Primary Magazine Issue 100: continuity and development in the teaching of fractions across KS2 and 3

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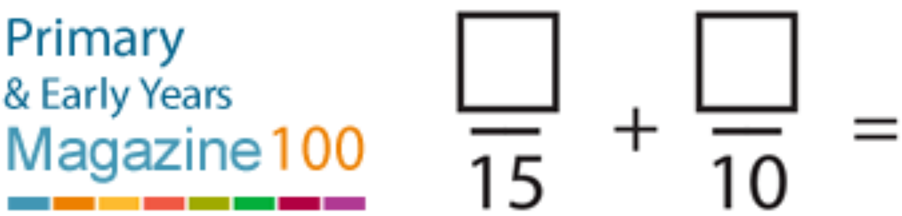

Continuity and development in the teaching of fractions across Key Stages 2 and 3

This article looks at the fundamental understanding of what a fraction is and how it works. These are the concepts that children should be engaging with in primary school and into KS3, as building blocks for sound reasoning throughout their mathematical lives. For each strand of understanding fractions, described below, there is an example question intended to inspect the strength of understanding, by requiring that children use their knowledge in a different way to 'standard' sorts of questions.

Understanding what fractions are, is crucial for reasoning about fractions *as numbers*, and *within calculations*.

In Upper Key Stage 2, pupils should have a deep understanding of what a fraction is and what the numbers in a fraction represent. The teaching should expose the fact that *the denominator is the number of equal parts in the whole*

and that *when comparing and combining fractions, the whole has to be the same* for all the fractions being considered:

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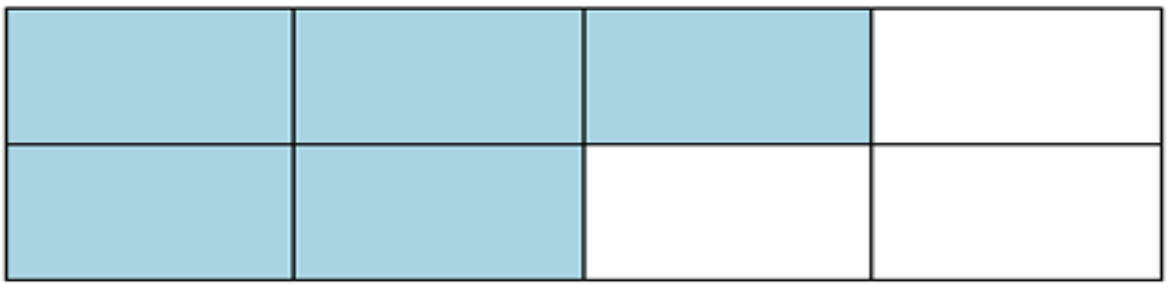
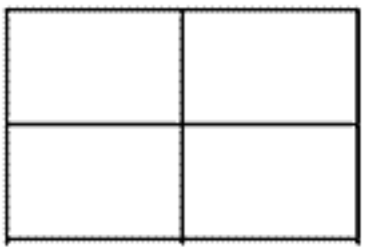
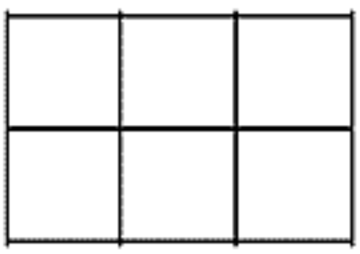


The pupils should be able to make and explain the generalisation that, *for the same whole, the bigger the denominator, the smaller the size of the pieces…*



$\frac{\square}{4}$



$\frac{\square}{6}$

They will also understand that *the numerator tells us how many of those equal parts we have*.

For the same whole, larger denominator = smaller pieces

The following question is one which would be classified as a **dòng nǎo jīn question*** as it is unfamiliar to the pupils and, unlike most of the other examples they will have encountered, does not ask for an exact answer but is interested in the reasoning that the pupils would have to go through to ensure that the answer is as small as possible.

Using the numbers 5 and 6 only once, make this sum have the smallest possible answer:

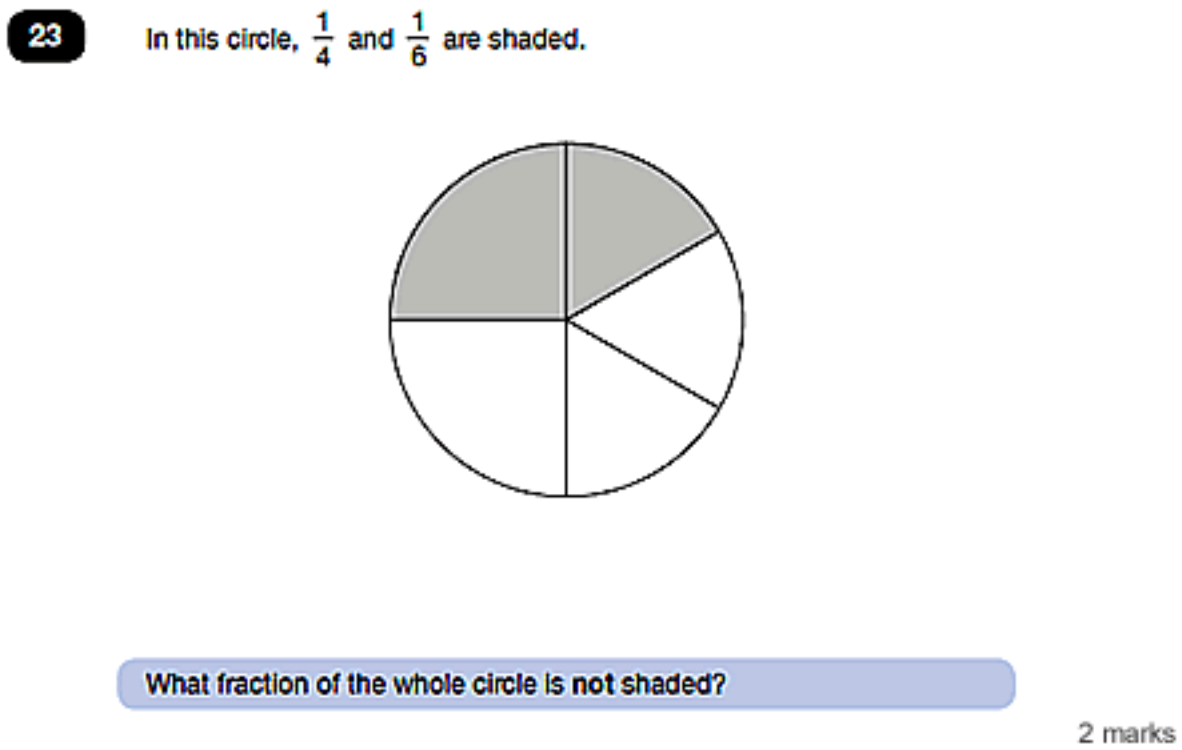
$\frac{\square}{15} + \frac{\square}{10} =$

*from the **NCETM Year 5 Assessment Materials (Demonstrating Mastery)***

The pupils would have to draw on their understanding that, for the same whole, fifteenths are smaller than tenths, so that the smaller number (5) is put with the tenths.

An understanding of fractions that allows adding with different denominators

As pupils end their time at primary school, their knowledge and understanding of fractions will include basic calculation with fractions. They are expected to be able to use their knowledge of equal parts, and the relation to the whole, to handle fractions with different denominators, when adding and subtracting. This example from the 2017 KS2 SATs shows how representation is used to reveal the structure of calculation and to expose the need for common denominators to calculate with fractions of different denominations.



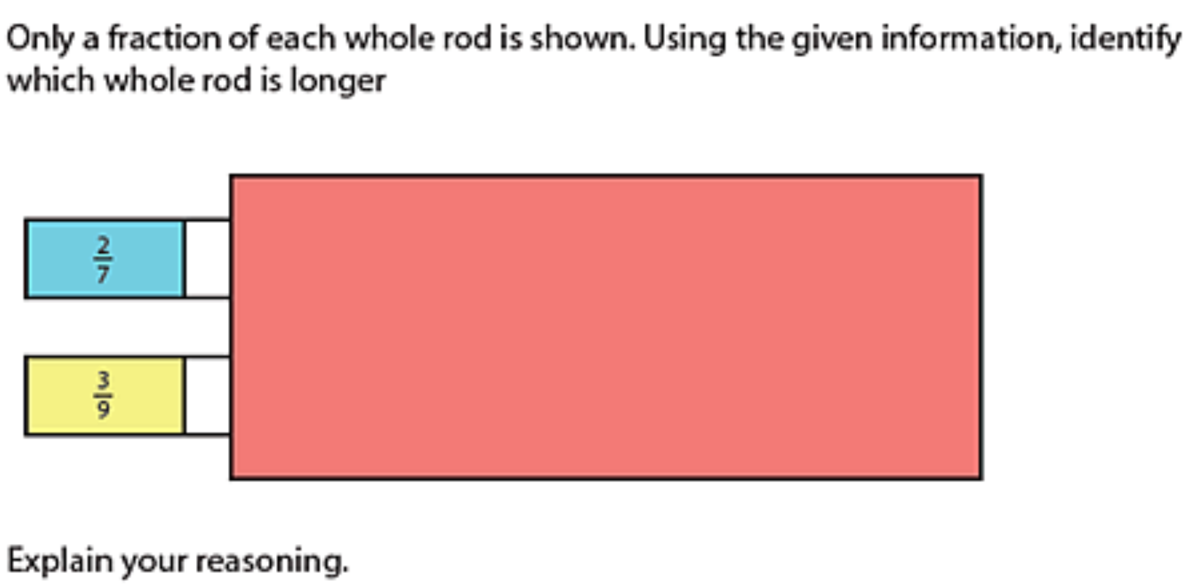
from the 2017 KS2 SATs Reasoning Papers

Pupils might be able to reason that the unshaded part of the circle is a half and another half of a sixth, which they should recognise as a twelfth. It is therefore possible that pupils would be able to reason their way to an answer of seven twelfths without having converted the quarter and sixth in to twelfths themselves. This flexibility of thinking and ability to make connections will enable subsequent teachers to build on this reasoning with the conventions of converting fractions into common denominators and record the problem entirely symbolically. This representation also demonstrates that it is not necessary to use 24ths as a common denominator but that the lowest common multiple of 4 and 6 is 12.

The use of images and representations such as this is now very common in Primary Schools across the country and provides a good starting point for Secondary Schools who quickly need to find out where their new intake are at with their maths. If the procedures are not secure or remembered then the representations will allow the pupils to demonstrate their understanding of fractions, onto which more formal methods can be built.

Understanding of the whole in relation to each fraction

Understanding of the whole in relation to each fraction is vital. In this case, pupils need to understand what the fraction represents in each case.



from the ***Year 6 NCETM Assessment Materials – Greater Depth***

This time the shaded portions are the same size and they are asked to consider the whole in relation to the parts. If understanding of parts and wholes and the structure of a fraction is secure, then the pupils should be able to reason that $\frac{3}{9}$ is the same as $\frac{1}{3}$ and therefore there will be 3 of the yellow sections in the whole rod. $\frac{2}{7}$ is less than $\frac{1}{3}$ (or $\frac{2}{6}$) therefore there will be '3 and a bit' blue sections in the whole so the blue rod will be longer. Reasoning their way to an answer in this way would perhaps demonstrate a greater depth of understanding as it is more efficient than using common a denominator of 63.

Fractions as values in their own right

By the time pupils move into Key Stage 3, 'Fractions' no longer has a heading of its own in the curriculum. 'Fractions' is part of 'Number' so understanding their behaviour as *values in their own right* is key.

This activity develops pupils' ability to reason about fractions as dividends and divisors within calculations. Dividing one fraction by another is the classic algorithm which many adults will quote to you as: 'turn the second one upside down and multiply' as Alice says below:

Alice, Bekah and Clare are explaining why $\frac{2}{3} \div \frac{1}{3} = 2$

- Alice says "Because you turn the second number upside down and multiply, so $\frac{2}{3} \div \frac{1}{3} = \frac{2}{3} \times \frac{3}{1} = \frac{6}{3} = 2$
- Bekah says "Because if I share two thirds of a cake between one third of a person then to get a whole person I need to multiply by three, so that means that the person gets six thirds of the cake and six thirds is the same as two."
- Clare says "$\frac{2}{3} \div \frac{1}{3}$ means 'how many one thirds are there in two thirds?' Because two thirds is the same as $2 \times \frac{1}{3}$, the answer must be 2"

Which explanation do you find most convincing? Why?

*from the **NCETM KS3 Assessment Materials***

If pupils understand the structure of division, they can then apply it to the case when a fraction is divided by another. This understanding means that they do not need to remember the rule, they stand a better chance of ensuring that their answer is correct, and also being able to reason their way through a problem where the ability to calculate may not be the focus.

Pupils being able to apply their deep understanding of a subject, to reason and solve unfamiliar problems is what we are looking for when we say that a child has achieved 'Mastery'.

* In teaching for mastery in Shanghai, the dòng nǎo jīn question is a regular part of the lesson that can be something tricky or puzzling about the concept, particularly that encourages pupils to use or develop their understanding in a different way.

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19 February 2018 12:19
Why don't we use the equivalence between fractions, decimals and percentages? They are all ways to identify subdivisions and can be shown on the same numberline. Sometimes switching between them makes for an easier calculation.
By **janghileri**   **Alert us about this comment**

31 January 2018 12:42
Higher level thinking aplenty here. The more ways you 'get-it' the better. I remember a PGCE lecture on Fractions when I was training; the guy delivering it was honest enough to say he hated them and never really understood the need. I worked for Ladbrokes/Corals for years so had them running through my veins. A big change was pushing thirds lower down into the infants otherwise they try halving as the first step to get 3 segments. A bookie has many parts to juggle: stake, winnings, total return(both), liabilities vs £££ in the briefcase. I always taught them as families 1/2 1/4 1/8 then 1/3 1/6. Draw them, cut them out, walls, number lines, cuisenaire with diff wholes etc etc. Explain 'x/div top then x/div bottom' with images till grasped. If you crack this ratios, scale factors, proportion and algebra is a logical step for them. Also the multiplication grid can be folded to show all equivalents (flexitables resources are best) 1/2 2/4 3/6 4/8 etc. Thanks for the article.
By **Quisza**   **Alert us about this comment**

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