How to . . .
teach data handling across the curriculum

Sgiliau Sylfaenol Cymru
Basic Skills

Words Talk-Numbers Count
Geiriau'n Galw-Rhifau'n Cyfri

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Introduction

There are a group of learners who have difficulty in understanding and handling data skills. More often than not, these learners usually have gaps in their general mathematics understanding that, in turn, can prevent them developing an understanding within handling data activities. This group of learners may have problems due to:

- poor calculation skills;
- lack of strategies or alternative approaches;
- data not in a meaningful context for them;
- not making connections with everyday examples;
- lack of useful resources to aid understanding.

This booklet will identify the key points that this group of learners need to know about each type of graph or chart, and help you identify and use strategies and resources which will help them overcome common misconceptions.

The ability to collect information or data, present it appropriately and interpret its findings is an important aspect of everyday life. Surveys, graphs and charts are often used by the media to inform, persuade and at times, mislead the audience.

Providing learners with the knowledge of how this data is collected and the ways in which it can be represented will:

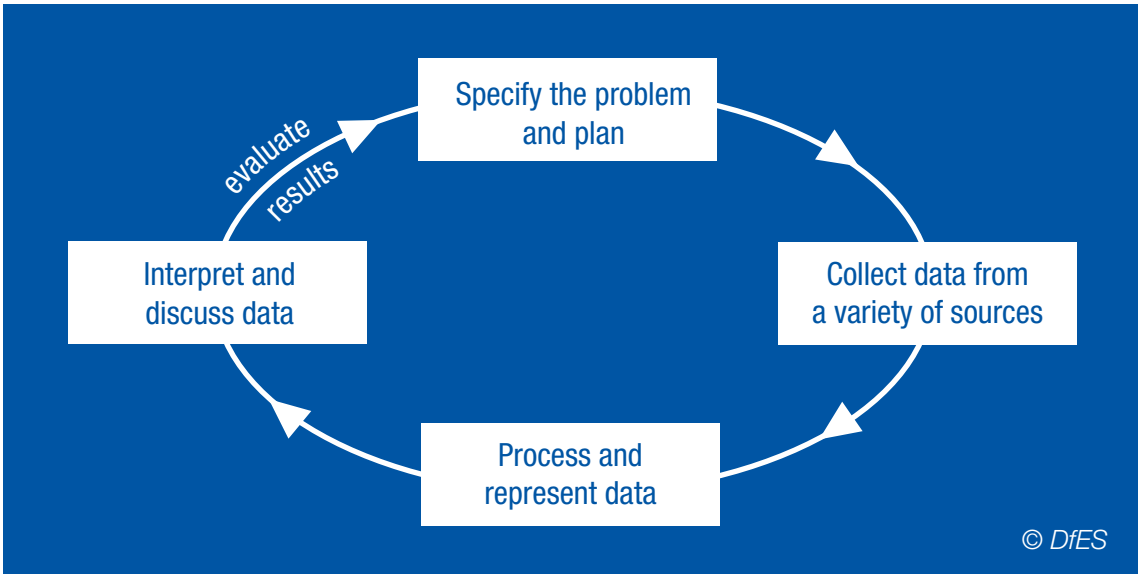
- enhance the skills of the individual; and
- develop the confidence needed to be able to ask questions of (interrogate) the data so that interpretation is accurate.

The purpose of this guidance is to clarify the basic principles of data handling and to show, with examples, the elements of simple graphical representation.

Each type of graph or chart is discussed under the following headings:

- General Information and Definition
- Key Features
- Key Vocabulary
- Common Misconceptions/Errors
- Teaching Ideas/Activities
- Example
- Everyday Examples

The Data Handling Cycle



This diagram shows how handling data can be seen as a series of linked stages.

All too often, too much time is spent on drawing graphs/charts, and not enough time on actually finding out what the graph/chart is telling us (interpreting).

There are many elements to consider at each stage of the cycle:

- What data do we need to collect and why?
- How will we collect, organise and represent the data?
- Which graph or chart is best to represent the data?
- Is the data reliable?
- What 'story' does this data tell us?

So, when planning data handling opportunities for learners, it is essential to ensure a balance of activities are provided, including: collecting, organising, representing, interpreting and discussing data.

Everyday Examples

It can be very time consuming to complete *all* the stages for *every* set of data. Why not use data from various contexts to provide a meaningful situation for learners to choose the best way to represent the data? e.g. use data from an experiment conducted during a science session to help learners construct a line graph in a maths/ICT session.

Is it a graph or is it a chart?

Throughout this booklet, there are references to graphs and charts. There is no universal agreement on what constitutes a diagram, graph or chart. Quite often, teaching materials may use different terms to refer to the same thing. It is important to be consistent when using these terms in order to avoid unnecessary confusion!

Choosing a graph or chart appropriate for the data

Discrete or Continuous data?

When choosing the type of graph or chart to represent the data, learners will need to consider the type of data.

Discrete data: data resulting from counting separate items or events, e.g. number of people

Continuous data: data resulting from measurement, e.g. length, temperature, weight. It is possible for continuous data to take any value between two values. It can only be measured approximately to a certain degree of accuracy. Continuous data are usually represented by a line.

Here are some examples of discrete data and continuous data:

Discrete	**Continuous**
Shoe size	Length of foot
Make of car	Acceleration time 0-60mph
Type of fish	Weight of salmon
Number of sunny days	Hours of sunshine
Mode of transport used to go to shops	Distance from home to shops

Vocabulary

There is a reference to key vocabulary within each of the sections. See the **Glossary** at the back of this booklet for a vocabulary list.

Numeracy Box

Note: Throughout this booklet, references are made to the 'Numeracy Box.' The numeracy box was produced by the Basic Skills Agency as part of its campaign to promote numeracy and raise standards at Key Stage 3. The resources contained within the box have been carefully selected for the purpose of promoting and supporting the teaching of numeracy across the curriculum.

Please refer to the Basic Skills Agency publication '*How to …… use the numeracy box resources across the curriculum*' for further guidance. Copies of this publication are available from Prolog 0845 603 1108 by quoting stock code A1918.

Pictogram*/Pictograph

* pictogram used for consistency

Definition

A way of representing data. Pictures or symbols represent a number of objects (or frequency). Part of a picture or symbol is used to represent a rough proportion of the number.

General Information

Pictograms are a simple way to represent data with pictures.

The chosen symbol can be used to represent any value, and this must be specified in a 'key'. e.g. a symbol may represent 1, 2, 5, 10, 20, 50, 100 …… etc.

Note: Learners should be aware that representation is not exact, so numbers may be rounded.

Key features

- Pictures represent numerical data
- Must have a title
- Pictures must be the same size, and must be equally spaced
- A picture can represent any number
- Part of a picture can represent a part of the whole e.g. ½ , ¼ etc
- Pictures may be arranged horizontally or vertically
- A key must be included to show what the symbols mean

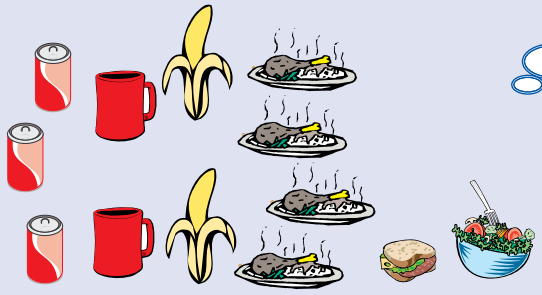
Vocabulary

data	title
symbol/picture	key
fraction	proportion

Common Misconceptions/Errors

- No title
- Pictures not the same size
- Pictures not appropriately arranged
- No key given

Example



What data does this pictogram represent? Collect ideas from the learners.

Once a key is supplied, we are better equipped to interpret the data.

However, without the key, the pictogram suggests that:

- more bananas were sold than hot meals;
- the number of hot drinks sold was similar to the number of cold drinks sold;
- more salads were sold than sandwiches;
- less hot drinks were bought than bananas.

Key: Numbers sold in the canteen on 4 Februrary

= 20

= 20

= 20

= 20

= 20

= 20

It is useful to present an incorrectly drawn representation of data to learners, encouraging them to highlight and discuss errors.

Teaching Ideas/Activities

As well as using the 'food' example above, consider the following:

- Demonstrate the importance of keeping the pictures/symbols the same size, cut out square pieces of paper or card in the following sizes 3cm x 3cm, 7cm x 7cm and 10cm x 10cm. You will need enough squares so that learners have one square each (some will have a $3cm^2$, others a $7cm^2$ and others a $10cm^2$ square.)
- Ask a simple question which you think will have a varied but limited number of answers, e.g. "How did you get here today?" (Walk/Bus/Car/Bike)
- Mark simple axes on the board, and the words (Walk/Bus/Car/Bike) below.
- Invite the learners to place their square above their answer (Fixing with blu-tack).
- Once everyone has given their answer, discuss whether the pictogram shows a fair picture.
- Does it matter that the squares are not the same size?
  - Demonstrate that it is not necessarily the 'tallest column of pictures' which is the most popular answer.
  - What about the spaces left between the squares? Are they equal? Why is this important?
- Alongside the first pictogram, invite the learners to do the same again, but this time, using squares of equal size, and taking account of the spaces left between the pictures.
- In the activity above, each picture (or square) represents 1 person. Provide a set of data whose values are too large to use a square to represent 'one' e.g. data with values up to around 50 (e.g. 32, 12, 40, 20, 4). It would take forever to cut out the squares! Suggest that it may be useful to use one 'square' to represent a larger number.(in this case - a square could represent perhaps 4 or 5 or 8, even 10!)
- When deciding what number each symbol will represent, look for common multiples in the data. You may want to refer learners to multiplication table posters. Use Target Boards (supplied in Numeracy Box) to practice recognition of multiples e.g. Highlight the multiples of 3.

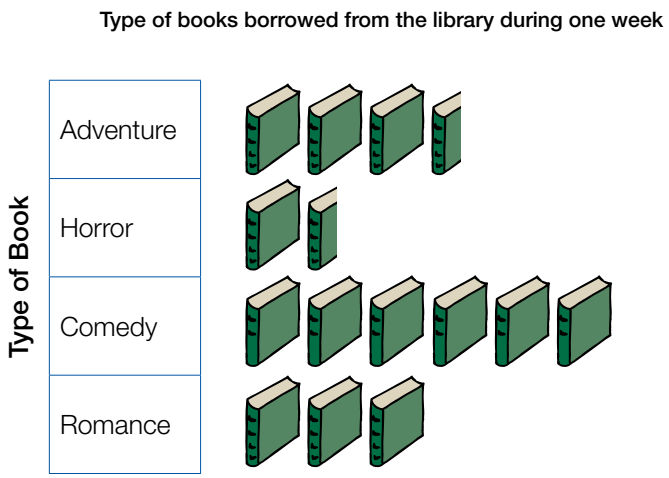
21	3	5	19	37
11	27	12	6	42
9	25	45	90	76
30	18	60	15	50

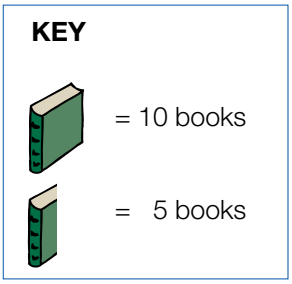
- It is useful for learners to be familiar with counting in steps of equal size e.g. if a picture represents 5, use the counting stick to practice counting in 5s.
- **Using parts of pictures -** Tip: To find ¼ of a number → halve and halve again e.g. ¼ of 20 : halve (10) and halve again (5) - show on counting stick.

Example

The following example could be used to practice the skills required to interpret a pictogram.

Type of Book	Number
Adventure	34
Horror	16
Comedy	61
Romance	31





Spend time discussing what information the **pictogram** is giving us. Working in pairs, invite the learners to offer their suggestions e.g. it shows which books were borrowed from the library …… a 'whole' book means that 10 of them were borrowed …… more Comedy books were borrowed than any others ……

Ask questions ……

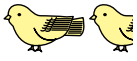
1. Which type of book was the most/least popular?
2. How many more Adventure books were borrowed than Horror books?
3. What is the total number of books borrowed?
4. If we collected the same data next week, would it be the same?
5. How would the data look during the school holidays?

Invite pairs of learners to come up with their own question.

Everyday Examples

- A council report may include a pictogram to show the number of kg of waste recycled each month, over 1 year.

- RSPB may show the results of a National Birdwatch in the form of a pictogram.



- Music tracks downloaded from a website per hour.

Table

Definition

A way of representing data. Information organised in columns and rows.

General Information

Data is often collected, organised and presented in the form of a table. This data can then be transferred to an appropriate chart or graph form.

At its simplest level, a table will provide information under two headings.

Everyday tables include price lists, catalogues, timetables (school/travel), weather charts, distance tables, mobile phone tariffs and sports fixtures/league tables.

Key features

- Needs to be systematic/have a logical order
- Rows and columns
- Heading titles on rows/columns, including units (if appropriate)

Vocabulary

data
cell
column
title
row

Common Misconceptions/Errors

Learners should be encouraged to have some sort of system when collecting data and organising data. The following example could be used to emphasise how the organisation of data is important, in order to make interpretation and analysis of results easier.

Example

A survey was conducted to find out which pupils used the school tuck shop. They were asked which school year they were in. Here are the results:

7	8	7	9	7	9	9	8
10	10	9	7	7	11	7	11
9	8	11	7	11	10	8	8
7	7	11	9	8	9	10	10
8	10	8	8	9	7	7	7

The data has been collected and presented in a table. However, it is not easy to interpret the data. How can we represent the data more effectively?

Year	Tally	Total
7	𝍸 𝍸 ||	12
8	𝍸 ||||	9
9	𝍸 |||	8
10	𝍸 |	6
11	𝍸	5

Using a tally chart to organise the data makes it more straightforward to see the overall results.

Representing the data in the form of a graph or chart may further enhance any patterns or trends in the data. (See further sections on individual types of graphs/charts)

Teaching Ideas/Activities

- Encourage learners to consider **how** they will collect the data. Use questions such as:
  - **Who shall we ask?** (Discuss 'Would it be fair to ask boys only?' Should we ask more pupils in Year 8 than Year 9 - does this give a fair picture?)
  - **How many shall we ask?** (size of sample) Learners should understand that:
    - » asking too few pupils may not give a fair picture of the situation, and
    - » asking too many pupils may be more difficult to manage.
    - » What is a reasonable size for the sample?
  - **When/Where shall we conduct our survey?**
    - » Should we stand by the tuck shop and ask them as they use it?
    - » Is the end of lunch time a good time to conduct the survey?
    - » Should we conduct the survey on more than one day to see if there are any differences?

- Opportunities to **create** questionnaires are valuable. It is important to phrase questions carefully so that the data collected is clear. **This can take quite a bit of practice!**

  e.g: if an Internet company was to ask *"Do you use the internet?"* and only give a choice of 'Yes' or 'No' as answers, it would be quite difficult to analyse the results. When you think about it - an answer of 'yes' has a range of meanings.

  Consider offering multiple choice answers:
  e.g: *"How often do you use the internet?"* Every day/3-6 times a week/ 1-2 times a week/less than once a week/never

- Invite learners to find a 'table' which is related to their hobbies/interests and use this as a basis for developing their skills and understanding.

  For example:

  1. Someone planning a journey may have come across a timetable
  2. Sports fanatics may want to view the results of matches played over the weekend - which are often represented in a table (Played/Won/Lost/Draw/ Points)
  3. Buying a mobile phone - tables are used to show the costs (price of handset/price per minute/free minutes/monthly contract)

- In order to develop understanding of the **Key Vocabulary, Target Boards** (supplied in Numeracy Box) can be used to practice finding cells, by referring to columns and rows. What is the number in the 3rd column, 2nd row? Use the words 'column' and 'row' to tell us where the number 50 is. Consider numbering/lettering the rows and columns (as you would find on a spreadsheet.) What is the number in Cell D9?

21	3	5	19	37
11	27	12	6	42
9	25	45	90	76
30	18	60	15	50

- Play a ‘Battleships’ game.
- Encourage learners to see the connection between **data in tables** and **data in graphs/charts**. Prepare sets of data shown in a table, and a corresponding graph or chart. Ask learners to match the graph/chart to the data in the table.

Example

The following example could be used to practice the skills required to read a table.

Accommodation Costs for Last Lodge

Accommodation rating

Number of guests	3*	4*	5*
2	£280	£350	£450
3	£320	£400	£510
4	£355	£445	£565
5	£385	£485	£615
6	£410	£520	£660

Prices quoted are based on a 1 week stay in a self-catering lodge.
Children under 16 go free!
Bed-linen provided.

Spend time discussing what information the **table** is giving us - **as well as the small print!** Working in pairs, invite the learners to offer their suggestions. e.g. the table tells us that there is 3*, 4* and 5* accommodation, children under 16 go free, the prices in the table are all for 1 week, it’ll cost £280 for 2 people to stay in a 3* accommodation.

Make ‘True’ or ‘False’ statements:

e.g. 4 people can stay in 4* for £400 (False)
It’s cheaper for 5 people to stay in 3* than for 3 people to stay in 4* (True)

Once the learners are happy with the content of the table, pose the following scenario:

There are two adults, one 18 year old, a 16 year old and a 9 year old who wish to book some accommodation. They have a total budget of £600, they can spend during the week. Which type of accommodation would you recommend? Do they have to bring sleeping bags? What other costs should they account for during their stay?

Everyday Examples

- A travel agent may use ‘Currency conversion tables’ to help their customers with their holiday money.
- A bus driver would use a timetable to ensure he arrives at his destinations on time.
- A TV Guide uses tables to show which programmes are on at which time.

Bar Chart*/Bar Graph

* bar chart used for consistency

Definition

A way of representing data. Different numbers (or frequencies) are represented by vertical or horizontal bars of equal width. The longer the bar, the higher the frequency.

General Information

There are a wide variety of bar style charts to choose from as seen below.

They are good for demonstrating and comparing simple data very clearly. However, bar charts can be drawn to give the picture you want to show! Consequently, bar charts can be quite misleading!

It is useful to be familiar with both vertical and horizontal bar charts.

They are most commonly used for discrete data (see Introduction for reference to Discrete and Continuous data), and therefore important that there are spaces between the bars.

Key features

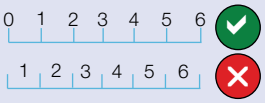
- Must have a title
- Must be drawn on squared/graph paper (depending on ability)
- Bars must be equal width and have equal spaces between them
- Labels are placed below each bar
- Bars should not be split into blocks (as in a Block Graph)
- The most appropriate scale is chosen based on the data collected, and must be labelled **on** each division not between the divisions

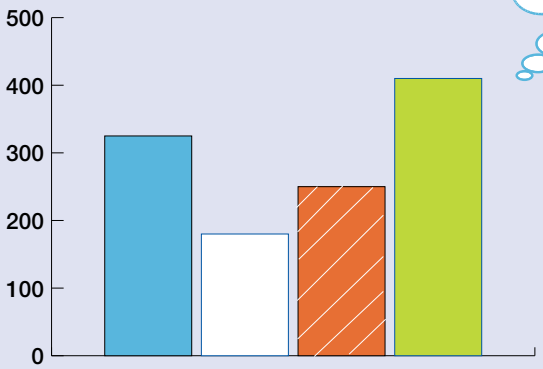
Vocabulary

data	title
axis/axes	scale
division	label

Common Misconceptions/Errors

- No title
- Bars may not be the same width
- No labels, or labels on axes placed incorrectly
- Inappropriate scales chosen
- Scales labelled incorrectly
- Blank paper or lined paper used



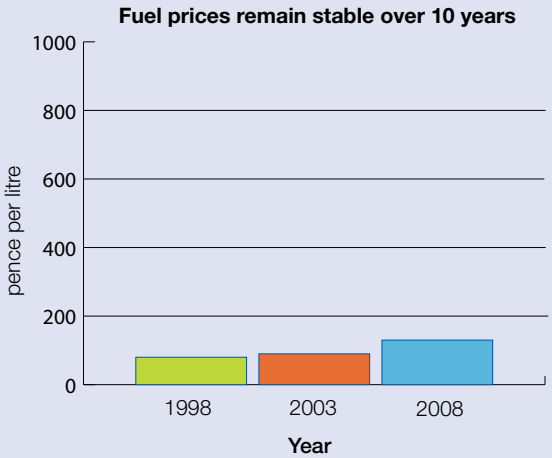


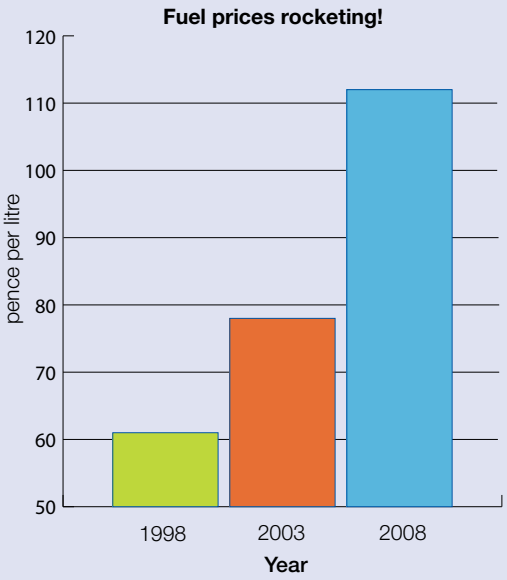
How many mistakes can you find?

Sales in 4 months	Number sold
Mobile Phone	325
Mobile Phone with aditional accessories	250
Mobile Phone with internet facility	250
Mobile Phone with camera	400

It is useful to present an incorrectly drawn representation of data to learners, encouraging them to highlight and discuss errors.

The bar charts below demonstrate how data can be distorted to give the desired effect!





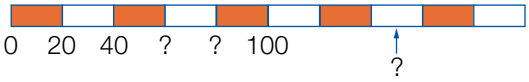
Comparing these bar charts can develop learners' understanding of why choosing the most suitable scale is important.

Teaching Ideas/Activities

- Reading scales is a very important skill when handling data. Provide opportunities for practice by using the counting stick:

  - Hold the counting stick either horizontally or vertically to correspond with the axis in question. Remember, it is a specific point that represents a specific number. So use a finger to point to the divisions, **not** the whole hand to hold onto a section.

    e.g. if counting in 20s, where is 200?



  - Don't forget about the values between the divisions.

  - Where is 110? What about 25?

- When deciding on a scale, encourage learners to look at the data, and provide a selection of 'Scale Selectors' to help them choose the most appropriate one. (See Scale Selectors Pg 39-42 for guidance on how to use.)

- Use the two 'Fuel Prices' bar charts for discussion of why different scales have been used. Which one do you think the Government would prefer to display? Which one would a fuel protestor choose?

- Encourage learners to sketch the bar chart on a wipe clean whiteboard, (supplied in Numeracy Box) before asking them to draw it accurately.

- When ready to construct the graph, encourage learners to note how many 'categories' they will need to fit along the axis. E.g. in a survey of 'favourite pets' there were 5 'categories' (cat, dog, fish, rabbit and horse). They will need to allow space for 5 equal bars, plus the gaps between them. Work out the space needed before starting to draw or you may run out of space! As a guide, on graph paper, use the bolder vertical lines to help with the construction of the bars. (The templates from the Overhead Grid Pack, supplied in Numeracy Box, can be used for demonstration.)

- What's the story? - tell the story that goes with the graph.

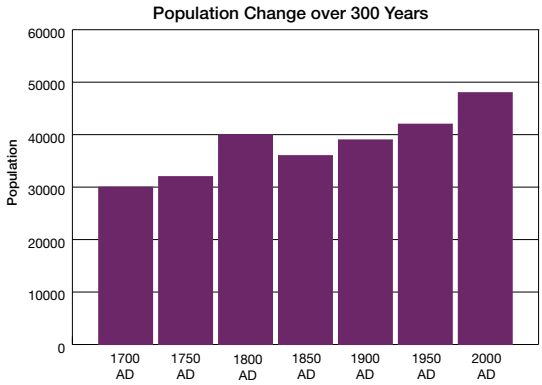
- Use the Bookmarks provided to encourage learners to check their work.

Note:
Remember to offer a balance in the type of activities offered: **interpreting** as well as **constructing** graphs and charts.

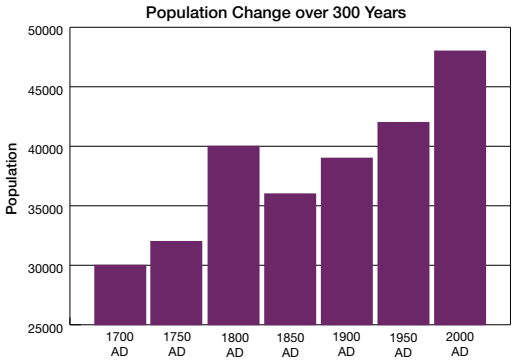
Examples

Many different types of Bar Chart are used in the media, and it is useful for learners to be aware of them (see below).

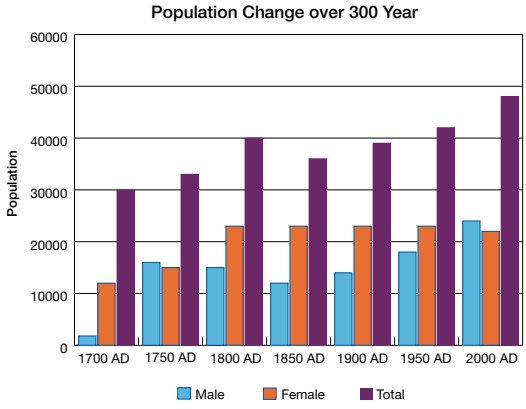
However, for the purposes of this guidance, we will focus on Bar Charts A and B only.



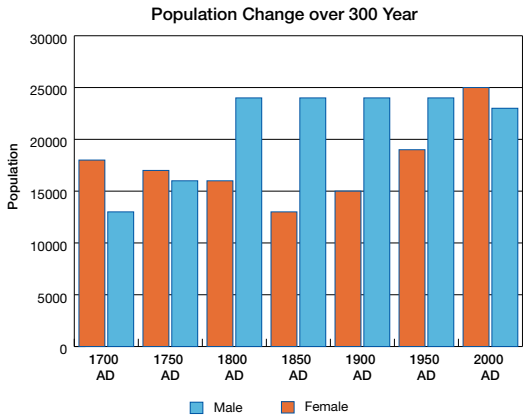
A Bar Chart



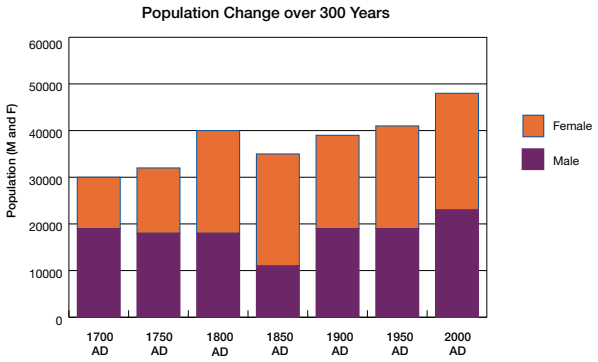
B Bar Chart



C Grouped Bar Chart



D Grouped Bar Chart



E Composite/Grouped Bar Chart

All these bar charts have been created using the same data.
Give learners Bar Charts A and B, and ask them to compare and contrast.
What are the differences and similarities? Which do they prefer? Why?

Everyday Examples

- Agriculturalists comparing land use in different countries.
- Meteorologists may use bar charts to look at total rainfall per month over 12 months.
- Radio stations: Survey of favourite types of music.

Be aware

The term 'frequency' is used in mathematics to refer to how many times a certain event has occurred, and is often used as a label on one of the axes.

It is important to note that 'frequency' is also a term which is used in Science, but with a very different definition.

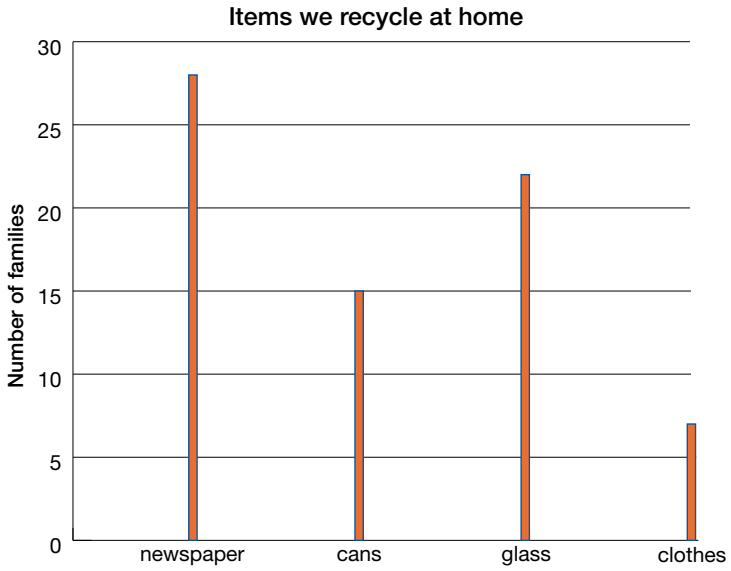
Bar-Line Chart/Bar-Line Graph

This type of chart is very similar to a bar chart, but the data is represented by lines rather than bars. See the above section for similar features, misconceptions and teaching ideas.

Example

72 families were asked what types of materials they regularly recycle.

Here are the results:



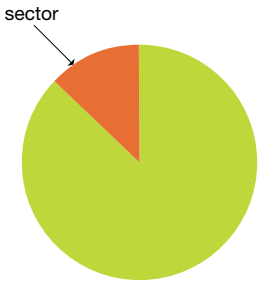
Pie Chart

Definition

A way of representing data. A circle is divided into sectors. Each sector represents part of the total. The larger the angle at the centre of the circle, the larger the frequency.

General Information

Pie charts are used to represent discrete data (see Introduction for reference to Discrete and Continuous Data), and the circle that is used represents **all** the data.



Sectors are used to show how the data is split into sub-sets, which are represented as a part of the whole. Generally, a pie chart should not have too many sectors, otherwise it can become difficult to interpret.

Key features

- A circle is used to represent all the data
- Must have a title
- Each sector must be labelled, or a key provided to aid interpretation
- Each sector is calculated as a part of the whole
- When comparing pie charts, the total sample size should be provided

Vocabulary

data	title
circle	sector
key	fraction/proportion
angle	

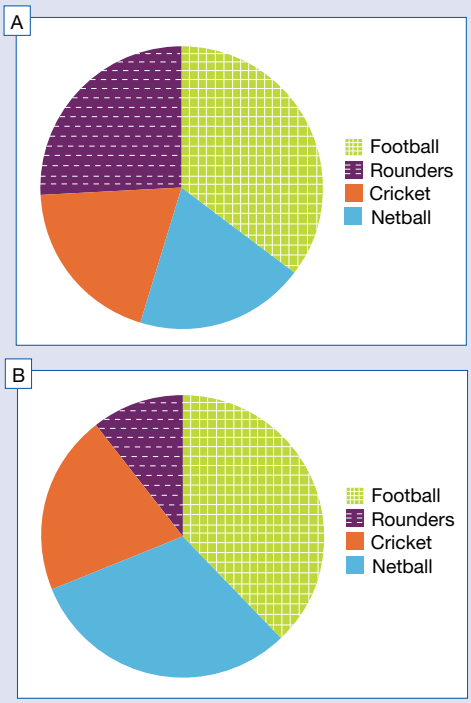
Common Misconceptions/Errors

- No title
- No key given
- Size of circle or sector interpreted as being larger values (see example 1)
- The value for the frequency is used as the value for the angle to form the sector (see example 2)

Example

1. Interpreting pie charts

Group A and Group B were asked to vote on one of four sports. The data is represented in these pie charts.



Which of these statements are true?

a) Fewer children voted for netball in Group B than Group A

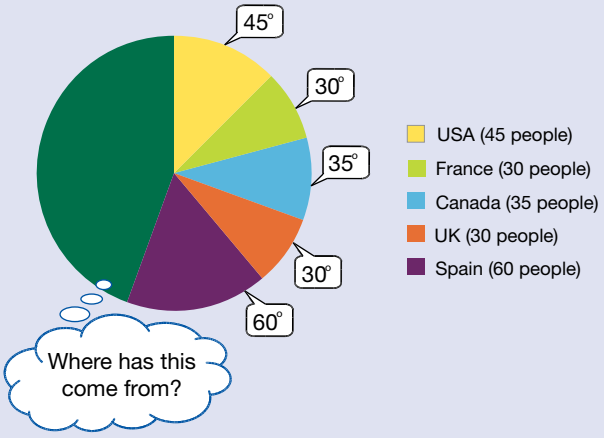
b) More children voted for rounders in Group A than Group B

c) A higher proportion of children voted for cricket in Group B than Group A

The number of children in each group would need to be known in order to comment on statements a) and b). If we say that Group A = 20, Group B = 100, then statement a) would be false, because netball (blue sector) is approximately ¼ of the circle, and ¼ of Group A = ¼ of 20 = 5. Whereas in Group B, again netball (blue sector) is approximately ¼ of the circle, but this time it is ¼ of Group B = ¼ of 100 = 25.

2. Constructing Pie Charts

Survey of 200 people: Where would you like to go on holiday?



Each sector *should* be calculated as a part or proportion of the whole

i.e. 45 people out of 200 said U.S.A. which is roughly ¼

»so to work out the angle:

$$\frac{45}{200} \times 360 = 81°$$

It is useful to present an incorrectly drawn representation of data to learners, encouraging them to highlight and discuss errors.

Teaching Ideas/Activities

- At this level, more emphasis is given to *interpreting* pie charts than *constructing* them. Being able to estimate angles is a valuable skill when interpreting pie charts. Use an 'Angle Estimator' to practice (see page 23).
- Opportunities to reinforce the relationship between fractions, decimals and percentages can be useful when introducing pie charts. This can be done by using the counting stick.

e.g. using the data from the example above

Holiday	Number of peple
USA	45
France	30
Canada	35
UK	30
Spain	60

What is the total number of people asked? (200)

If the whole counting stick represents 200 people, where would 100 people be? (Halfway, or 5/10)

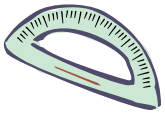
What is each division worth? i.e. the stick (200) is divided into ten 'parts', so each 'part' must be worth 20. (200÷10)

What section of the stick would represent the 30 people who said France? [one part (20) and half part (10)]. Rotate the stick to find the equivalent percentage. (15%)

e.g. label one side of counting stick with numbers and the other with corresponding percentages then use the data from the example above.

Encourage learners to estimate the fraction of the pie chart for 'Spain.' 60 people out of 200 is like 30 people out of 100, which is 30%, which is a little bit more than 25% or ¼.

- Sketch a pie chart on individual whiteboards before constructing accurately
- During the *early stages* of learning how to construct a pie chart a stencil based on % rather than ° can be used.



  - » For example, if you wanted to represent 90 people out of a total of 150, ask learners to estimate first (i.e. it'll be more than half or 50%, so more than 180°)

To work out the percentage:

» $\frac{\text{part}}{\text{total}} \times 100 = \frac{90}{150} \times 100 = 60\%$

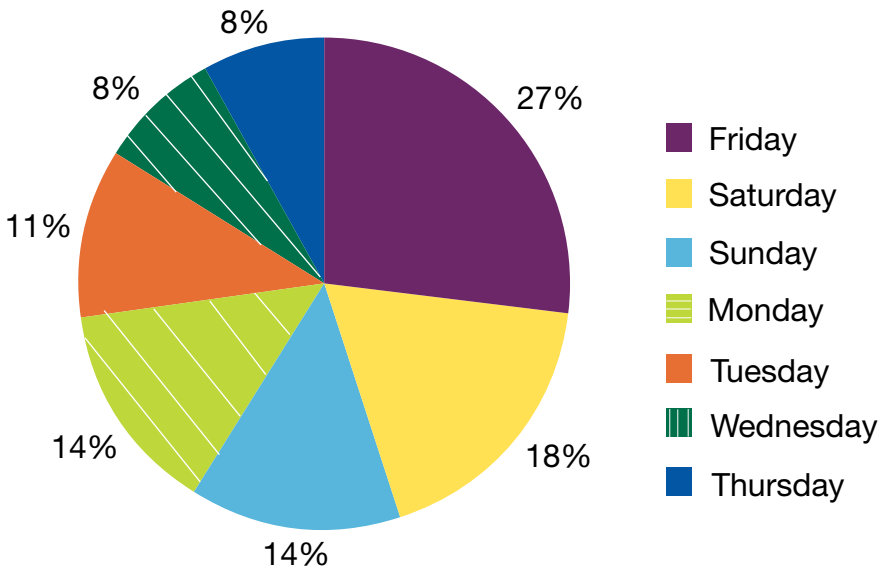
» Find 60% on Pie Chart Stencil

(For whole group demonstration, use the Pie Chart template in Overhead Grid Pack, supplied in Numeracy Box)

Example

The following example could be used to practice the skills required to interpret a pie chart.

Visitors to Theme Park



Total number of visitors = 5000

Ask learners to discuss what the pie chart is showing us.

Roughly what fraction is coloured purple? (¼) How many people would be represented by 10% (10% of 5000 = 5000÷10 = 500) Roughly how many people attended in total on Wednesday and Thursday? (around 1000)

Other questions to ask .....

1. What percentage of visitors attended on Wednesday?
2. How many visitors attended on Wednesday?
3. True or False? More visitors attended the park on Monday than Tuesday.
4. On which day did more than a quarter of the total number of visitors for the week attend the park? Does this surprise you?

Everyday Examples

- Local Councils use pie charts in annual reports to show how public money is spent.
- Sports coverage to show Olympic Medals won per country.
- Opinion Polls in magazines: (Excellent/Good/Satisfactory/Poor).

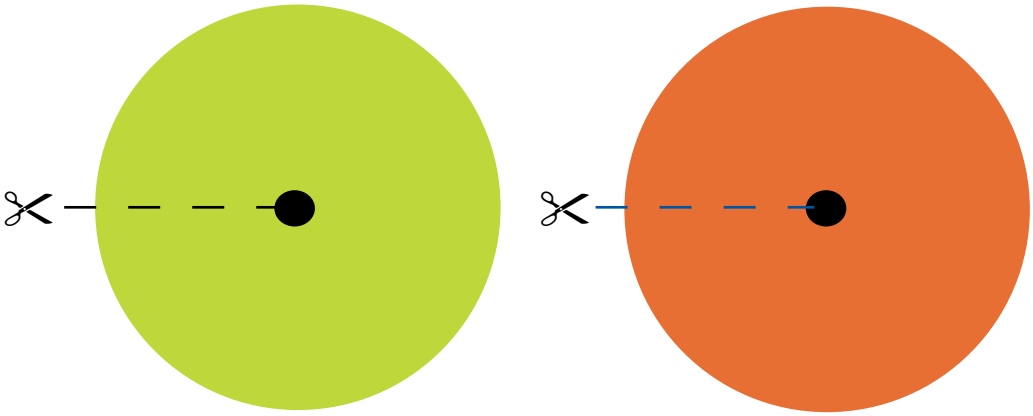
Angle Estimator

The Angle Estimator can be used by:

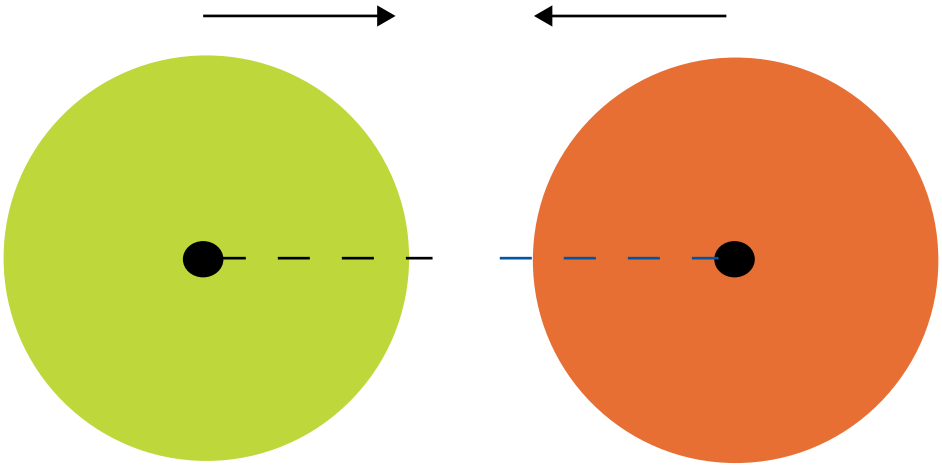
- the educator - for demonstration purposes;
- the learner - to show responses to questions (remember this is used for estimation, not an accurate measurement of angles).

Instructions

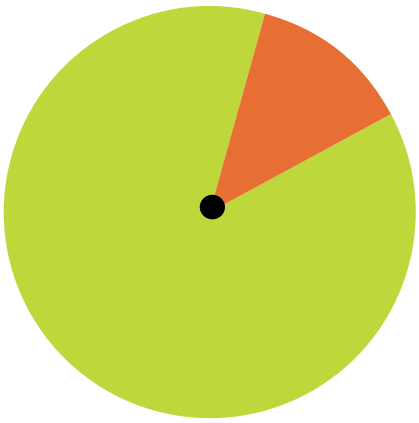
- Cut two circles of contrasting coloured card (suggested radius of 10-20cm) (more uses can be made of this resource:
  - if laminated card is used - dry wipe pens can be used to mark them;
  - three interlocking circles are used, to display three sets).
- Mark the radius on both, and cut along them.



- Slot one circle onto the other, so that the centre points of both circles meet.



- Pierce both circles through their centre points, using a brass fastener to secure them.
- Rotate one circle over the other to reveal a coloured sector.



Possible Questions

If the circle represents a total of 1000 people, show me ……

- the orange sector to represent 500 people. What's the angle? (180°) What's the percentage? (50%) What's the fraction? (500/1000, 50/100, ½ etc.)
- an angle of 90° - how many people does this represent?
- the size of the green sector, if 10% of the people are represented.

Line Graph

Definition

A way of representing data. A diagram which shows how two sets of information are related, in the form of a line.

General Information

A line graph is suitable for continuous data (see page 3 for reference to Discrete and Continuous data).

It is drawn by plotting points (with a x) related to two sets of information. These points are then joined to create a line. Only the plotted points have real meaning, the line only shows the pattern that may have occurred between the plotted points.

A line graph is particularly useful when showing a pattern over time.

Key features

- Must have a title
- Should be drawn on squared/graph paper (depending on ability)
- Each axis should have a label, and include units e.g. time (seconds)
- The most appropriate scale is chosen based **on** the data collected, and must be labelled **on** each division not between the divisions
- Points plotted with a x

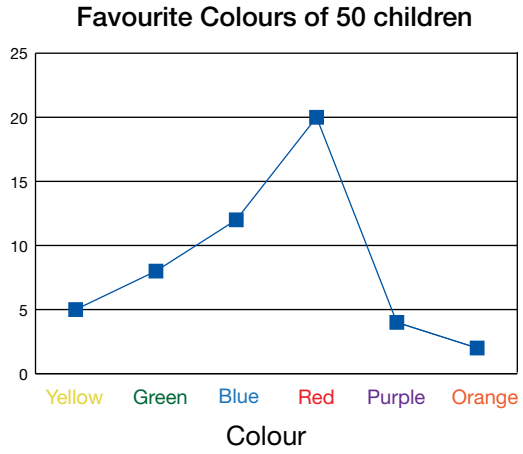
Vocabulary

data	title
axis/axes	scale
label	plot
trend	

Common Misconceptions/Errors

- No title
- No labels, or labels on axes placed incorrectly
- Inappropriate scales chosen
- Blank paper or lined paper used
- Line Graph not suitable for type of data
- When both scales include numerical values - reading the wrong axis leads to incorrect interpretation

Example



Constructing a Line Graph

The data represented on this line graph is discrete, i.e. colour categories, and therefore a line graph is unsuitable.

This error is common when learners use an ICT package to input data, which then creates a graph on their behalf.

i.e. in this example - the line joining 'blue' and 'red' does not have meaning, because it is not possible to have a colour between 'Blue' and 'Red.'

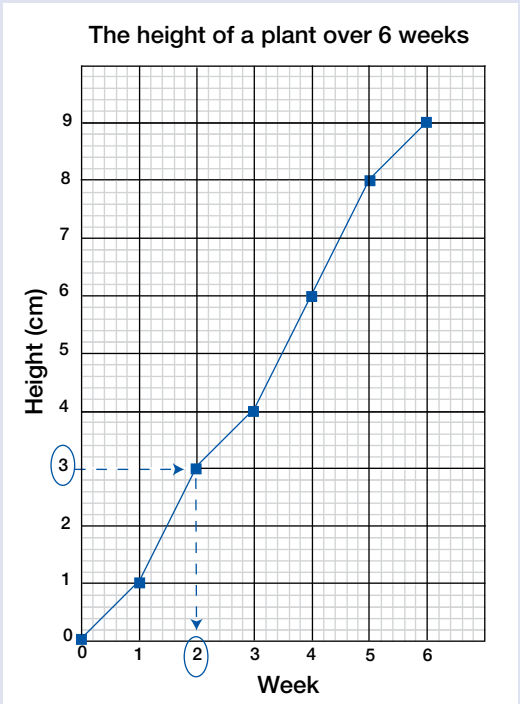
Interpreting a Line Graph

Question: How tall was the plant at 3 weeks?

Answer: 2

The labels on the scales have been ignored, thus the graph has been read incorrectly, and no units have been given. The correct answer is 4cm.

It should also be noted (as in the section on bar charts) that the choice of scale on the vertical axis can change the 'appearance' of the data plotted on a graph.

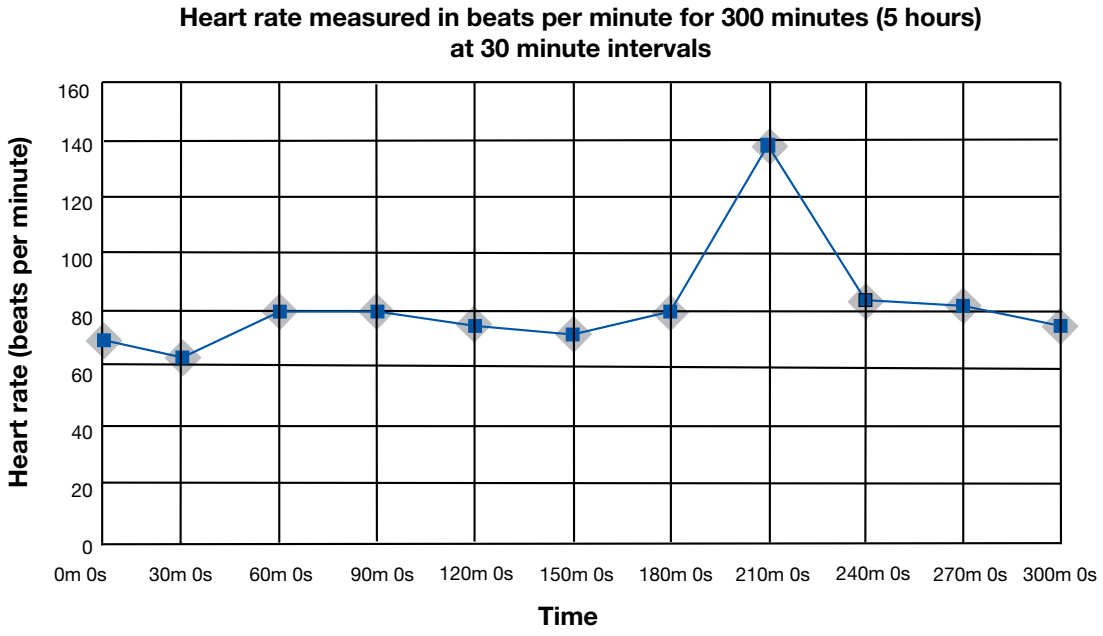


Teaching Ideas/Activities

- Encourage learners to discuss what the graph is telling us, before attempting to answer any questions. e.g. with reference to the 'Height of plant over 6 weeks' graph above - *"…… the time is shown along the horizontal axis, and as the weeks go by, the plant is getting taller. It was at its tallest of 9cm at 6 weeks ……"* By encouraging them to 'tell the story' of the graph first, they will be more likely to succeed in interpreting the data correctly.
- Give a collection of line graphs, with different parts left out (title, labels, scales). Ask them to think of a story which describes each graph.
- Remind learners to check the type of data they wish to represent, before deciding whether a line graph is suitable. "Is there a possible value between these two points?"
- Encourage them to choose a scale which will form a graph which is just over half the page they're drawing on. Is it best to hold the paper in portrait or landscape? See Teaching Ideas/Activities in **Bar Chart** and **Scale Selector** sections for further guidance.

Example

The following example could be used to practice the skills required to interpret a line graph.



1. How long did it take for the heart rate to reach 80 bpm?
2. After how much time was the heart rate 135 bpm?
3. Tell the story from the graph.

Everyday Examples

- A Health Visitor records the Weight of a baby over 12 months on a line graph.
- Tour operators may use a line graph to record hours of sunshine in a travel brochure.
- Changes in ‘Stocks and Shares’ frequently use line graphs to show trends over time.

Mean, Mode, Median and Range

Definitions

Mean: A type of average. The arithmetic mean is obtained by adding two or more values together and dividing the total by the number of values

Mode: the value which occurs most often (frequently) in a set of data

Median: The middle value when a set of values are placed in order from smallest to largest

Range: The difference between the smallest and largest values in a set of numerical data

General Information

The term 'average' is commonly used in the media, but in fact, there are three types of average: *Mean, Mode and Median.*

Usually the 'average' that is referred to on a day-to-day basis is actually the *mean*.

All three types of average can be calculated from a given set of numerical values, which may be whole or decimal numbers.

Key features

- See 'Examples' below

Vocabulary

data	values
ascending order	most common
least common	minimum value
maximum value	spread

Common Misconceptions/Errors

- The most common error when dealing with the three types of average is when learners confuse which is which!

Mean

- Calculation errors (adding or dividing).
- Using a calculator without estimating first.

Mode

- Mis-counting the most common value.
- It **is** possible to have more than one mode.

Median

- Values not arranged in ascending order before selecting the middle value.
- In an even set of values, selecting two values for the median, rather than finding the value which is between the two.
- It is **not** possible to have more than one median.

Range

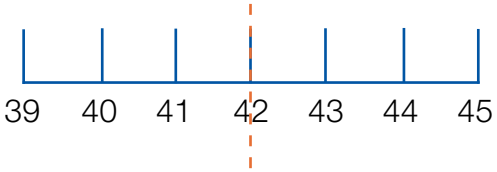
- Calculation errors (subtraction).

Teaching Ideas/Activities

- Encourage learners to estimate the mean first before using a calculator. This will enable them to decide whether their answer is sensible.
- Display a poster on *each* type of average, and encourage learners to use it as a reference. (One poster containing *all* the types can become overcrowded.)
- **Median:** If difficulties arise when there are two 'middle values'

  e.g. 32 33 38 ***39*** ***45*** 45 46 49

  encourage the use of a tape measure or number line. Fold at the two values (39 and 45) then fold this in half. This fold will mark the point which is half way between them, or the median value (42).



Example

Lap times (in seconds) for 10 motor racing drivers:

24	19	32	20	23	28	27	37	30	24

Mean

'add up all the values and divide by the number of values'

(24 + 19 + 32 + 20 + 23 + 28 + 27 + 37 + 30 + 24) ÷ 10 = 26.4

Mean = 26.4

Mode

'the value which appears most often'

24 19 32 20 23 28 27 37 30 24

Mode = 24

Median

'place all the values in ascending order, and select the middle value'

19 20 23 24 24 27 28 30 32 37

There are two middle values - the median is half way between these two values.
i.e. it is the mean of 24 and 27 : (24 + 27) ÷ 2 = 25.5

Median = 25.5

Range

'the difference between the smallest and largest values'

24 19 32 20 23 28 27 37 30 24

Smallest Value

Largest Value

Range = 37 - 19 = 18

Everyday Examples

- Football supporters magazine records average number of goals scored by players during a season.
- Garden Centre labels on seed packets: Average number of germinated seeds per pack.
- Average time for a long distance runner to work out personal best.

Bookmarks

Handling Data Checklist

P-TASK

Have I checked ……

PAPER
Have I used graph paper?

TITLE
Have I remembered to put a title on my graph/chart?

AXES
Have I labelled the axes?
Do I need to include units? (seconds, cm, kg …)

SCALE
Have I chosen the most suitable scale for the data?
Have I remembered to label the divisions, not the gaps?

KEY
Do I need to include a key to explain what things mean?

Handling Data Checklist

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Have I chosen the most suitable scale for the data?
Have I remembered to label the divisions, not the gaps?

KEY
Do I need to include a key to explain what things mean?

Glossary

(relevant to booklet)

Definitions are written in the specific context of Handling Data

angle	when two lines meet at a point an angle is formed. It is the measure of rotation from one line to the other. Angles are measured in degrees (°)
ascending order	a set of values placed in order, starting with the smallest
axis/axes	a horizontal or vertical line on a graph to show the position of a point
average	sometimes used instead of 'mean.' Other measures of average include median and mode
bar chart **bar graph**	a way of representing data. Different numbers (or frequencies) are represented by vertical or horizontal bars of equal width. The longer the bar, the higher the frequency
bar-line chart **bar-line graph**	a way of representing data. Different numbers (or frequencies) are represented by thin vertical or horizontal lines. The longer the line, the higher the frequency
block graph	a way of representing data similar to bar chart/ bar graph. Different numbers (or frequencies) are represented by blocks (representing one unit) which are arranged in columns
chart	a drawing which shows information
column	information arranged vertically
continuous data	data collected from measurement, which can take any value between two values
data	a collection of information consisting of counts or measurements, gathered by observation or questioning

database	a large amount of information usually stored on a computer system
diagram	a drawing which shows information
discrete data	data collected from a count of separate items or events
fraction	part of a number
frequency	the number of times something happens
frequency table	a table which shows how frequently each event or quantity occurs
graph	a diagram which shows how two sets of information are related
key	a list of symbols used in a graph or chart, and what they mean
line graph	a diagram which shows how two sets of information are related, in the form of a line
maximum value	the largest value in a set of data
mean	a type of average. The arithmetic mean is obtained by adding two or more values together and dividing the total by the number of values
median	the middle value when a set of values are placed in ascending order
minimum value	the smallest value in a set of data
mode	the most frequently occurring value in a set of data
percentage	number of parts in 100
pictogram **pictograph**	a way of representing data. Pictures or symbols represent a number of objects (or frequency). Part of a picture or symbol is used to represent a rough proportion of the number.
pie chart	a way of representing data. A circle is divided into sectors. Each sector represents part of the total. The larger the angle at the centre of the circle, the larger the frequency

plot	to make marks on a graph or chart to show data
proportion	part of something compared to the whole
questionnaire	list of questions that are asked of a number of people
range	the difference between the smallest and largest values in a set of numerical data
row	information arranged horizontally
scale	a series of calibrated marks on the axis of a graph.
sector	the area created when two radii are drawn on a circle, and enclosed by an arc
set	a collection of items or values
sort	to put a number of things in order, or separate them into groups
spread	the area or range covered by data
survey	a method of collecting a sample of data by asking people questions
symbol	a sign or object which is used to represent something else
table	information organised in columns and rows
tally	a record or count of the number of items represented by vertical marks for each one, the fifth mark represented by a strike through. i.e. 𝍸
tally chart	a table to organise tally marks to record the number of items.
trend	describes how data changes over time
value	numerical worth or amount
vote	to express a choice or opinion

Answers

Pictogram - Page 8

1. Most popular - Comedy
   Least popular - Horror

2. Encourage learners to appreciate that the symbols can only represent a rough proportion of a number.

   Using the table - 18 more Adventure books were borrowed than Horror books (34 - 16)

   Using the pictogram - 20 more Adventure books were borrowed than Horror books (35-15)

3. Using the table - Total books = 142
   Using the pictogram - Total books = 140

4. Take suggestions e.g. *"No, I think more Comedy books will be borrowed next week because there's a local comedy festival being held, and it will make people want to read funny books."*

5. Take suggestions e.g. *"I think the number of books would increase because people may have more spare time or go on holiday, and take some books with them to read"* ***or*** *"children wouldn't borrow books during their school holidays because they want a break from reading!!"*

Table - Page 12

Accommodation Tariff - 4 adults (the 16 year old is counted as an adult).
There are three possible answers, but encourage learners to justify their choice of how the £600 is to be spent.

They could spend £335 (3*) or £445 (4*) or £565 (5*) on their accommodation, but they would need to account for other costs such as food, travel, entertainment etc.

Bar Chart - Page 17

Bar Charts A and B are both correct representations of the same data.
Encourage learners to look at the scale, discuss the most appropriate and justify their preference.

Pie Chart - Page 22

1. Visitors on Wednesday = 8% of 5000
2. Encourage learners to estimate first → 10% of 5000 is 500, so 8% will be a little less (400)
3. True
4. Friday. e.g. *"Yes it does surprise me because Friday is a week day, and most people work during the week and children go to school"* or *"No, it doesn't surprise me because when we go on school trips, we usually go on a Friday."*

Line Graph - Page 27

1. 60 minutes
2. 210 minutes
3. Take suggestions. e.g. *"This person had been doing some housework and the heart rate was 70 bpm. They sat down for half an hour before leaving the house to go for a walk to the shops. The shops were half an hour away, and by the time they got there, the heart rate was 80 bpm …… etc ……*

Scale Selectors

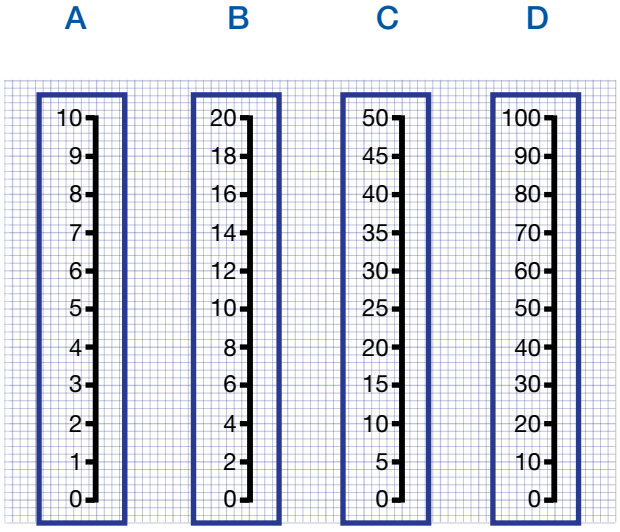
Notes

- To avoid having to draw accurate scales on the board, have a selection of ready made scales as a useful resource. (EXAMPLES SUPPLIED ARE NOT EXHAUSTIVE)
- Have a few blank laminated scales, which are marked with divisions only (a blank number line from the Numeracy Box could be used).
- Encourage learners to look at the data in order to choose the most suitable scale.
- Take suggestions, and discuss how appropriate each one is.

Example

A survey of 200 children's shoe sizes

Shoe size	Number
4	9
4½	4
5	8
5½	14
6	46
6½	35
7	29
7½	22
8	14
8½	14
9	5



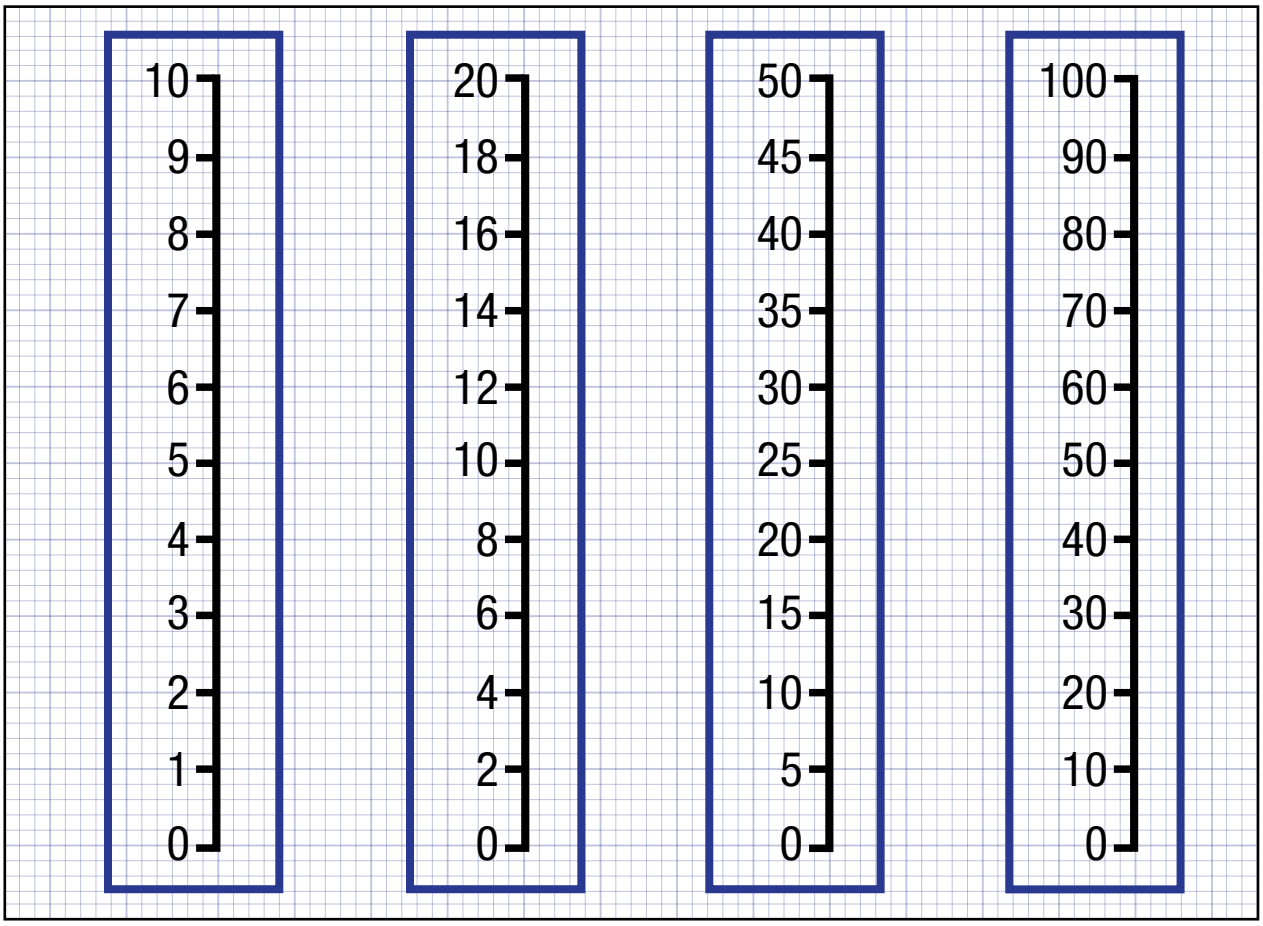
The smallest value is 4, and the highest is 46.

Scales A and B are unsuitable because their highest value is not high enough.

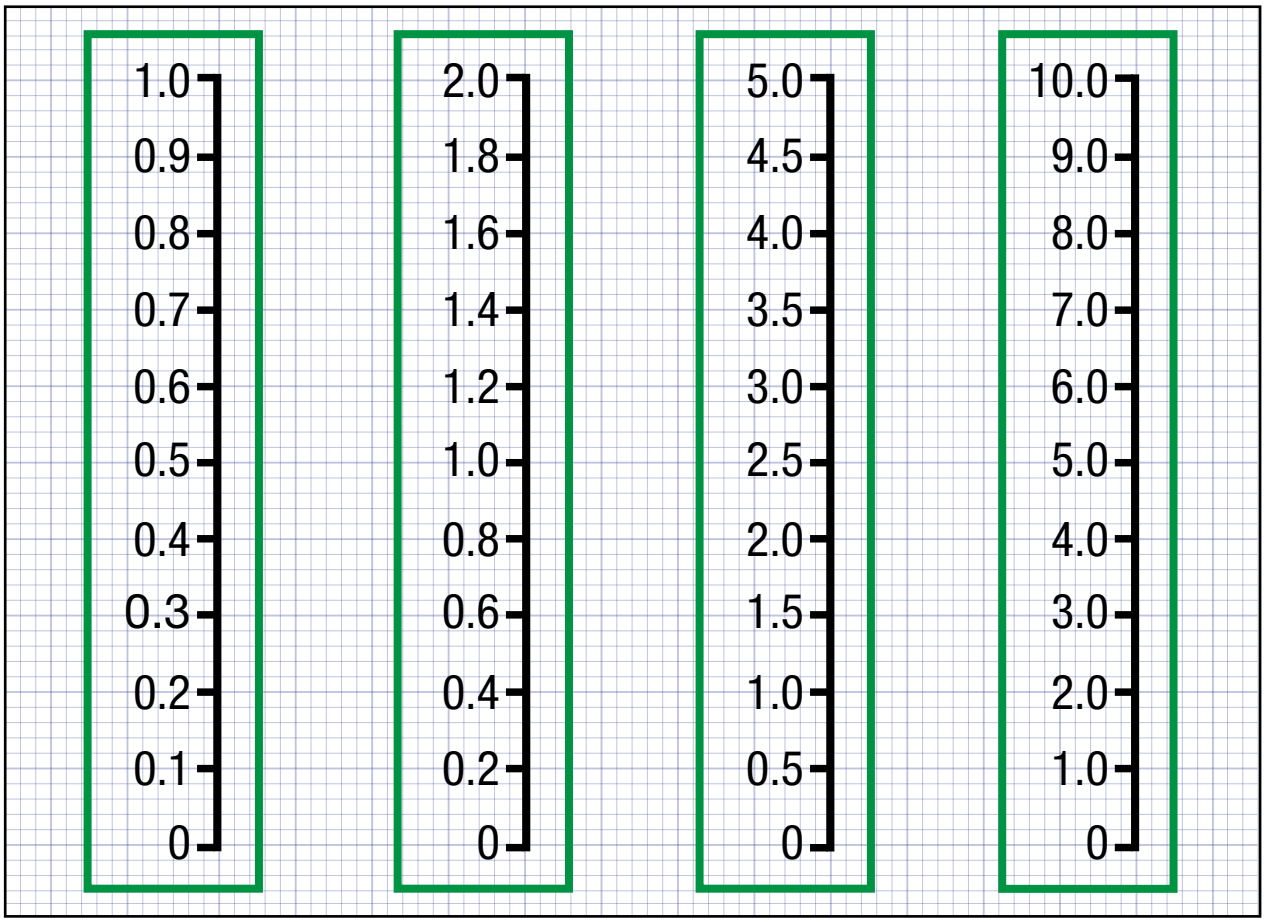
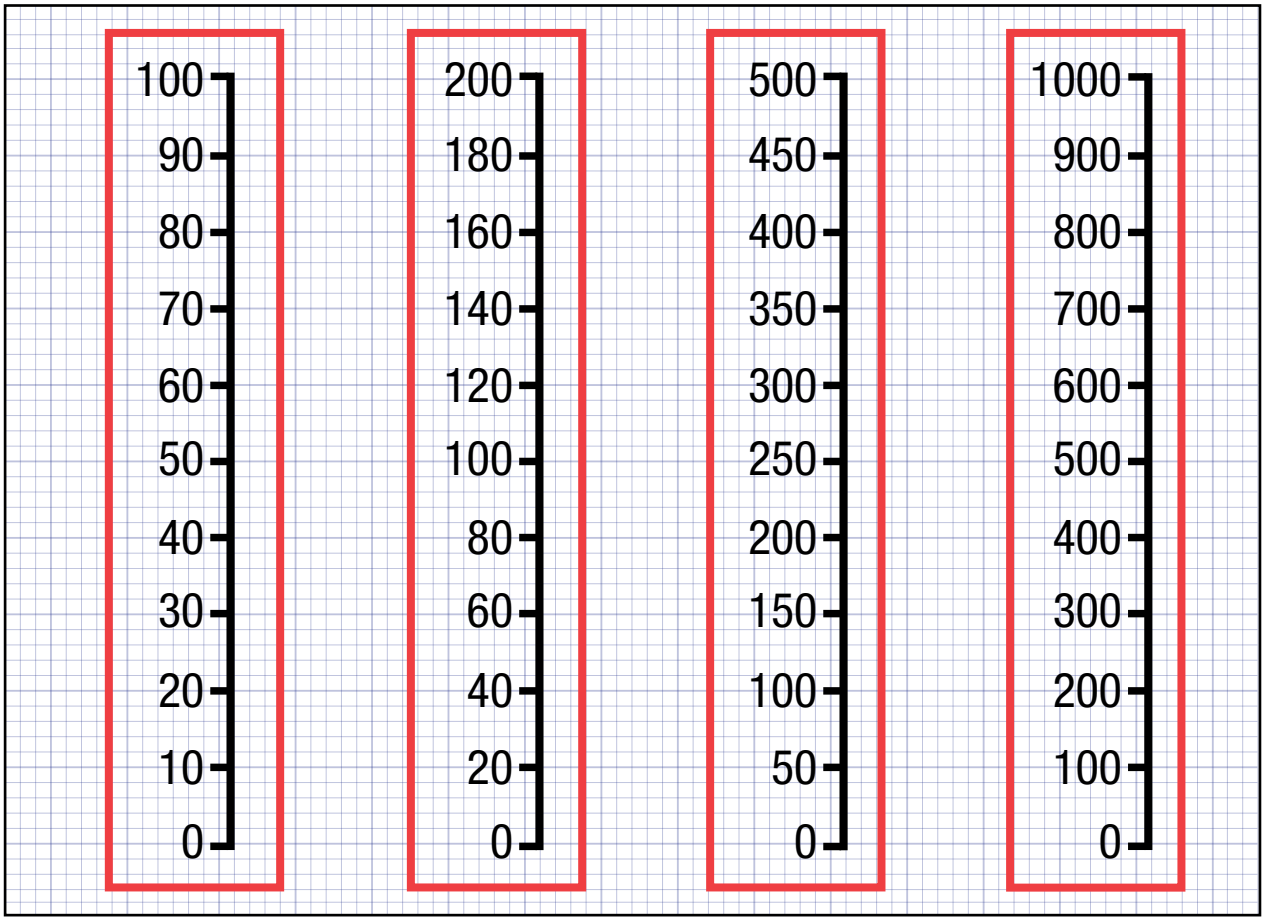
Scales C and D are suitable because they both have a maximum value above 46.

Ask some learners to use scale C and others to use scale D - to see what they deduce from the results.

Scale Selectors



Scale Selectors



Scale Selectors