LESSON 16.2 Mean Absolute Deviation

? **ESSENTIAL QUESTION**

How can you determine and use the mean absolute deviation of a set of data points?

EXPLORE ACTIVITY *Real World*　　**COMMON CORE** 6.SP.5c

Understanding Mean Absolute Deviation

A **measure of variability** is a single number used to describe the spread of a data set. It can also be called a measure of spread. One measure of variability is the **mean absolute deviation (MAD)**, which is the mean of the distances between the data values and the mean of the data set.

The data represent the height, in feet, of various buildings. Find the mean absolute deviation for each data set.

A 60, 58, 54, 56, 63, 65, 62, 59, 56, 58

Calculate the mean. Round to the nearest whole number.

Complete the table.

Height (ft)	60	58	54	56	63	65	62	59	56	58
Distance from mean										

Calculate the MAD by finding the mean of the values in the second row of the table. Round to the nearest whole number.

B 46, 47, 56, 48, 46, 52, 57, 52, 45

Find the mean. Round to the nearest whole number.

EXPLORE ACTIVITY *(cont'd)*

Complete the table.

Height (ft)	46	47	56	48	46	52	57	52	45
Distance from mean									

Calculate the MAD. Round to the nearest whole number.

> **Math Talk**
> **Mathematical Practices**
> What is the difference between a measure of center and a measure of variability?

Reflect

1. **Analyze Relationships** Compare the MADs. How do the MADs describe the distribution of the heights in each group?

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Using Mean Absolute Deviation

The mean absolute deviation can be used to answer statistical questions in the real world. Many of these questions may have implications for the operation of various businesses.

EXAMPLE 1 *Real World*   **COMMON CORE** 6.SP.5c

A chicken farmer wants her chickens to all have about the same weight. She is trying two types of feed to see which type produces the best results. All the chickens in Pen A are fed Premium Growth feed, and all the chickens in Pen B are fed Maximum Growth feed. The farmer records the weights of the chickens in each pen in the tables below. Which chicken feed produces less variability in weight?

Pen A: Premium Growth Weights (lb)									
5.8	6.1	5.5	6.6	7.3	5.9	6.3	5.7	6.8	7.1

Pen B: Maximum Growth Weights (lb)									
7.7	7.4	5.4	7.8	6.1	5.2	7.5	7.9	6.3	5.6

STEP 1 Find the mean weight of the chickens in each pen. Round your answers to the nearest tenth.

Pen A: $\dfrac{5.8 + 6.1 + 5.5 + 6.6 + 7.3 + 5.9 + 6.3 + 5.7 + 6.8 + 7.1}{10} \approx 6.3$

Pen B: $\dfrac{7.7 + 7.4 + 5.4 + 7.8 + 6.1 + 5.2 + 7.5 + 7.9 + 6.3 + 5.6}{10} \approx 6.7$

STEP 2 Find the distance from the mean for each of the weights.

The distances from the mean for Pen A are the distance of each weight from 6.3 lb.

Pen A: Premium Growth										
Weight (lb)	5.8	6.1	5.5	6.6	7.3	5.9	6.3	5.7	6.8	7.1
Distance from mean	0.5	0.2	0.8	0.3	1.0	0.4	0	0.6	0.5	0.8

The distances from the mean for Pen B are the distance of each weight from 6.7 lb.

Pen B: Maximum Growth										
Weight (lb)	7.7	7.4	5.4	7.8	6.1	5.2	7.5	7.9	6.3	5.6
Distance from mean	1.0	0.7	1.3	1.1	0.6	1.5	0.8	1.2	0.4	1.1

STEP 3 Calculate the MAD for the chickens in each pen. Round your answers to the nearest tenth.

Pen A: $\dfrac{0.5 + 0.2 + 0.8 + 0.3 + 1.0 + 0.4 + 0 + 0.6 + 0.5 + 0.8}{10} \approx 0.5$ lb

Pen B: $\dfrac{1.0 + 0.7 + 1.3 + 1.1 + 0.6 + 1.5 + 0.8 + 1.2 + 0.4 + 1.1}{10} \approx 1.0$ lb

Since Pen A's MAD is less, Premium Growth feed produces less variability in weight.
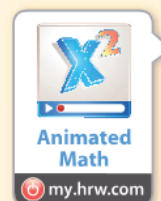
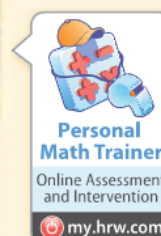**Math Talk**
Mathematical Practices

Will a smaller mean always signal less variability?

YOUR TURN

2. Two waiters at a cafe each served 10 large fruit smoothies. The amount in each large smoothie is shown below. Which waiter's smoothies showed less variability?

Amounts in Waiter A's Large Smoothies (oz)									
19.1	20.1	20.9	19.6	20.9	19.5	19.2	19.4	20.3	20.9

Amounts in Waiter B's Large Smoothies (oz)									
20.1	19.6	20.0	20.5	19.8	20.0	20.1	19.7	19.9	20.4

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Using a Spreadsheet to Find MAD

Spreadsheets can be used to find the mean absolute deviation of a data set.

EXAMPLE 2 Real World   COMMON CORE **6.SP.5c**

A paper mill is testing two paper-cutting machines. Both are set to produce pieces of paper with a width of 8.5 inches. The actual widths of 8 pieces of paper cut by each machine are shown. Use a spreadsheet to determine which machine has less variability and, thus, does a better job.

Widths of Pieces of Paper Cut by Machine A (in.)							
8.502	8.508	8.499	8.501	8.492	8.511	8.505	8.491

Widths of Pieces of Paper Cut by Machine B (in.)							
8.503	8.501	8.498	8.499	8.498	8.504	8.496	8.502

STEP 1 Enter the data values for Machine A into row 1 of a spreadsheet, using cells A to H.

	A	B	C	D	E	F	G	H
1	8.502	8.508	8.499	8.501	8.492	8.511	8.505	8.491
2								
3								

STEP 2 Enter "mean =" into cell A2 and the formula =AVERAGE(A1:H1) into cell B2.

	A	B	C	D	E	F	G	H
1	8.502	8.508	8.499	8.501	8.492	8.511	8.505	8.491
2	mean =	8.501125						
3								

STEP 3 Enter "MAD =" into cell A3 and the formula =AVEDEV(A1:H1) into cell B3.

	A	B	C	D	E	F	G	H
1	8.502	8.508	8.499	8.501	8.492	8.511	8.505	8.491
2	mean =	8.501125						
3	MAD =	0.005375						

The MAD for Machine A is about 0.0054 in.

STEP 4 Repeat Steps 1–3 with the data values for Machine B.

|	A	B	C	D	E	F	G	H
1	8.503	8.501	8.498	8.499	8.498	8.504	8.496	8.502
2	mean =	8.500125						
3	MAD =	0.002375						

The MAD for Machine B is about 0.0024 in.

Machine B has less variability, so it does a better job.

YOUR TURN

3. Two aspirin-making devices are set to make tablets containing 0.35 gram of aspirin. The actual amounts in 8 tablets from each device are shown. Use a spreadsheet to determine which device has less variability.

Amounts of Aspirin in Tablets Made by Device A (g)							
0.353	0.351	0.350	0.352	0.349	0.348	0.350	0.346

Amounts of Aspirin in Tablets Made by Device B (g)							
0.349	0.341	0.347	0.358	0.359	0.354	0.339	0.343

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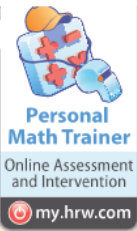
Guided Practice

1. A bus route takes about 45 minutes. The company's goal is a MAD of less than 0.5 minute. One driver's times for 9 runs of the route are shown. Did the bus driver meet the goal? (Explore Activity and Example 1)

Times to Complete Bus Route (min)								
44.2	44.9	46.1	45.8	44.7	45.2	45.1	45.3	44.6

   a. Calculate the mean of the bus times. _____

   b. Calculate the MAD to the nearest tenth. _____

   The bus driver [did / did not] meet the company's goal.

2. Below are a different driver's times on the same route. Find the mean and the MAD using a spreadsheet. Enter the data values into row 1 using cells A to I. Enter "mean = " into cell A2 and "MAD =" into cell A3. (Example 2)

Times to Complete Bus Route (min)								
44.4	43.8	45.6	45.9	44.1	45.6	44.0	44.9	45.8

   The mean is _____ minutes, and the MAD is _____ minutes.

   This time, the bus driver [did / did not] meet the company's goal.

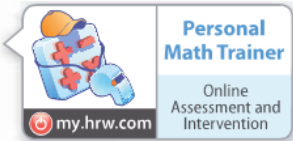**? ESSENTIAL QUESTION CHECK-IN**

3. What is the mean absolute deviation and what does it tell you about data sets?

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Name _____   Class _____   Date _____

16.2 Independent Practice

COMMON CORE 6.SP.5c

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Frank wants to know how many people live in each household in his town. He conducts a random survey of 10 people and asks how many people live in their household. His results are shown in the table.

Number of People per Household									
1	6	2	4	4	3	5	5	2	8

4. Calculate the mean number of people per household. _____

5. Calculate the MAD of the number of people per household. _____

6. What conclusions can you draw about the "typical" number of people in each household? Explain.

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Teachers are being trained to standardize the scores they give to students' essays. The same essay was scored by 10 different teachers at the beginning and at the end of their training. The results are shown in the tables.

Scores for Essay at Beginning of Teachers' Training									
76	81	85	79	89	86	84	80	88	79

Scores for Essay at End of Teachers' Training									
79	82	84	81	77	85	82	80	78	83

7. Calculate the MADs for the teachers' scores. Did the teachers make progress in standardizing their scores?

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8. **What If?** What would it mean if the teachers had a MAD of 0?

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The annual rainfall for Austin, Texas, and San Antonio, Texas, in each of the years from 2002 to 2011 are shown in the tables. Use the data for 9–11.

Annual Rainfall for Austin, Texas (in.)									
36.00	21.41	52.27	22.33	34.70	46.95	16.07	31.38	37.76	19.68

Annual Rainfall for San Antonio, Texas (in.)									
46.27	28.45	45.32	16.54	21.34	47.25	13.76	30.69	37.39	17.58

9. Use a spreadsheet to find the mean for the two cities' annual rainfalls. In which city does it rain more in a year, on average?

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10. Use your spreadsheet to find the MADs. Use the MADs to compare the distribution of annual rainfall for the two cities.

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11. **Make a Conjecture** Does the information allow you to predict how the future amounts of rainfall for the two cities will compare? Explain.

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12. **Critical Thinking** The life spans of 10 adult mayflies have a mean of 4 hours and a MAD of 2 hours. Fill in the table with possible values for the life spans. You can use the same value more than once.

Life Spans of Ten Mayflies (h)									

Can any one of the 10 mayflies in the group live for 1 full day? Justify your answer.

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H.O.T. FOCUS ON HIGHER ORDER THINKING

13. Multistep In a spreadsheet, before entering any data values, first enter "mean =" into cell A2 and the formula =AVERAGE(A1:J1) into cell B2. Next, enter "MAD =" into cell A3 and the formula =AVEDEV(A1:J1) into cell B3. You should see #DIV/0! in cell B2 and #NUM! in cell B3 as shown. Now do the following:

	A	B
1		
2	mean =	#DIV/0!
3	MAD =	#NUM!

a. Enter "1" into cell A1. What do you get for the mean and the MAD of the data set? Explain why this makes sense.

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b. Enter "2" into cell B1. What do you get for the mean and the MAD of the data set this time? Explain why this makes sense.

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c. Enter the numbers 3 through 10 into cells C1 to J1 and watch the mean and the MAD change. Do they increase, decrease, or stay the same? Explain why this makes sense.

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14. Make a Conjecture Each of the values in a data set is increased by 10. Does this affect the MAD of the data set? Why or why not?

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15. What If? Suppose a data set contains all whole numbers. Would the MAD for the data set also be a whole number? Explain.

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