Lesson - Data: averages and charts

Year: Year 7

Data helps us answer questions about the world. In this chapter you will organise data, calculate averages and the range, and draw and interpret charts.

Starter activity

Ask ten classmates how many brothers and sisters they have. Record your results in a tally chart. Find the mode, the median and the mean. Which average do you think best describes your class? Compare your answer with a partner.

Collecting and organising data

Definition: data types

Data are pieces of information. *Discrete* data can only take certain values, such as shoe sizes. *Continuous* data can take any value in a range, such as height or time.

Definition: frequency table

A **tally chart** counts items with marks grouped in fives. A **frequency table** shows each value and how many times it occurs (its **frequency**).

The mean, median, mode and range

Definition: averages and range

The **mode** is the most common value. The **median** is the middle value when the data are in order (halfway between the two middle values if there are two). The **mean** is the total divided by the number of values. The **range** is the largest value minus the smallest.

Method: finding the median

1. Put the data in order, smallest to largest.
2. Count the values. If the count is odd, the median is the middle one.
3. If the count is even, add the middle two and divide by 2.

Example 1

Find the mode, median, mean and range of 2, 3, 3, 4, 5, 5, 5, 9.

Mode: 5 (it appears three times). Median: the middle two of 8 values are 4 and 5, so

the median is 4.5. Mean: $36 \div 8 = 4.5$. Range: $9 - 2 = 7$.

Example 2

Find the median of 3, 7, 1, 9, 5.

In order: 1, 3, 5, 7, 9. The middle value is 5.

Frequency tables

Rule: mean from a frequency table

Multiply each value by its frequency, add these to get the total, and divide by the total frequency (the number of values).

Example 3

Shoe sizes in a class of 20: size 3 (2 pupils), size 4 (5), size 5 (8), size 6 (4), size 7 (1). Find the mode, mean and median.

Mode: 5. Total: $3 \times 2 + 4 \times 5 + 5 \times 8 + 6 \times 4 + 7 \times 1 = 6 + 20 + 40 + 24 + 7 = 97$. Mean: $97 \div 20 = 4.85$. The 10th and 11th values are both 5 (cumulative frequencies 2, 7, 15), so the median is 5.

Outliers and choosing an average

Definition: outlier

An **outlier** is a value much bigger or smaller than the others.

Key fact: choosing an average

The mean uses every value, so outliers affect it. The median is not affected by outliers. The mode is useful for non-numerical data, such as the most popular colour.

Example 4

Temperatures were 12, 13, 11, 14 and 40. Which average is most typical?

The mean is $90 \div 5 = 18$, which is higher than four of the five values. The median is 13, which is more typical.

Charts and graphs

- **Bar chart:** equal-width bars with gaps; the height shows the frequency.
- **Pictogram:** symbols represent a number of items. Always read the key.

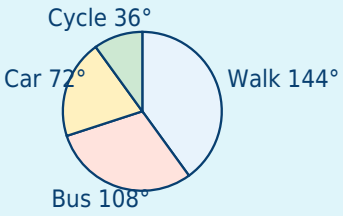
- **Pie chart:** a circle divided into sectors; the whole circle is 360°.

Rule: drawing a pie chart

Angle for one item = $360 \div$ total. Multiply by each frequency, and check the angles add up to 360°.

Example 5

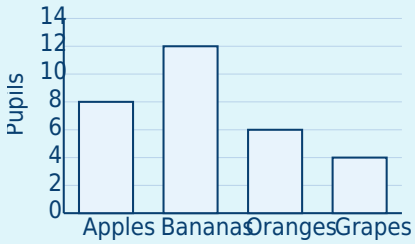
40 pupils were asked how they travel to school. 16 walk. Find the angle for walking, and check the other angles in the chart.



Each pupil is $360 \div 40 = 9^\circ$. Walking: $16 \times 9 = 144^\circ$. Bus 108°, car 72° and cycle 36° complete the chart: $144 + 108 + 72 + 36 = 360$.

Example 6

A bar chart shows how many pupils chose each fruit. How do you read it?



Find the bar, then read its height on the vertical axis. Always check the scale.

Comparing distributions

Example 7

Class A has a mean of 62 and a range of 30. Class B has a mean of 60 and a range of 12. Compare them.

Class A did slightly better on average, because its mean is higher. Class B was more consistent, because its range is smaller.

Note

Always write your comparison in context: say what the numbers mean for the

situation.

Common mistakes

- Not ordering the data before finding the median.
- Dividing by the number of different values instead of the total frequency.
- Giving the mode as the frequency rather than the value.
- Writing the range as two numbers instead of one.
- Starting a bar chart axis away from zero.

Watch out

The range is one number, not two. The mode is the value, not how often it occurs.

Worked example in context

The heights (in cm) of five players are 160, 165, 170, 172 and 193. Find the mean and the median. Which is better to describe a typical height?

Mean: $860 \div 5 = 172$. Median: 170. The outlier 193 pulls the mean up a little, but both are close, so either is a good description.

Common mistakes

- Finding the median without putting the data in order first.
- Dividing by the wrong number when working out the mean from a frequency table (divide by the total frequency).
- Saying the range is the biggest number instead of biggest minus smallest.

Did you know?

The word "average" is used in everyday life, but statisticians say there are three kinds. Sports analysts use averages to compare players, and weather forecasters compare today's temperature with the average for the month.

Averages in real life

Statisticians do not simply calculate numbers: they ask a question, collect data, present it clearly and then decide what the data tell them. This cycle is called the *data handling cycle*. In Year 7 you meet every stage of it, and in this section we look at how the averages and charts you have learnt are used to answer real questions about people, sport and the weather.

Method: the data handling cycle

1. **Plan**: write a clear question, for example “Do Year 7 pupils sleep more at the

weekend than on school nights?”.
2. **Collect**: choose a fair sample, avoid only asking your friends, and record the results in a tally chart or frequency table.
3. **Process and present**: work out the averages and the range, and draw a suitable chart (bar chart, pie chart or line graph).
4. **Interpret**: answer the original question in a full sentence, using an average and a measure of spread, and say whether more data would help.

Example 1

The heights of five plants in centimetres are 12, 15, 11, 15 and 22. A sixth plant is measured and the mean of all six becomes 15 cm. How tall is the sixth plant?

The mean of six plants is 15 cm, so their total height is $6 \times 15 = 90$ cm. The first five plants add up to $12 + 15 + 11 + 15 + 22 = 75$ cm. The sixth plant must make up the difference: $90 - 75 = 15$ cm. This “total first” method works for every missing-value question about the mean: multiply the mean by the number of values to find the total, then subtract the values you know.

Example 2

Two shops sell sandwiches. Shop A’s daily sales over a week have a mean of 40 and a range of 6. Shop B’s have a mean of 40 and a range of 25. Compare the two shops.

The means are the same, so on average both shops sell 40 sandwiches a day. The ranges are very different. Shop A’s sales only vary by 6, so they are consistent and easy to plan for. Shop B’s sales vary by 25, so some days it sells many more and other days many fewer. A good comparison always mentions an average *and* the spread, and it uses the context: “Shop A is more reliable, so it is easier to know how many sandwiches to make.”

Example 3

A pie chart shows how 72 people voted. The angle for “yes” is 130°. How many people voted yes?

The whole circle of 360° stands for all 72 people, so each person is worth $360 \div 72 = 5^\circ$. The “yes” sector is 130°, so $130 \div 5 = 26$ people voted yes. Always find the angle for one item first; it turns every pie chart question into a simple division.

Watch out

A chart can mislead. A bar chart whose vertical axis does not start at zero makes small differences look huge, and a pie chart says nothing about how many people were asked. Before you draw a conclusion, read the scale on the axes and check the total number of results.

Did you know?

Every ten years the UK carries out a census, a survey of every household in the country. The first modern census took place in 1801. Its averages, such as the mean household size or the median age, help the government decide where to build new schools, hospitals and roads.

Otto's tip

Remember MMMR: Mode is Most, Median is Middle, Mean is Mathematical (add up and divide), and Range is the Reach from smallest to largest. Always order the data first.