

Statistics and Data Displays: math lesson, Grade 6 – download the PDF

Every day people collect numbers: how long a bus ride takes, how many goals a team scores, how tall plants grow. **Statistics** is the science of collecting, displaying and describing data so that a pile of numbers tells a clear story. In this chapter you will learn to ask good questions, draw dot plots, histograms and box plots, and describe a data set with a center and a spread.

1. Statistical questions and variability

D Statistical question

A **statistical question** is a question you expect to have **many different answers** in the data you collect. The differences among the answers are called **variability**.

“How many pets does Maya have?” has one answer, so it is not statistical. “How many pets do the students in Grade 6 have?” is statistical, because you expect 0 pets for some students, 1 for others, 3 for others, and so on. A set of answers to a statistical question is called a **data set**, or a **distribution** when we look at how the values are spread out.



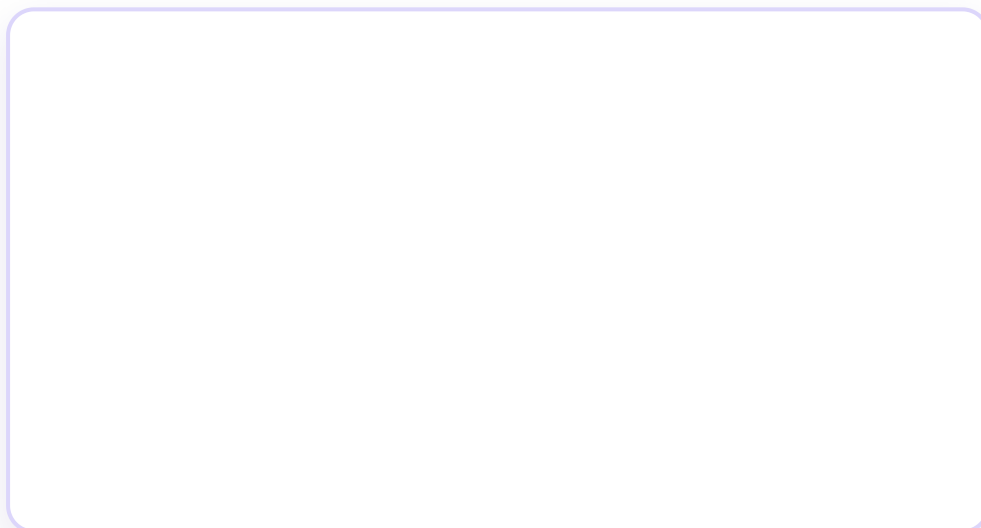
Common mistake

A question such as “What is the tallest mountain in Colorado?” has a single answer, even though it talks about many mountains. Ask yourself: *will I get different numbers if I ask different people or measure different things?* If yes, it is statistical.

2. Dot plots and frequency tables

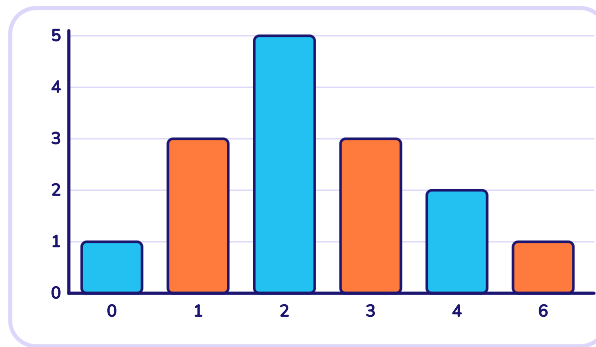
A **dot plot** puts one dot above a number line for every value in the data. A **frequency table** lists each value and how many times it occurs. Here are the numbers of siblings of 15 students:

0, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 4, 4, 6



Statistics grade 6 dot plot of the number of siblings for 15 students, with one dot per student stacked above each value from 0 to 6

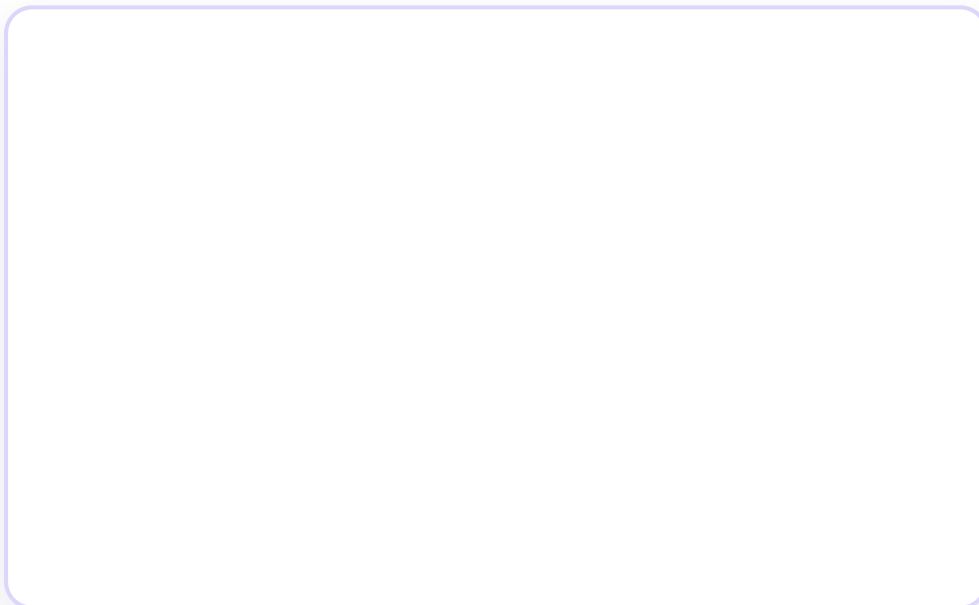
Siblings	0	1	2	3	4	6	Total
Frequency	1	3	5	3	2	1	15



The dot plot shows the shape right away: most students have 1 to 3 siblings, and the value 6 sits alone on the right. A value far from the others is called an **outlier** if it is unusually far away. The tallest stack, at 2, is the **mode**.

3. Histograms and choosing bins

When values are spread over a wide range, a dot plot becomes crowded. A **histogram** groups values into equal-width intervals called **bins** and draws a bar for each bin. The bars touch because the bins are continuous, and the height of a bar is the **frequency**, the number of values in the bin.



Statistics grade 6 histogram of homework time for 20 students using bins of width 10 minutes, bars of height 3, 6, 6, 3 and 2

Twenty students reported their homework time. The bin 20–30 means “at least 20 and less than 30 minutes”, and it holds 6 students. A histogram shows the shape but hides the exact values.

M**Method: building a histogram**

1. Find the smallest and largest values.
2. Choose a bin width that gives about 4 to 8 bins (10, 5 or 2 are common).
3. Make bins of equal width that do not overlap, such as 10–20, 20–30, and so on.
4. Count the values in each bin; the counts must add up to the total number of values.
5. Draw touching bars and label both axes.

If the bins are too wide you lose detail; if they are too narrow you get many tiny bars and cannot see the pattern.

4. The mean as a fair share and a balance point**D****Mean**

The **mean** of a data set is the sum of the values divided by the number of values. It is the amount each person would get if everything were shared equally, which is why it is called the **fair share**.

E**Example 1: fair share**

Four friends have 3, 5, 6 and 10 trading cards. Put all the cards together:

$3 + 5 + 6 + 10 = 24$. Share them equally among 4 friends: $24 \div 4 = 6$. The mean is 6 cards each.

The mean is also a **balance point**. Imagine the values as weights on a number line: the line balances exactly at the mean. In Example 1 the distances below 6 are **3** and **1**, a total of 4; the distances above 6 are **0** and **4**, a total of 4. The totals match, so the line balances at 6.

P Property: balance point

The distances from the mean to the values below it add up to the same total as the distances from the mean to the values above it.

! Zyro's tip

On my planet we say: "The mean is the value where the pulling to the left equals the pulling to the right." Check it by adding the distances on each side!

5. Median and mode

D Median and mode

The **median** is the middle value when the data are in order. With an even number of values, it is the mean of the two middle values. The **mode** is the value that occurs most often; a data set can have one mode, several modes or none.

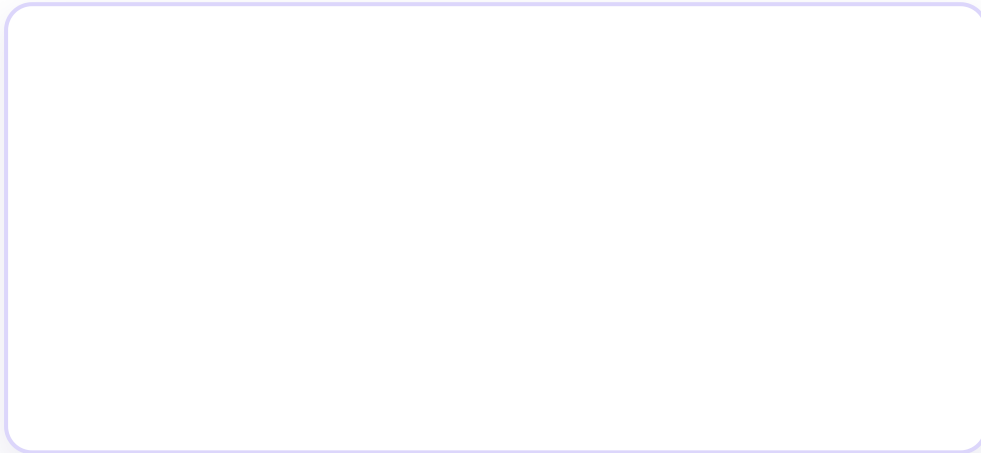
E Example 2: median of an even list

Quiz scores: 9, 4, 7, 10, 6, 8. In order: 4, 6, 7, 8, 9, 10. There are 6 values, so take the two middle ones, 7 and 8: $\frac{7+8}{2} = 7.5$. The median is 7.5. No value repeats, so there is no mode.

For the sibling data the median is the 8th of 15 values, which is 2, and the mode is 2 as well.

6. Box plots and the five-number summary

To describe the spread of the middle of the data, split the ordered list in two halves at the median. The median of the lower half is the **first quartile** Q_1 ; the median of the upper half is the **third quartile** Q_3 . When the number of values is odd, leave the middle value out of both halves. The **five-number summary** is: minimum, Q_1 , median, Q_3 , maximum.



Statistics grade 6 box plot of 11 scores showing the minimum 3, first quartile 5, median 9, third quartile 12 and maximum 20

A **box plot** draws the box from Q_1 to Q_3 , a line at the median, and “whiskers” out to the minimum and maximum. Each of the four parts (left whisker, left half of the box, right half of the box, right whisker) holds about one quarter of the values, so the box contains about half of the data.

7. Range, IQR and mean absolute deviation

D Measures of spread

Range = maximum – minimum. **Interquartile range (IQR)** = $Q_3 - Q_1$. **Mean absolute deviation (MAD)** = the mean of the distances between each value and the mean.

E Example 3: five-number summary and IQR

Scores in order: 3, 5, 5, 6, 8, 9, 10, 12, 12, 14, 20 (11 values). The median is the 6th value, 9. Lower half: 3, 5, 5, 6, 8, so $Q_1 = 5$. Upper half: 10, 12, 12, 14, 20, so $Q_3 = 12$. The summary is 3, 5, 9, 12, 20. Range: $20 - 3 = 17$. IQR: $12 - 5 = 7$.

E Example 4: MAD

Data: 4, 6, 6, 8, 11. The mean is $35 \div 5 = 7$. Distances from 7: 3, 1, 1, 1, 4. Their sum is 10, so $MAD = 10 \div 5 = 2$. On average, the values are 2 units from the mean.

M Method: finding the MAD

1. Find the mean.
2. Find the distance from each value to the mean (always positive).
3. Add the distances and divide by the number of values.

I 8. Choosing measures and describing the shape

A good description of a distribution gives its **center**, its **spread**, its **shape** and any **outliers**. The shape can be roughly **symmetric** (balanced on both sides), **skewed right** (a long tail toward large values) or **skewed left** (a long tail toward small values).

- If the data are fairly symmetric with no outliers, use the **mean** and the **MAD**.
- If the data are skewed or have an outlier, use the **median** and the **IQR**, because they are not pulled by extreme values.



Common mistake

An outlier drags the mean toward it. Compare the data 5, 6, 7, 8, 9 (mean 7) with 5, 6, 7, 8, 29 (mean 11): one large value moved the mean by 4, while the median stayed at 7.

Also report the units and the number of values, for example: “20 students, median 31.5 minutes, IQR 15.5 minutes, skewed right.”

Key takeaways

- A statistical question expects different answers; the differences are called variability.
- Dot plots and frequency tables show every value; histograms group values in equal bins.
- Mean = $\text{sum} \div \text{number of values}$: the fair share and the balance point.
- Median = middle value of the ordered data; mode = most frequent value.
- Five-number summary: minimum, Q_1 , median, Q_3 , maximum, shown in a box plot.
- Range = $\text{max} - \text{min}$; IQR = $Q_3 - Q_1$; MAD = mean distance from the mean.
- For skewed data or outliers, prefer the median and the IQR.



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