Lesson plan: MATHS KS3

A SLICE OF THE PIE

Calculating the angles for sectors in pie charts involves some useful thinking, says Colin Foster…

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WHY TEACH THIS?

This lesson invites students to draw pie charts from different sets of data and to compare what they tell us.

KEY CURRICULUM LINKS

- Construct and interpret appropriate tables, charts, and diagrams
- Types covered include frequency tables, bar charts, pie charts, and pictograms for categorical data

In this lesson, students learn how to calculate the angles of the sectors in a pie chart for various data presented in frequency tables.

This is something that students will often learn in a mechanical fashion, and as a consequence, become confused over when to multiply or divide, and where the '360' is supposed to go.

In this lesson, students build up to these calculations from simple examples. The aim is to work with students' understanding of the situation, rather than with meaningless rules.

Q How can we find the angles needed to draw pie charts?

STARTER ACTIVITY

Q *Imagine asking some pupils what colour their bedroom walls are. Here is some data:*

Colour	*Frequency*
Red	5
Green	4
Blue	1
Yellow	2

Q *Write down three things you can tell from this data.*

Students might need to be reminded that 'frequency' means the number of pupils saying that colour. Note that this is a different use of the word 'frequency' from that in science. Students might come up with the following observations:

- There were 12 pupils
- There were only 4 colours of bedroom
- The most common colour (the mode) was red, closely followed by green
- The least common colour was blue

MAIN ACTIVITY

Q *What kind of graph or chart could we draw to represent these data?*

Students might suggest bar charts, pictograms or pie charts. You could quickly create the associated bar chart or a pictogram on the board (see Fig 1).

Q *I want you to sketch roughly how a pie chart would look for our data.*

Students could do this on mini-whiteboards, or they could approach the board and show how they think a pie chart might look. They

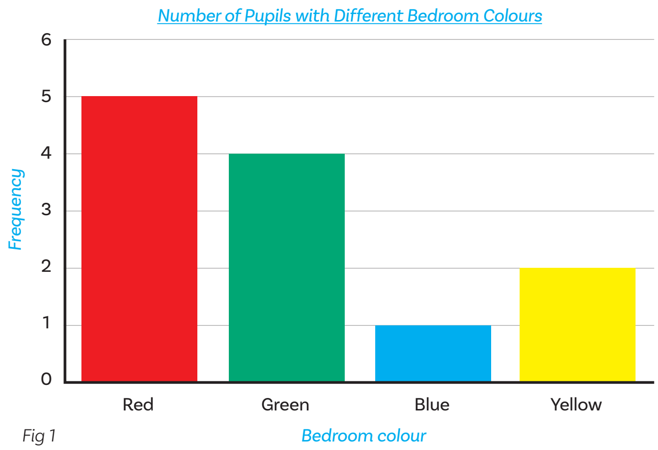


Fig 1

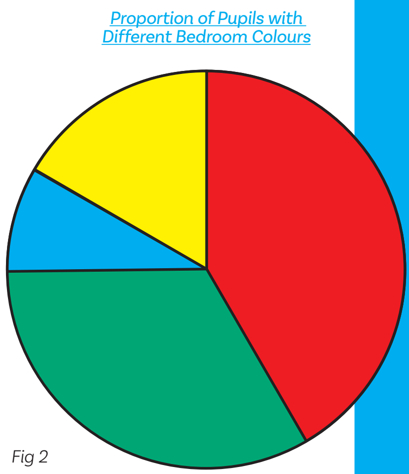


Fig 2

may realise that although red is the largest category, it accounts for *less than half of the total frequency* and should therefore fill less than half of the 'pie'.

Q *Now we are going to calculate the angles exactly. How should we do it?*

Colour	Frequency	Angle
Red	5	
Green	4	
Blue	1	
Yellow	2	
TOTAL	12	

Students will realise that the *total* frequency is important, and that this can be written at the bottom of the 'Frequency' column.

Q *Which colour do you think is easiest to work out first?*
Blue is clearly easiest, because the people with blue bedrooms were exactly $\frac{1}{12}$ of all the pupils. So, their angle must be $\frac{1}{12}$ of the total angle,which is 360°, so the angle of the blue sector must be $\frac{360°}{12} = 30°$. And once we have that then it's easy to calculate all of the other angles, as multiples of this one.

Colour	Frequency	Angle
Red	5	150°
Green	4	120°
Blue	1	30°
Yellow	2	60°
TOTAL	12	360°

This is the easiest one to start with

Make sure that students always check that their calculated angles add up to 360° before they start to draw the pie chart.

Q *Now use protractors to make an accurate pie chart for this data.*

Students should end up with the pie chart shown in Fig 2.

Q *Why doesn't it need a key?*
In this case, the colour of the sectors is sufficient to communicate which one is which. The order of the sectors doesn't matter.

Q *Now try another one, which **will** need a key. Here are some data from pupils about their favourite flavours of ice cream.*

Flavour	Frequency
Vanilla	2
Strawberry	8
Chocolate	5
Raspberry	3

In this case, there's no category with a frequency of 1. Students should *imagine* that there was, calculate what angle it would have, and then multiply up from this for all of the categories.

They should then draw pie charts to compare the ice cream preferences of these different classes:

	Class A	Class B	Class C
Flavour	Frequency	Frequency	Frequency
Vanilla	7	6	11
Strawberry	7	4	2
Chocolate	8	7	9
Raspberry	8	15	3

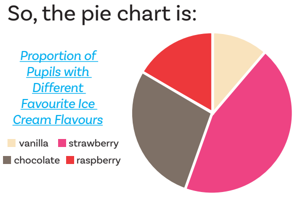
DISCUSSION

Q *How did your pie charts look? Which ones were easy to make and which were harder? Why? What did you conclude about the three classes and their ice cream preferences?*

Since the total frequency for the first one is 18, the angle for a hypothetical category with a frequency of 1 would have been $\frac{360°}{18} = 20°$. So, the angles for the actual frequencies are all integer multiples of this:

Flavour	Frequency	Angle
Vanilla	2	40°
Strawberry	8	160°
Chocolate	5	100°
Raspberry	3	60°
TOTAL	18	360°

So, the pie chart is:



Q *What's the same and what's different about these two pie charts?*

Students might pick up on many things, such as needing a key for the second one.

The angles for the three classes are:

	Class A	Class B	Class C
Flavour	Angle	Angle	Angle
Vanilla	84°	67.5°	158.4°
Strawberry	84°	45°	28.8°
Chocolate	96°	78.75°	129.6°
Raspberry	96°	168.75°	43.2°

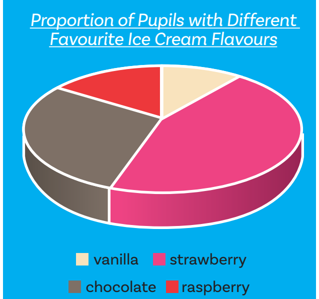
For class A, the frequencies (and therefore the angles) are so similar that it is hard to see the differences. This could be clearer in a bar chart, and is one reason why pie charts are less useful for precise work. For classes B and C, some of the angles turn out not to be integer numbers of degrees, and we just have to draw them as accurately as we can. Students could discuss which classes are in more or less agreement about their ice cream flavour preferences.

ADDITIONAL RESOURCE

It is easy to use an Excel spreadsheet to create pie charts and watch them change 'live' as you alter the frequencies for each category.

GOING DEEPER

Confident students could consider what may be misleading about 3D pie chart representations like this one. How accurately can you estimate the proportions of the sectors? Why might some



ABOUT OUR EXPERT

Colin Foster is a Reader in Mathematics Education at the Mathematics Education Centre at Loughborough University. He has written many books and articles for mathematics teachers.

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