tell you about a data set? Why is it used as a measure of the center of a distribution?"*

  It tells us where to divide a data set so that half of the data points have that value or smaller values and the other half have that value or larger.

- *"Why do we need another measure of center other than the mean?"*

  Sometimes the mean is not a good indication of what is typical for the data set.

Student Workbook



13 Lesson Summary

The **median** is another measure of center for a distribution. It is the middle value in a data set when values are listed in order. Half of the values in a data set are less than or equal to the median, and half of the values are greater than or equal to the median.

To find the median, we order the data values from least to greatest and find the number in the middle.

Suppose we have 5 dogs whose weights, in pounds, are shown in the table. The median weight for this group of dogs is 32 pounds because three dogs weigh less than or equal to 32 pounds and three dogs weigh greater than or equal to 32 pounds.

20 25 32 40 55

Now suppose we have 6 cats whose weights, in pounds, are listed here. Notice that there are 2 values in the middle: 7 and 8.

4 6 7 8 10 10

The median weight must be between 7 and 8 pounds, because half of the cats weigh less than or equal to 7 pounds, and half of the cats weigh greater than or equal to 8 pounds.

When there are even numbers of values, we take the number exactly in between the two middle values. In this case, the median cat weight is 7.5 pounds because

$(7 + 8) \div 2 = 7.5$

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.

Lesson Summary

The **median** is another measure of center for a distribution. It is the middle value in a data set when values are listed in order. Half of the values in a data set are less than or equal to the median, and half of the values are greater than or equal to the median.

To find the median, we order the data values from least to greatest and find the number in the middle.

Suppose we have 5 dogs whose weights, in pounds, are shown in the table. The median weight for this group of dogs is 32 pounds because three dogs weigh less than or equal to 32 pounds and three dogs weigh greater than or equal to 32 pounds.

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When there are even numbers of values, we take the number exactly in between the two middle values. In this case, the median cat weight is 7.5 pounds because

$(7 + 8) \div 2 = 7.5$

Cool-down

Practicing the Piano

5 min

Student Task Statement

Jada and Diego are practicing the piano for an upcoming rehearsal. The number of minutes each of them practiced in the past few weeks are listed.

Jada's practice times:

10 10 20 15 25 25 8 15 20 20 35 25 40

Diego's practice times:

25 10 15 30 15 20 20 25 30 45

1. Find the median of each data set.

   Jada's median: 20 minutes
   Diego's median: 22.5 minutes

2. Explain what the medians tell you about Jada's and Diego's piano practice.

   Sample response: Half of Jada's practices are 20 minutes or shorter and the other half of her practices are 20 minutes or longer. Half of Diego's practices are 22.5 minutes or shorter, and the other half are 22.5 minutes or longer.

Lesson 13

Practice Problems

6 Problems

Problem 1

Here are data that show a student's scores for 10 rounds of a video game.

130 150 120 170 130 120 160 160 190 140

What is the median score?

A. 125 **B.** 145 **C.** 147 **D.** 150

Problem 2

When he sorts the class's scores on the last test, the teacher notices that exactly 12 students scored better than Clare and exactly 12 students scored worse than Clare. Does this mean that Clare's score on the test is the median? Explain your reasoning.

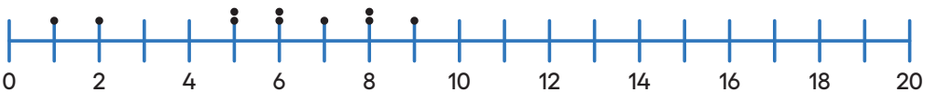
Yes

There are 25 students in the class, and Clare's score was exactly in the middle, so her score is the median.

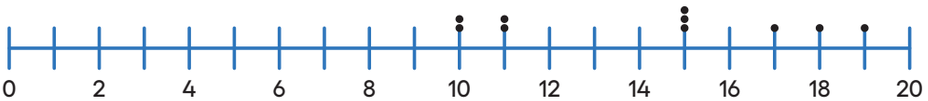
Problem 3

The medians of the following dot plots are 6, 12, 13, and 15, but not in that order. Match each dot plot with its median.

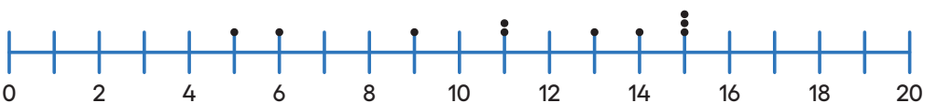
dot plot 1 6



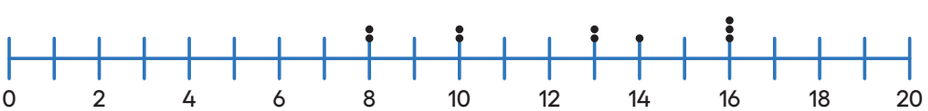
dot plot 2 15



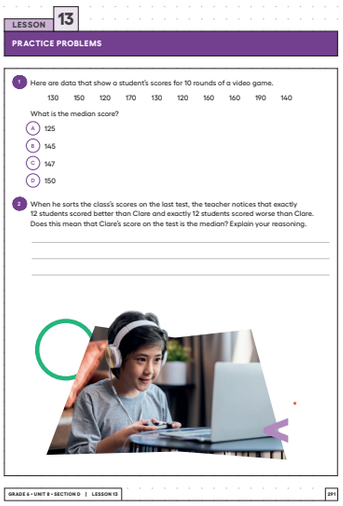
dot plot 3 12



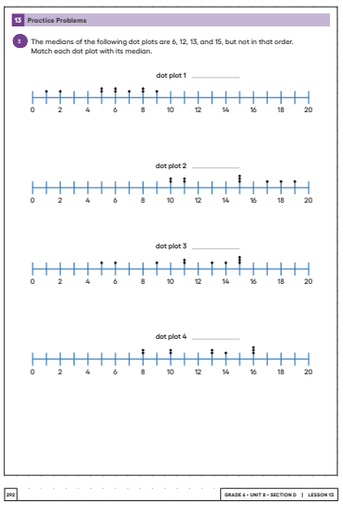
dot plot 4 13



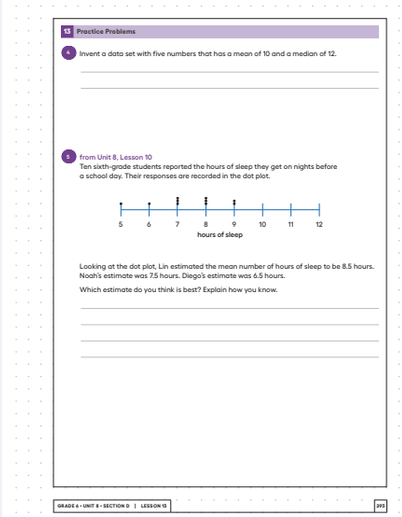
Student Workbook


LESSON 13
PRACTICE PROBLEMS
1 Here are data that show a student's scores for 10 rounds of a video game.
130 150 120 170 130 120 160 160 190 140
What is the median score?
A 125
B 145
C 147
D 150
2 When he sorts the class's scores on the last test, the teacher notices that exactly 12 students scored better than Clare and exactly 12 students scored worse than Clare. Does this mean that Clare's score on the test is the median? Explain your reasoning.

Student Workbook


13 Practice Problems
3 The medians of the following dot plots are 6, 12, 13, and 15, but not in that order. Match each dot plot with its median.
dot plot 1
dot plot 2
dot plot 3
dot plot 4
0 2 4 6 8 10 12 14 16 18 20

Student Workbook


13 Practice Problems

4 Invent a data set with five numbers that has a mean of 10 and a median of 12.

5 from Unit 8, Lesson 10
Ten sixth-grade students reported the hours of sleep they get on nights before a school day. Their responses are recorded in the dot plot.

5 6 7 8 9 10 11 12
hours of sleep

Looking at the dot plot, Lin estimated the mean number of hours of sleep to be 8.5 hours. Noah's estimate was 7.5 hours. Diego's estimate was 6.5 hours.

Which estimate do you think is best? Explain how you know.

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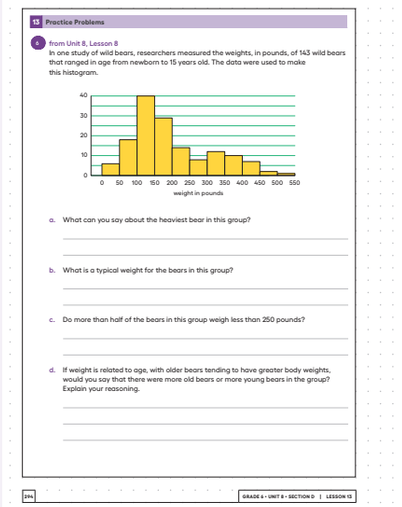
Student Workbook


13 Practice Problems

6 from Unit 8, Lesson 8
In one study of wild bears, researchers measured the weights, in pounds, of 143 wild bears that ranged in age from newborn to 15 years old. The data were used to make this histogram.

40 30 20 10 0
0 50 100 150 200 250 300 350 400 450 500 550
weight in pounds

a. What can you say about the heaviest bear in this group?

b. What is a typical weight for the bears in this group?

c. Do more than half of the bears in this group weigh less than 250 pounds?

d. If weight is related to age, with older bears tending to have greater body weights, would you say that there were more old bears or more young bears in the group? Explain your reasoning.

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Problem 4

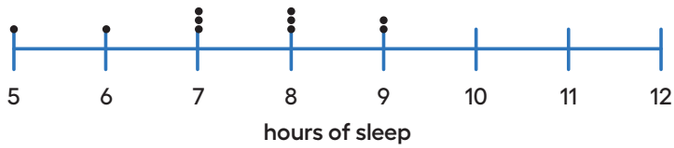
Invent a data set with five numbers that has a mean of 10 and a median of 12.

Sample response: 1, 11, 12, 13, 13

Problem 5

from Unit 8, Lesson 10

Ten sixth-grade students reported the hours of sleep they get on nights before a school day. Their responses are recorded in the dot plot.



Looking at the dot plot, Lin estimated the mean number of hours of sleep to be 8.5 hours. Noah's estimate was 7.5 hours. Diego's estimate was 6.5 hours.

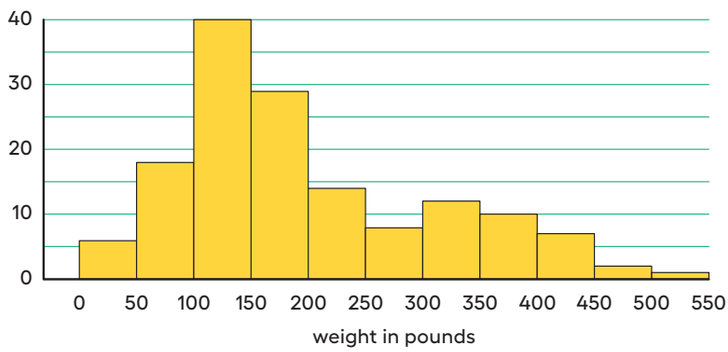
Which estimate do you think is best? Explain how you know.

Noah's estimate of 7.5 hours is best. Sample explanation: It is a better balance point for the data, balancing the distances to the left and to the right.

Problem 6

from Unit 8, Lesson 8

In one study of wild bears, researchers measured the weights, in pounds, of 143 wild bears that ranged in age from newborn to 15 years old. The data were used to make this histogram.



a. What can you say about the heaviest bear in this group?

The heaviest bear had a weight between 500 and 550 pounds.

b. What is a typical weight for the bears in this group?

About 200 pounds

c. Do more than half of the bears in this group weigh less than 250 pounds?

Yes

d. If weight is related to age, with older bears tending to have greater body weights, would you say that there were more old bears or more young bears in the group? Explain your reasoning.

More young bears. There are more bears with smaller weights than larger weights, so there are probably more young bears in the group.