Representing Data

Year 8

#MathsEveryoneCan

White Rose Maths

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Autumn	**Proportional Reasoning**						**Representations**					
	Ratio and scale		Multiplicative change		Multiplying and dividing fractions		Working in the Cartesian plane			Representing data		Tables & probability
Spring	**Algebraic Techniques**						**Developing Number**					
	Brackets, equations and inequalities				Sequences	Indices	Fractions and percentages			Standard index form		Number sense
Summer	**Developing Geometry**						**Reasoning with Data**					
	Angles in parallel lines and polygons		Area of trapezia and circles		Line symmetry and reflection		The data handling cycle				Measures of location	

Autumn 2: Representations

Weeks 1 to 3: Working in the Cartesian Plane

Building on their knowledge of coordinates from KS2, students will look formally at algebraic rules for straight lines, starting with lines parallel to the axes and moving on to the more general form. They can explore the notions of gradient and intercepts, but the focus at this stage is using the equations to produce lines rather than interpretation of m and c from a given equation; this will be covered in Year 9. Use of technology to illustrate graphs should be embedded. Appreciating the similarities and differences between sequences, lists of coordinates and lines is another key point. Students following the higher strand may also explore non-linear graphs and mid-points of line segments.
National curriculum content covered:

- move freely between different numerical, algebraic, graphical and diagrammatic representations
- develop algebraic and graphical fluency, including understanding linear (and simple quadratic) functions
- make connections between number relationships, and their algebraic and graphical representations
- substitute numerical values into formulae and expressions
- recognise, sketch and produce graphs of linear functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane

Weeks 4 and 5: Representing Data

Students are introduced formally to bivariate data and the idea of linear correlation. They extend their knowledge of graphs and charts from Key Stage 2 to deal with both discrete and continuous data.

National curriculum content covered:
describe, interpret and compare observed distributions of a single variable through appropriate graphical representation involving discrete, continuous and grouped data

- construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data
- describe simple mathematical relationships between two variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs
- use language and properties precisely to analyse probability and statistics

Week 6: Tables and Probability

Building on from the Year 7 unit, this short block reminds students of the ideas of probability, in particular looking at sample spaces and the use of tables to represent these.
National curriculum content covered:

- record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale
- generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities
- use language and properties precisely to analyse probability and statistics

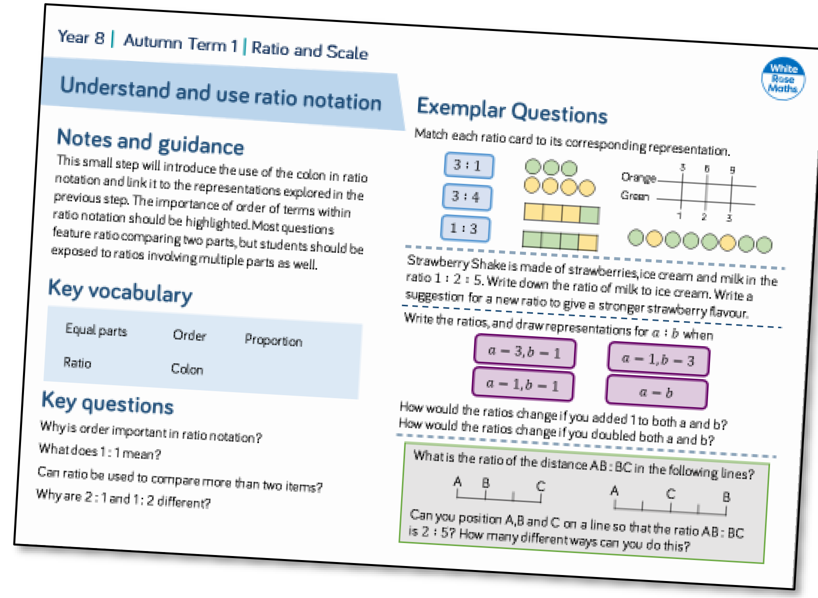
Why Small Steps?

We know that breaking the curriculum down into small manageable steps should help students to understand concepts better. Too often, we have noticed that teachers will try and cover too many concepts at once and this can lead to cognitive overload. We believe it is better to follow a "small steps" approach.

As a result, for each block of content in the scheme of learning we will provide a "small step" breakdown. ***It is not the intention that each small step should last a lesson – some will be a short step within a lesson, some will take longer than a lesson.*** We would encourage teachers to spend the appropriate amount of time on each step for their group, and to teach some of the steps alongside each other if necessary.

What We Provide

- Some ***brief guidance*** notes to help identify key teaching and learning points
- A list of ***key vocabulary*** that we would expect teachers to draw to students' attention when teaching the small step,
- A series of ***key questions*** to incorporate in lessons to aid mathematical thinking.
- A set of questions to help ***exemplify*** the small step concept that needs to be focussed on.


Year 8 | Autumn Term 1 | Ratio and Scale

Understand and use ratio notation

Notes and guidance

This small step will introduce the use of the colon in ratio notation and link it to the representations explored in the previous step. The importance of order of terms within ratio notation should be highlighted. Most questions feature ratio comparing two parts, but students should be exposed to ratios involving multiple parts as well.

Key vocabulary

Equal parts, Order, Proportion, Ratio, Colon

Key questions

Why is order important in ratio notation?
What does 1 : 1 mean?
Can ratio be used to compare more than two items?
Why are 2 : 1 and 1 : 2 different?

Exemplar Questions

Match each ratio card to its corresponding representation.

3 : 1
3 : 4
1 : 3

Orange
Green

Strawberry Shake is made of strawberries, ice cream and milk in the ratio 1 : 2 : 5. Write down the ratio of milk to ice cream. Write a suggestion for a new ratio to give a stronger strawberry flavour.

Write the ratios, and draw representations for $a : b$ when

$a = 3, b = 1$
$a = 1, b = 3$
$a = 1, b = 1$
$a = b$

How would the ratios change if you added 1 to both a and b?
How would the ratios change if you doubled both a and b?

What is the ratio of the distance AB : BC in the following lines?

Can you position A, B and C on a line so that the ratio AB : BC is 2 : 5? How many different ways can you do this?

- These include reasoning and problem-solving questions that are fully integrated into the scheme of learning. Depending on the attainment of your students, you many wish to use some or all of these exemplars, which are in approximate order of difficulty. Particularly challenging questions are indicated with the symbol .
- For each block, we also provide ideas for key representations that will be useful for all students.

In many of the blocks of material, some of the small steps are in **bold**. These are content aimed at higher attaining students, but we would encourage teachers to use these with as many students as possible – if you feel your class can access any particular small step, then please include it in your planning.

Representing Data

Small Steps

- Draw and interpret scatter graphs
- Understand and describe linear correlation
- Draw and use line of best fit (1) & (2)
- Identify non-linear relationships
- Identify different types of data
- Read and interpret ungrouped frequency tables
- Read and interpret grouped frequency tables
- Represent grouped discrete data
- Represent continuous data grouped into equal classes
- Represent data in two-way tables

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Draw and interpret scatter graphs

Notes and guidance

Students need to be confident in drawing and labelling axes, scaffolding this may be necessary. A wide range of examples should be used (include numbers less than 1 and bigger than 1000). Examples of pairs of variables that are appropriate/not appropriate to represent using a scatter graph should be discussed.

Key vocabulary

Variable	Relationship	Origin
Scale	Coordinate	Axis
Increase	Decrease	

Key questions

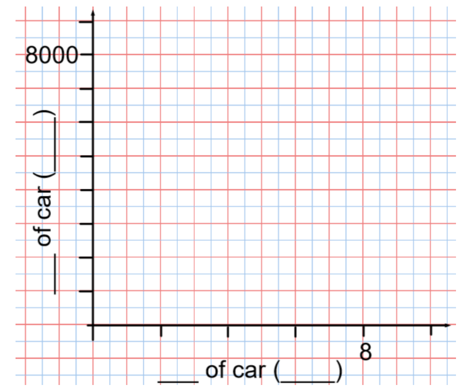
How do we use the data to generate coordinates?
Does it matter if the data points are not in size order?
How do we know how long to draw our axes?
How do we know what scale to use on our axes?
Which labels do we need to place on our graph?

Exemplar Questions

The table shows the age and value of a car.

Age of Car (Years)	2	4	6	8	10
Value of Car (£s)	7500	6250	4000	3500	2500

Complete the pair of axes.
Now use the data in the table to generate coordinates and plot them on the graph.
Complete the sentence,
As the age of the car __________,
the value of the car __________.
Do you think this will always be true? Explain your answer.



For each of the following, decide whether it is appropriate to use a scatter diagram to represent the data. If it is appropriate, sketch what the scatter diagram might look like. If it isn't appropriate, explain why.

- Colour of car and make of car
- Cost per mile and distance travelled
- Number of ice creams sold and temperature during the day
- Distance a student lives from school and height of student

Linear correlation

Notes and guidance

In this small step, teachers support students to recognise positive and negative correlation. They also consider the strength of this correlation. Students are also able to decide if there is no correlation, or non-linear correlation. Even when there is non-linear correlation, it is still possible that there is a relationship between the variables and students may need support in describing this.

Key vocabulary

Relationship	Correlation	Positive
Negative	Strong	Weak

Key questions

How can you tell if correlation is positive or negative?

How is correlation useful to us? Can you give some real-life examples?

What's the same and what's different about positive and negative correlation? Can you give some real-life examples for each?

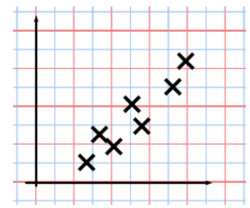
Exemplar Questions

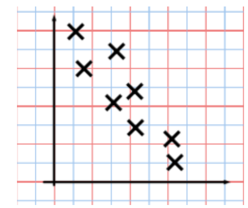
Match one description to each graph. Give two other example descriptions that could fit each graph.

Height and weight of 5 to 18 year-olds

Amount of petrol in tank and distance travelled

Average time watching TV and size of TV





Complete the sentences.

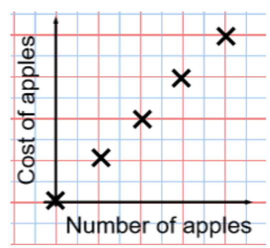
As one variable __________, the other variable also __________.

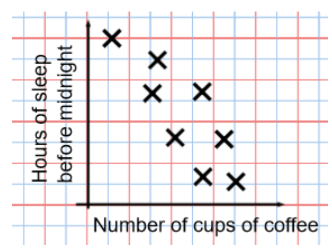
This relationship is called __________ correlation.

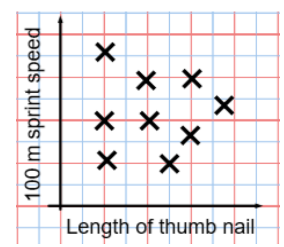
As one variable __________, the other variable __________.

This relationship is called __________ correlation.

For each graph below, state the type of correlation shown. Describe the relationship between the two variables.







Draw and use line of best fit (1)

Notes and guidance

Teachers should check student misconceptions around lines of best fit: it doesn't have to go through the origin, it doesn't have to go through all of the points, it isn't always drawn from bottom left to top right. Students need to understand that there are approximately the same number of points above the line as below it. Also explore why the line of best fit is straight rather than curved.

Key vocabulary

Line of best fit	Origin	Estimate

Key questions

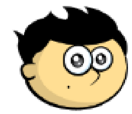
True or false:

- The line of best fit has to go through the origin
- The line of best fit goes through as many points as possible
- The line of best fit extends across the whole graph

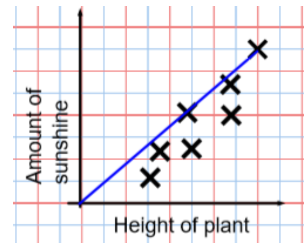
Why do you need the line of best fit in order to make a good estimate? How can you show your method for estimating on the graph?

Exemplar Questions

Jack and Dora are both drawing a line of best fit.
Whose method is better? Explain why.



Jack



Dora

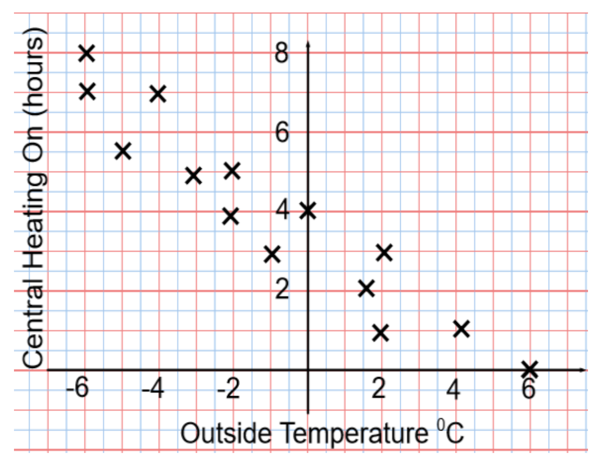
Jack has joined the point representing the tallest plant with the origin.

Dora has wiggled her ruler around until there are roughly the same number of points on each side of the line.

Describe the correlation.

Explain why it's appropriate to draw a line of best fit on this graph. Draw a line of best fit on the graph.

Use your line of best fit to estimate how long the central heating is on for when the outside temperature is 0.5°C



Draw and use line of best fit (2)

Notes and guidance

Students should always show how they arrive at an estimate, by drawing additional lines on the graph.

The term ‘extrapolation’ will need explaining so that students are aware of why it isn’t always sensible to make an estimate which is outside of the range of data presented.

Students are also introduced to outliers.

Key vocabulary

Line of best fit	Origin	Estimate
Straight	Extrapolate	Outlier

Key questions

What does ‘extrapolate’ mean?

Why might it be a risk to make an estimate outside of the range of your data?

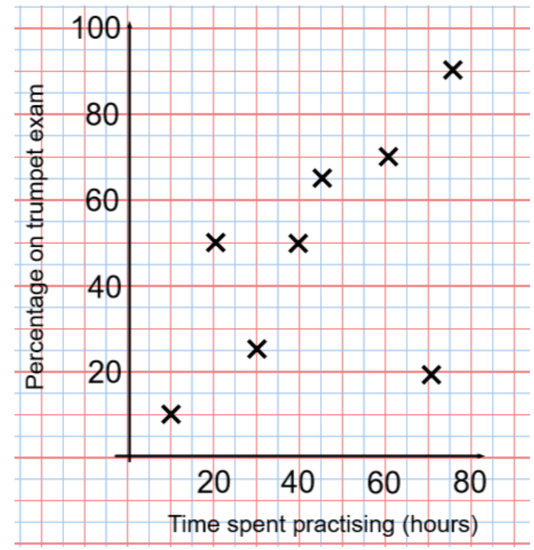
Exemplar Questions

Tommy has practised playing his trumpet for 70 hours. He wants to use the graph to estimate what percentage he will get in the exam.

He looks at the graph and estimates that he will get 20%. What mistake has Tommy made?

Use a line of best fit to estimate the percentage Tommy will get in the exam.

Identify an outlier.



Draw a scatter graph for the following data.

Height of plant (cm)	95	70	80	40	50	25
Width of plant (m)	0.85	0.25	0.8	0.45	0.45	0.2

Circle the outlier. Why is it an outlier?
Describe the relationship between the height of the plant and the width of the plant.
Draw on a line of best fit. Why isn’t it sensible to estimate the height of a plant if the width is 2 m?

Identify non-linear relationships

Notes and guidance

Students are also able to decide if there is no correlation, or non-linear correlation.

Even when there is non-linear correlation, it is still possible that there is a relationship between the variables and students may need support in describing this.

Key vocabulary

Non-linear	Outlier	Variable

Key questions

Is there a relationship between the data?

Is it linear or non-linear? How do you know?

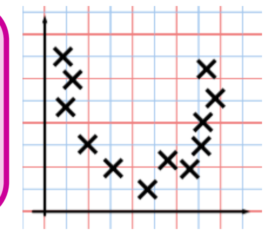
What does non-linear mean?

Draw different representations of non-linear scatter graphs and add on possible labels for the axes.

Exemplar Questions

Whitney

This isn't positive or negative correlation. This means that there is no relationship between the variables.



Explain why Whitney is wrong.

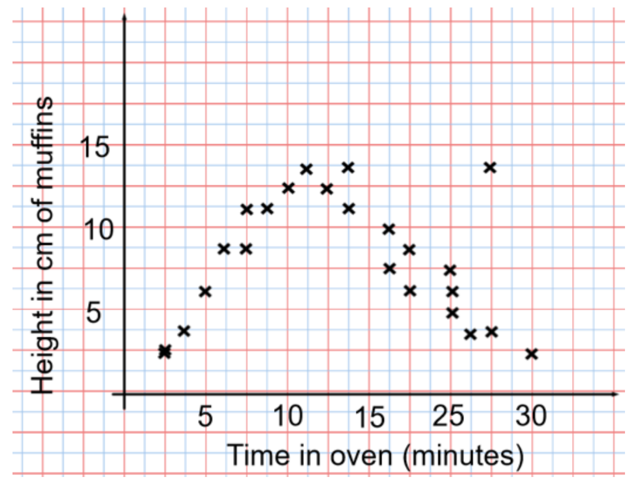
Jack's baking some muffins with his friend Eva. They construct this graph.

You can't draw a line of best fit

Jack

There isn't a relationship

Eva



Jack's right and Eva is wrong. Explain why.
One muffin doesn't fit the pattern. What is the height of this muffin and how long has it been in the oven for?

Identify different types of data

Notes and guidance

In this small step, students are introduced to discrete and continuous data. Teachers could explain continuous data as 'measurements' and discrete data as 'counts'. Qualitative data is also introduced. It's important to establish that there are different data types and that we need to know these so that we can use appropriate graphs and calculations to represent them.

Key vocabulary

Discrete	Continuous	Measured
Counted	Qualitative	Quantitative

Key questions

How can we recognise discrete, continuous and qualitative data? Give me examples of each type.

Why do we need to know about different types of data?

Why do we sometimes have a gap between bars on a bar chart?

Exemplar Questions

Sort the statements into discrete and continuous data.
Two of the statements don't belong in either category, why?

Discrete Data:
E.g. Number of children on a bus

Continuous Data:
E.g. Heights of children on a bus

Number of school buses

Speed of school buses

Age of a person

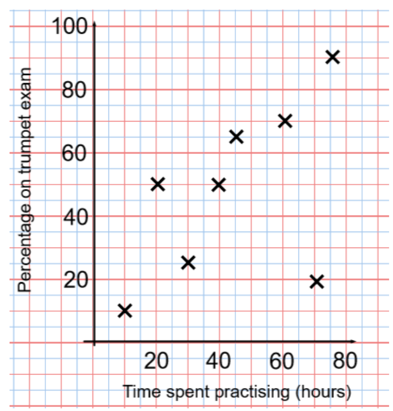
Make of mobile phone

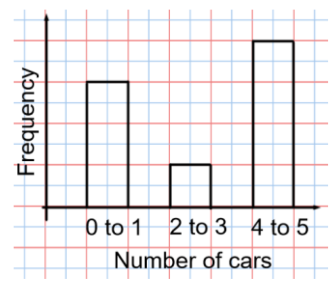
Cost of apples

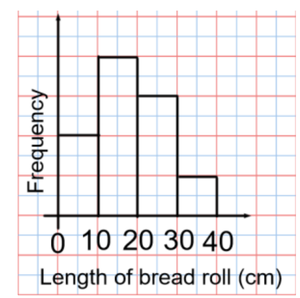
Favourite colour

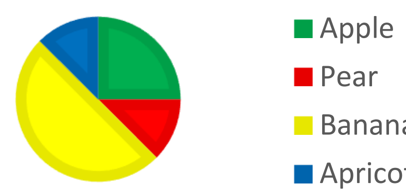
Explain the difference between the types of data to your partner.
Add an example of your own to each category.

For each graph and chart, decide what type of data is being represented, discrete, continuous or qualitative.









White Rose Maths

Ungrouped frequency tables

Notes and guidance

Students understand 'frequency' by counting the number of items in a given list, and by completing tables. They interpret data by using the information from the table to answer questions in context.

Teachers may want to do a class survey (for example, number of siblings) and calculate the total (by subtotalling each row in the table). Ensuring children work with '0' in either column of the table is key.

Key vocabulary

Frequency	Ungrouped
Total	Subtotal

Key questions

What does the word frequency mean?
What type of data is best represented by ungrouped frequency tables?
How can I calculate subtotals in my frequency table?
Do I still need the row if the frequency is 0?

Exemplar Questions

Dexter asks 10 children in his class how many siblings they have.
Here is his list: 4, 1, 0, 2, 1, 2, 0, 1, 2, 2

Dexter doesn't think he needs the row in his table for 3 siblings.

Is he right? Explain your answer.

Complete the frequency table.

Number of siblings	Frequency
0	
1	3
2	
3	
4	1

Country	Frequency
Poland	11
Spain	24
Greece	34
Pakistan	18
Ghana	1

The table shows results from a survey about which country people had visited.

- How many people took part in the survey?
- How many more people visited Greece than Spain?
- How many fewer people visited Ghana than Pakistan?

Goals Scored	Frequency	Total number of goals
5	4	
6	3	6 x 3 = 18
7	0	
8	1	
		Total Goals =

The table shows the number of goals scored in netball matches over the weekend.

Complete the table to work out the total number of goals scored.

White Rose Maths

Read & interpret grouped tables

Notes and guidance

This step might be taught in conjunction with the following step. Students start by exploring when it is and isn't appropriate to use an ungrouped frequency table. They then consider sensible class boundaries for grouped frequency tables. Teachers pose different questions related to the grouped frequency table so that students become familiar with reading and interpreting them.

Key vocabulary

Grouped	Tally	Range
Group	Frequency	Equal

Key questions

When would a grouped frequency table be more appropriate to use than an ungrouped table?

How can we work out how to group the data?

Why is it useful to have groups of equal size?

Exemplar Questions

Annie has completed a survey about sparrows. She wants to put her data into a table.

Number of sparrows spotted by different people in her class:

14, 7, 2, 18, 16, 15, 4, 3, 8, 1, 19, 5

Why would an ungrouped frequency table be unsuitable?
What groups would be suitable to use in your table? Explain why.

Number of sparrows	Frequency
6 - 10	2
11 – 15	

Use Annie's data to complete this grouped frequency table.

Look at the number in the circle. Write a full sentence to say what this number tells you.

Number of books	Frequency
0 – 10	2
11 –	3
21 – 30	
- 40	1

A group of 15 children were asked how many books they had in their house.
When results were put in a table, the pen leaked to leave blotches. What numbers are beneath the blotches?

Tommy thinks that 1 person had 40 books in their house.

Mo thinks that 1 person had 35 books in their house.
What do you think?

Alex thinks that the range of the number of books could be as much as 40 or as little as 21. Is she right? Explain why.

White Rose Maths

Represent grouped discrete data

Notes and guidance

Teachers might start by checking students understand the difference between grouped and ungrouped frequency tables. In this small step, the focus is on discrete data. Populating grouped frequency tables from different types of sources, such as a list of data or a set of written information regarding each group, supports understanding.

Key vocabulary

Grouped	Frequency	Discrete
Class	Class Boundary	Estimate

Key questions

Why do we have gaps between the classes in a discrete grouped frequency table?

If presented with a completed grouped frequency table, do we know the actual data items represented within each group?

Exemplar Questions

Mo is investigating the cost of TVs. He starts putting his data in a grouped frequency table. He has 10 more prices to add into his table:
£279, £120, £249, £239, £280, £299, £169, £150, £199, £299
Use these prices to complete the table.

Cost of TV (£)	Tally	Frequency
101 – 150	~~IIII~~ II	
151 – 200	~~IIII~~ ~~IIII~~ I	
201 – 250	~~IIII~~	
251 - 300	III	

How many TVs cost more than £150?

What's the maximum possible range for the cost of a TV?

The table shows how many babies were born in a hospital every day in February. Complete the table using the information provided.

Number of babies	0 – 2	3 - 5	6 - 8	9 - 11	12+
Number of days	7				

- On 5 days, 6 to 8 babies were born
- On 13 days, less than 5 babies were born
- 12 or more babies were born on 1 more day than 6 – 8 babies

Represent continuous data

Notes and guidance

Students may need a reminder of the difference between discrete and continuous data.

The idea of rounding continuous data is now explored as this links to why we use inequality signs when writing class boundaries. Students need reminding of the meaning of inequality signs.

Key vocabulary

Grouped	Tally	Less than/Equal to
Greater than	Discrete	Continuous

Key questions

Why is there a gap between the groups when the table represents discrete data?

Why isn't there a gap for continuous data?

When would a grouped frequency table be more appropriate to use than a non-grouped table?

Exemplar Questions

Rosie

I am 1.3 m tall

Rosie cannot be exactly 1.3 m tall, but is 1.3 m tall to 1 decimal place

Whitney

Explain why Whitney is correct.
Why do we need to round continuous data?

Match each inequality to the statement that describes it.
The first one has been done for you.

$0 < x \leq 10$	x is greater than or equal to 0 but less than or equal to 10
$0 \leq x \leq 10$	x is greater than 0 but less than 10
$0 < x < 10$	x is greater than 0 but less than or equal to 10
$0 \leq x < 10$	x is greater than or equal to 0 but less than 10

Eva records the weights of some eggs and records the results in this grouped frequency table. The last egg she weighed was 50 g.

x Weight(g)	Frequency
$40 < x \leq 50$	1
$50 < x \leq 60$	3
$60 < x \leq 70$	5
$70 < x \leq 80$	1

Which group should she place it in? Amend the table to show the correct frequency for this last egg.

Eva says that 90% of the eggs are less than or equal to 70 g in weight. Is she right?

Represent data in two-way tables

Notes and guidance

Students start with concrete or pictorial representations to help them understand the structure and purpose of a two-way table. Teachers should then ensure that students can find the correct piece of information from their table through questioning.

Topics such as fractions, percentages and ratio are easily interleaved into this small step.

Key vocabulary

Frequency | Totals | Ratio

Fraction | Percentage

Key questions

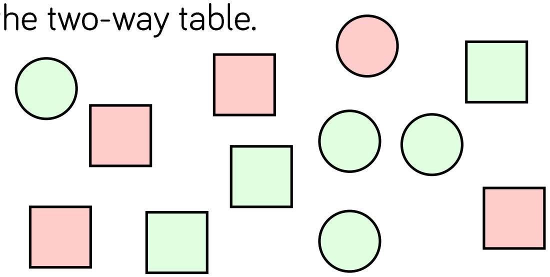
How do we know what each number in each cell means?

Why do we use columns and rows?

Why does the overall total only appear once in our table?

Exemplar Questions

A game has circle and square pieces. Count the pieces and complete the two-way table.



	Squares	Circles
Green	3	
Red		

Dora did a survey of her class about whether they preferred running or swimming. She recorded her results in this two-way table.

How many more girls prefer running to boys?
How many more children prefer swimming to running?
Draw a frequency tree to represent this data.

	Boys	Girls	Totals
Running	6	9	15
Swimming	13	12	25
Totals	19	21	40

There are 24 chocolates in a box. $\frac{1}{3}$ are dark chocolate and the rest are milk chocolate. Of these, some have a soft centre and the rest have a chewy centre. 5 of the milk chocolates have a chewy centre. 25% of the dark chocolates have a soft centre.

Complete the two-way table.

Write down the ratio of soft chocolates to chewy chocolates.

	Soft		
Milk			
Totals			