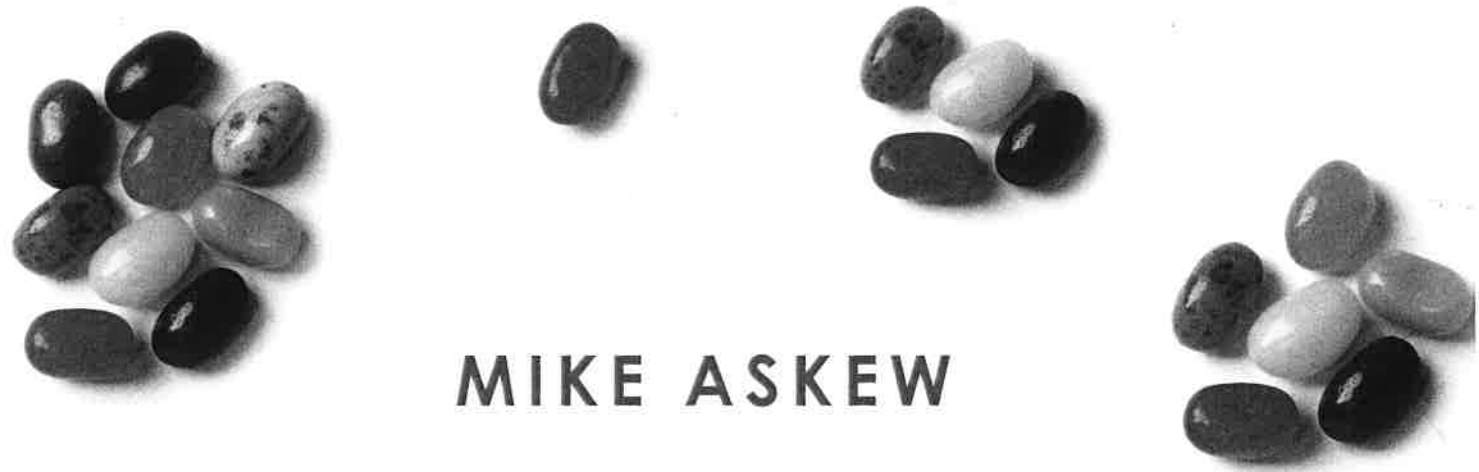




MIKE ASKEW

A PRACTICAL GUIDE TO TRANSFORMING **PRIMARY** MATHEMATICS

Activities and tasks
that really work

9 Data handling and statistics

Traditionally, teaching about data handling and statistics has largely focused on getting pupils to create graphs. Now, however, few graphs are drawn by hand; they are more often created using technology such as spreadsheets. The ease with which graphs can be created means that they are used more frequently and so the emphasis in teaching now needs to focus more on reading and interpreting graphs. In fact, producing graphs is only one part of a five stage data handling cycle that comprises:

- identifying and refining a question or issue;
- deciding what data to collect and how to collect it;
- collecting the data;
- presenting the data;
- interpreting the data in the light of the original question.

Big ideas

- Learning about data handling and statistics means engaging with all the stages of the data handling cycle.
- Posing good questions is essential in deciding what data to collect.
- The same data can be presented in many different ways and different presentations highlight different aspects of the data.

Making connections

- Data handling and statistics connects to measures.
- Presenting data can help learners' understanding of scale.
- Data handling can provide pupils with experience of posing problems as well as solving them.

Progression in data handling and statistics

Although England's National Curriculum does not specifically include work on statistics in Year 1, as a prelude to work on bar charts and pictograms, children can be invited to solve problems that involve sorting themselves in groups and so create 'human' bar graphs, as the task *Sort us out* demonstrates.

Through the use of pictograms, *What's in a name* introduces the big idea that one item (picture, symbol, block on a graph) in a mathematical representation can 'stand in for' more than one item in the real world.

Collecting data can often be time consuming and pupils' attention is more caught up in the collecting than in the subsequent presenting. The task *What's your score?* provides an example of a way of quickly collecting a range of data and representing it.

Too often data collection can become simply an end in itself, with pupils collecting and presenting data without any real questions that they are trying to answer. *Is it true that?* takes a claim - that three times the distance around your crown is about the same as your height - as an opportunity for pupils to use data they have gathered to check the veracity of something. Over and above this, it provides a practical, embodied introduction to the idea of the mean average.

The final two tasks take pupils into working with data that is broader than that which can simply be set up and collected within the classroom. The fantasy context of *How far could you get?* engages pupils in collecting data from the Internet and challenges them to set up some mathematical models to enable them to compare how far they could travel by different modes of transport in the same time.

The world wide web has extended the range of data that pupils can gain access to, including data about other schools and other learners. *Are you a bookworm?* involves pupils in interrogating a large data base and then gathering data to test out whether the pupils in their school are representative of what this large data set purports is typical.



SORT US OUT

Foundational inquiry.

Stages

Key Stage 1.

Direct object of learning

Introduce simple bar charts.

Indirect object of learning

Problem solving: create and interpret human bar charts.

Tools

Paper and coloured pencils.

Task

Public talk

Put the class into groups of about eight and ask each group to stand in a line facing the front of the class.

Ask, 'How quickly can you find the tallest person in your group and put everyone in order?'

Pupils sort themselves into a line with the smallest person at one end and the tallest at the other and in so doing will be engaged in a lot of comparing of heights.

Now ask them to sort themselves by the day of the month their birthday is on, or the number of buttons they can see on each other.

Private talk

Further challenges, like sorting by shoe size or numbers of brothers or sisters, are likely to mean that a single line is not possible (for example, three children might have the same shoe size), and so several children may have to stand together. Work on how they could form a 'human graph' by these sub-groups standing one behind the other. Pupils take a different coloured cube each and use these represent their orderings. These will go from putting the cubes out in one line, to piling some cubes up on top of others (three children have no brothers or sisters), thus producing instant mini-block graphs. Provide paper and coloured pencils and invite pupils to find some way of recording the ordering.

Assessment

- Can pupils suggest some criteria according to which they can sort themselves?
- Do pupils record their work in a simple graph-like format?

Public conversation

Bring the class together and invite pupils to go and stand in new groups, this time in response to questions with 'yes/no' answers:

- 'Do you like sprouts?'
- 'Do you walk to school?'
- 'Are you wearing trainers?'

Variations

An extension to this is to get the pupils to line up facing you. You decide on a 'secret' question (such as, 'Are you wearing a sweat shirt?'). Each pupil approaches and is directed to the left or right according to whether or not they fit your rule. Once the two groups have been established, can the learners figure out what your rule was? Pupils can take it in turns to think of a rule and sort everyone out.

An 'instant graph' chart can easily be set up and used almost every day to do some data handling (and a bit of calculating). All you need is a board about 1 m x 50 cm (strong cardboard will do), with a line drawn down the centre, lengthwise. Paper, a bulldog clip and a collection of spring clothes pegs complete the set up.

Each morning, before the pupils arrive, clip paper to the top of the board with a 'yes/no' question on it, such as, 'Do your shoes have laces?' or, 'Is 592 an even number?' Label the halves of the board 'yes' and 'no'. As they arrive, pupils collect a peg and clip it to the side of the board according to their answer to the question. An instant, visible representation of the data is created and you can discuss this as well as looking at the number of pegs on each side and the differences between these.

WHAT'S IN A NAME?

Practice and consolidation.

Stages

Key Stage 1.

Direct object of learning

Use information presented in scaled bar charts and pictograms and tables to answer questions.

Indirect object of learning

Problem solving: select and use appropriate calculation skills to solve problems involving data presented in a scaled fashion.

Tools

Class lists of names of children in various classes across the school.

Task

Public talk

Ask the pupils to write down their first name and to count the number of letters in it.

Who has the name with the most number of letters? Whose name has the least number of letters?

Say the range is from three ('May') to nine ('Christina') letters - write the numerals from '3' to '9' on the board.

Go round the class asking each pupil in turn for the number of letters in their name, tallying alongside the numbers and finally putting up the total.

Talk about creating a block graph for the data collected and explain that this will be in the form of a pictogram where an image will be used to represent every two people. Decide on a simple image to use and go through the totals working out with the class the number of symbols required for each number of letter names. Construct the graph either using post-its with one symbol on each or electronically. Label the axis, and put in the scales

Ask various questions about the graph such as:

- Which is the most common number of letters in our names?
- How many children have names with that number of letters?
- Which is the least common number of letters in our names?
- How many children have names with that number of letters?
- What is the difference in numbers of children between the most common and the least common?

Private conversation

Give pairs of children a class list. Working together they draw up a chart like the one on the board. One child counts the number of letters in the first names while the other tallies - they swap over about half way through. They complete a pictogram with a symbol representing two children. They pose and answer five questions about their graphs.

Assessment

- Can pupils pose questions that involve comparisons, for example, how many more pupils have names with six letters than names with five letters?
- Asked questions about their graphs, do pupils correctly use the fact that each symbol stands for two pupils?

Public talk

Display some of the graphs produced and the questions the pupils asked about them.

Looking across a number of graphs are there any patterns in the data?

Draw up a chart to collate the data from five or six classes.

Back in their pairs, pupils produce a pictogram for this combined data but this time one picture represents every five pupils.

Variation

As pupils become confident, help them turn their pictogram graphs into bar charts with appropriate scales on the y-axis. There are many things that can be used for such surveys but choose data that is not going to embarrass any learner: favourite colour or flavours of crisp rather than, say, height or weight.

WHAT'S YOUR SCORE?

Practice and consolidation.

Stage

Lower Key Stage 2.

Direct object of learning

Interpret and construct simple pictograms, tally charts, block diagrams and simple tables.

Indirect object of learning

Problem solving: interpret, collate, organise and compare information.



Tools

Semi-open number lines.

Task

Public talk

Demonstrate to the class how to draw a star by drawing a triangle and drawing a second one inverted over the other.

Let the pupils practise drawing these. Explain that they are going to have one minute to draw as many stars as they can. Emphasise that the point here is not to try and 'win' by drawing the most number of stars. They should draw the stars as quickly as they can but not sacrifice making them reasonably accurate for speed.

After the pupils have had a short time to practise, time them for exactly one minute. They count up the number of stars they completed.

Provide everyone with a 1–100 number line, the scale marking the multiples of five and ten. Also have one on the board to complete in the same way that the pupils will complete their individual ones. Go round the class asking each pupil to call out their score.

For each value an X is marked above that point on the number line – the pupils also write in the number below on their lines if it is not already there. For example, if a pupil drew 23 stars, everyone marks the point 23 on their lines, with the numeral 23 below the line and an X marked above it. If a score is called out again, a second X is marked above the X already there – so a form of block graph is built up.

Talk about the highest and lowest scores and get the pupils to figure out the difference between these two values. When the class has agreed on this value, talk about how this value is called the 'range' of the data.

Do any scores have more than one X on them? Is there a score that has more Xs than any other score? That is the mode value of the data.

Most likely the Xs will be spread out along the number line with gaps between them with several values having, at most, only have one or two Xs on above them. Discuss with the children how the Xs from an 'instant' graph, but that is it a bit 'spread-out' and rather 'flat'. Discuss how rather than recording the exact score of every child, the scores can be put into groups, say, scores between 20 and 24. Work with the class on agreeing on a set of groups that will reduce the data to around 6 or so groups. This will depend on the range of the scores. For example, if the scores have a range of around 50 (from say 25 to 76) then the groupings might be 20–29, 30–39, 40–49, 50–59, 60–69, 70–79. But if the range is smaller, say 20 (from 22 to 41) then the groups need to be smaller; 20–24, 25–29, 30–34, 35–39, 40–45.

Draw up a table for the groupings chosen and get the pupils to record their own.

Go round the class again with pupils calling out their scores once more. Now as scores are called out, everyone puts a tally into their chart to record which group the score goes in.

Private talk

The pupils can now create block graphs of the grouped data.

Assessment

- Do pupils display knowledge of the conventions of graphs: clear scales, labelling axes and so forth?
- Can they answer questions about their graphs such as, 'How many pupils scored more than 30?' or, 'Which did more pupils score in, between 10 and 19 or between 20 and 29?'

Public talk

Display the number line record and grouped data together and discuss why the same data looks different on each. What are the advantages and disadvantages of each representation?

Variation

A variety of tasks to be completed in a short period of time could be used. For example, the children could be asked to list multiples of five for one minute. How many were they able to write down?

IS IT TRUE THAT?

Extension challenge.

Stage

Lower Key Stage 2, but also suitable for older learners.

Direct object of learning

Interpret and present discrete and continuous data using appropriate graphical methods.

Indirect object of learning

Problem solving: collect data and use scales in their representations.

Tools

Tape measures.

Task

Public talk

Before setting off on the main inquiry, pupils can explore the idea of mean average from measuring their 'crowns'.

Provide each pupil with a strip of paper that is more than long enough to fit around his or her head and across the forehead (as if making a paper crown). Working in pairs the pupils fold the strip to create a reasonably accurate measure of their 'crown' (not allowing for any overlap – the ends of the strip should just meet). They cut or tear off the extra paper and discard this. Using rulers or tape measures, everyone measures and records the length of their 'crowns' – some may measure this in centimetres and millimetres, some you may direct to measure it to the nearest centimetre.

Private conversation

Working in groups of four or five, using their paper strips, can the children figure out what the average 'crown' is for their group? Discuss the idea of 'average' being what the measurement would be if everyone had the same size crown but the total of all the crowns together did not change. Pupils can tape all their paper strips together, end to end, and then fold the long strip into four or five equal parts depending on the number in the group. They measure the length of this 'average' that they have created. Using calculators and the lengths that they previously recorded can they check by calculating if their practical way of finding the average has worked?

Public talk

The children are now set up for the challenge. Explain that you heard someone say, 'Three times round your head is about the same as your height'.

Discuss this statement. What would count as 'about'? Set the pupils off in groups to find out if the statement is true.

Private conversation

Provide the learners with paper strips, tape measures, calculators and, if they are familiar with them, the opportunity to use spreadsheets. But apart from that, leave it to the pupils to decide what data they are going to collect and how they will present it.

Groups have to prepare a presentation that they will give to the class on their conclusions about whether or not the claim is accurate.

Assessment

- Do the pupils use measuring tools accurately?
- Are they checking the relationship by multiplying (scaling up the lengths of their crowns by a factor of three) or by dividing (dividing their heights by three)?

Public talk

As it would take too long for everyone to present their findings to the class, you could divide the class up into two sets of the groups. So if, say, there were eight groups, four work together, each group presenting their findings to the other three groups in their half of the class.

Variation

There are other 'folk' claims about proportions of body parts that could be checked, for example:

- Holding your arms out wide, the distance from fingertip to fingertip (body span) is the same as your height.
- The length of your nose is the same as your ear's.

Source

A classic inquiry that I first met in around 1992 (Askew, Brown, Prestage, & Walsh, 1992) when developing materials to support the introduction of the National Curriculum.

HOW FAR COULD YOU GET?

Extension challenge.

Stage

Upper Key Stage 2.

Direct object of learning

Read and interpret information in timetables.

Indirect object of learning

Problem solving: decide how best to organise and present findings.

Tools

ICT.

Task

Public talk

Set up a fantasy scenario:

Aliens have announced that they are going to transport the school, its grounds and the surrounding area into space in two hours' time. The aliens have disabled all cars and motor cycles, but not public transport. Everyone is going to try and get as far away from the school as possible, either on foot, cycling or public transport.

Using one, some, or all of these modes of transport, what is the furthest the learners think that they could get away from the school? Take some suggestions of how far they think they could get - record these for later reference.

Private conversation

Pupils work in pairs or small groups. The problem is set up in such a way that they are going to have to either generate data (speed of walking) or search the Internet to find out things like average cycling speeds or local timetables for public transport.

Give the groups initially only around five minutes to talk together and plan what information they are going to seek out. Get groups to join up with other groups and share their ideas and plans.

Assessment

- Are the pupils prepared to pursue different lines of inquiry, for example comparing travelling by bus with cycling?
- Can they present their workings in ways that make clear to others the assumptions they are making about the models they create?

Public talk

Ask groups to share their plans for solving the challenge.

How do the solutions found compare with the suggestions made at the beginning of the lesson?

Which group thinks they have found the furthest that could be travelled? Can they convince everyone else of their findings?

Variation

Challenges of the 'would you rather' type provide contexts for setting up models and finding solutions:

- Would you rather have your weight in £1 coins, or your height as a stack of £2 coins?
- Would you rather have to copy out a chapter from a reading book or do 1000 long multiplications?

ARE YOU A BOOKWORM?

Extension challenge.

Stages

Upper Key Stage 2.

Direct object of learning

Interpret and construct pie charts and use these to solve problems.

Indirect object of learning

Reasoning: decide how best to organise and present findings and explain and justify reasons.



Tools

Calculators. Data from the Internet – see the 'Source' section at the end of this activity.

Use this data and a spreadsheet program such as Excel to produce two pie charts to display the reading preferences of males and females from a survey carried out in 2003:

	Male	Female
Adventure	2 274	2 007
Crime	1 066	392
Factual	850	2 069
Fantasy	1 087	589
Horror	1 961	1 754
Other	951	1 775

(The data can be downloaded directly into excel from the link at the end of this activity. The original data had eight categories – here, some categories have been collapsed together to make the pie charts easier to compare.)

Male**Female**

Task

Public talk

Display the two pie charts on the IWB, explaining what they represent.

In pairs, pupils spend a few minutes talking about what they can conclude about the reading preferences of males and females.

Discuss things like, which genre is most popular for each gender and whether there are any different preferences between the genders.

Talk about, say, the different regions showing a preference for fantasy books. Can we conclude from the pie charts that more boys than girls expressed a preference for fantasy?

Ask the learners to suppose the 500 males had answered the survey and 2,000 females. Could you conclude that more males expressed a preference for fantasy?

This is a key teaching point: pie charts only show the relative proportions. Without knowing the number of people in each sample, conclusions about absolute numbers in each category cannot be deduced.

Reveal that the total numbers of people sampled were:

Male: 8189

Female: 8586

Model on the board how to figure out an approximation for the actual numbers of people in each category by measuring one of the angles. Say it was 56° on the 'males' pie chart. Then as a proportion of the full turn, it is $56/360$. So you need to find $56/360$ of 8189. Take suggestions for how to do that. Go through finding $1/360$ by dividing 8,189 by 360 and then multiplying that by 56.

Private conversation

Give pairs of children copies of the pie charts, protractors and calculators. Challenge the learners to use the protractors to measure the size of the angle of each piece of the pie chart and figure out an approximation of the number of people who gave that preference. Support those children who need further help either in measuring the angles or carrying out the calculation.

Assessment

- Are pupils able to use the protractors correctly and accurately?
- Can they use the calculators appropriately and make sense of the answers obtained?

Public talk

Go through the numbers the learners came up with – how close are they to the actual numbers in the survey? Why are they not exactly the same?

Put the class into groups of three or four and set the challenge of coming up with a survey to see if the children in the class have preferences that are similar to these.

Private conversation

Groups carry out the survey and use a spreadsheet to present their findings. They should present these as pie charts and choose one other form of representation that they think highlights something different from the pie chart.

Public talk

Look at and discuss the various ways the learners chose to present the data? What does each highlight?

Variations

The Census at School website (see next) has a wealth of data that learners can explore.

Source

The data provided here was sourced from censusatschool.org.uk - a great resource for data handling. This particular challenge was adapted from: www.censusatschool.org.uk/resources/data-handling/142-are-you-a-bookworm.