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## 1.3.2 Quiz: Mean, Median and Middle Income

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### Question 1

1/1 point (graded)

Suppose the number of hours spent on the first section of this course by 10 students is as follows:

$\{3, 4, 2, 5, 8, 6, 10, 7, 20, 7\}$

What is the mean number of hours spent by these students? (Round your answer to the nearest tenth)

✓ Answer: 7.2

7.2

#### Explanation

The mean is the average – the total number of hours spent divided by the total number of students. In this case it is:

$$(3 + 4 + 2 + 5 + 8 + 6 + 10 + 7 + 20 + 7)/10 = 72/10 \\ = 7.2$$

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You have used 1 of 3 attempts

**i** Answers are displayed within the problem

### Question 2

1/1 point (graded)

Suppose the number of hours spent on the first section of this course by 10 students is as follows:

$\{3, 4, 2, 5, 8, 6, 10, 7, 20, 7\}.$

What is the median number of hours spent by these students? (Round to the nearest tenth)

✓ Answer: 6.5

6.5

**Explanation**

To find the median, we sort the number of hours spent by size and then find the value in the middle:

**3, 4, 2, 5, 8, 6, 10, 7, 20, 7**  $\longrightarrow$  **2, 3, 4, 5, 6, 7, 7, 8, 10, 20.**

The middle numbers are **6** and **7**. Their average is **6.5**, so the median is **6.5**.

Notice that if the student who spent 20 hours (an outlier) had not taken the class, the median number of hours spent would be **6** while the mean number of hours spent would instead be  $5\frac{2}{3}$ . The mean is more affected by outliers and thus changes more than the median here.

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**Question 3**

1/1 point (graded)

The mean is not usually a number in the set of data. What about the median? Choose the best answer.

- ☐ The median is always one of the data points in the data set.
- ☒ If there is an odd number of data points, the median is always one of those data points. ✓
- ☐ If there is an even number of data points, the median is always one of those data points.
- ☐ The median is never one of the data points in the set.

**Explanation**

If there is an odd number of data points in a set, the median is the middle data point and so the median is in the set. If there is an even number of data points in the set, the median is the average of the middle two data points and may or may not be in the set.

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You have used 1 of 2 attempts

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**Question 4**

1/1 point (graded)

As Nina remarked, the mean and median for the household income sample were very different. The mean was about \$79000/year, while the median was about \$58000/year. Which best explains the discrepancy in these numbers? Choose the best explanation.

- ☐ The data are a sample of the total population. If we looked at the mean of all households it would equal the median of all households.
- ☒ There may be some households with very large incomes and this makes the mean of the data much higher than the median. ✓
- ☐ There may be some households with very small incomes and this makes the mean of the data much larger than the median.
- ☐ The average household is upper middle income, not middle income.
- ☐ None of the above.

### Explanation

We hope that the data are a representative sample of the population, and that the mean of the data is close to the mean income of all households.

We know that outliers (like the 20 in the example of hours spent) can result in a difference between mean and median. From our histogram we see that there are no outlying household incomes on the left; they'd have to be negative or zero, which we excluded from the sample. However, there are a few incomes above \$450,000/year on the left. These values have a large effect on the mean of the data but do not greatly affect the median. The households with very large incomes make the mean of the data much higher than the median.

As our goal is to define "middle income", choice 4, an explanation which uses this term, is not very helpful.

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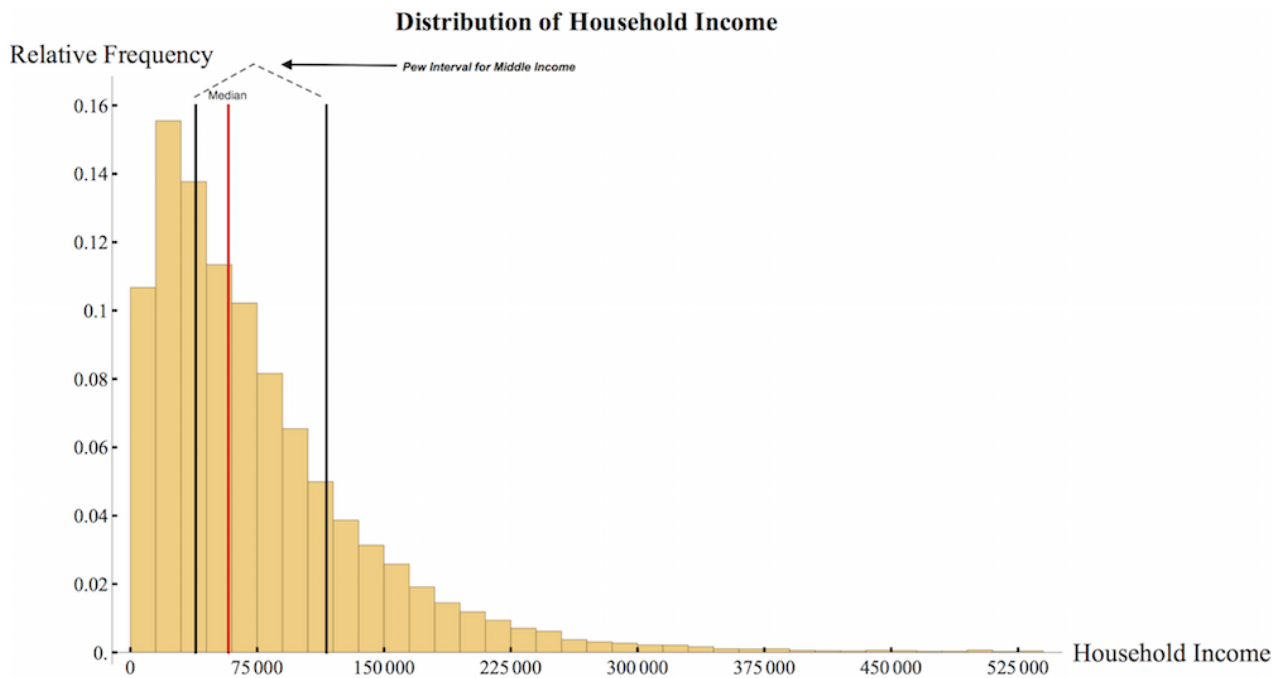
You have used 1 of 3 attempts

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## Question 5: Think About It...

1/1 point (graded)

The Pew Research Center wanted to look at how the fraction of adults living in middle-income households changed over time. Why did it not make sense to define middle income as the range between the first and third quartiles of the income distribution?



[View Larger Image](#)

Image Description

The range may be high due to outliers.



Thank you for your response.

### Explanation

The range between the first and third quartile always contains half of the data, because the first quartile cuts the data at the 25% mark and the third cuts the data at the 75% mark. So the fraction of households with income in that range would always be 0.5 (50%).

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## Question 6

1/1 point (graded)

Recall the Pew Research Center definition of middle income:

$$\left( \frac{2}{3} \cdot \text{Median}, 2 \cdot \text{Median} \right).$$

How large is the middle-income range, using the median for our sample of household data from the 2014 survey, which is \$58,003? Round your answer to the nearest dollar.

Size of the range:

✓ Answer: 77337

dollars

The middle-income range from 2014 is as follows (leaving units off for readability):

$$\left( \frac{2}{3} \cdot \text{Median}, 2 \cdot \text{Median} \right) = \left( \frac{2}{3} \cdot 58003, 2 \cdot 58003 \right) \\ \cong (38669, 116006).$$

What does this mean? The lowest income in the middle-income range is **\$38669**/year, while the highest is **\$116006**/year. The size of the range is  $116,006 - 38,669 = 77,337$ , meaning the difference between the highest and lowest income households in the middle-income range is \$77,337/year.

You have used 1 of 3 attempts

❗ Answers are displayed within the problem

## Question 7

1/1 point (graded)

The **Federal Reserve Bank** tracks and predicts median household income adjusted for inflation in the United States.

In 2008, before the US recession, the median household income was 55,376 (in adjusted dollars). In 2012, the median household income was 52,666 (in adjusted dollars).

Using this data, determine what happened to the middle-income range from 2008 to 2012. We are still using the Pew Center Definition of middle income,  $\left( \frac{2}{3} \cdot \text{Median}, 2 \cdot \text{Median} \right)$ .

For the data and details on the adjustments see U.S. Bureau of the Census, Real Median Household Income in the United States MEHOINUSA672N, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/MEHOINUSA672N>, July 20, 2017. (opens in a new window/tab)

☒ The range of middle income became smaller. ✓☐ The range of middle income became larger.☒ The range of middle income shifted left. ✓☐ The range of middle income shifted right.☐ The range of middle income stayed exactly the same.

**Explanation**

In 2008, the middle income range was **(36917, 110752)**, about 74,000 in length. In 2012, the range was **(35110, 105332)**, about 70,000 in length.

This means the difference between the highest and lowest income households in the middle- income range was smaller than in 2008, about \$70,000/year compared to \$74,000/year.

We also see that the middle income range shifted left, since the lower bound is 2/3 the median income and the upper bound is twice the median income. Thus a smaller median income means the lower and upper bound are both smaller (more left on the number line).

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Alternative formats for the Federal Reserve Bank of St. Louis MEHOINUSA672N data: Chart Data (.csv format download), Image (.png graphic download)

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