National Research and Development Centre
for adult literacy and numeracy

Fractions

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Maths4Life

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Contents

Approaches to learning about fractions

This booklet is aimed at all teachers working with learners from about entry level 3 to level 2. It is not a text book, or a list of recipes to teach particular aspects of fractions. Instead, it suggests some approaches that we have found effective in enabling learners to use fractions and to relate them to other mathematical concepts.

It is important that learners think about relationships between fractions, rather than just trying to memorise methods for processing them. An introduction to fractions should include a strong emphasis on developing reasoning skills, comparing fractional amounts and exploring equivalence.

Many learners may feel that listening to the teacher and completing their own worksheets individually is the main way of learning. However, we believe that learners learn more if they actually enjoy the activity, have a chance to discuss what they do, explain their work, and reach a shared understanding. There is now widespread recognition of the value of collaborative work in developing conceptual understanding.

Although the activities outlined in this booklet can be done individually, most of them will work better as collaborative tasks. This approach may be unfamiliar to many learners, particularly those whose previous maths experience was in a more traditional classroom.

Learning is generally most effective when learners are working collaboratively. The task could, for example, be pitched a bit higher, just outside an individual learner's comfort zone, so that it needs a second opinion. It may also involve practical equipment that needs a second pair of hands. An explanation of the benefits and ground rules is important for all learners before starting collaborative tasks, so that each group member gets a chance to express an opinion and challenge what others say.

In this context the teacher is not so much an instructor, as someone who asks the right kind of questions to move discussions on, and doesn't immediately confirm correct answers. The teacher will want to spend time listening to the discussion in small groups, and may join in, but should not try to replace whole class lectures with small group ones.

As with all learning situations, the teacher will have to make some snap decisions about how to react to situations that develop, particularly those where a group agrees about something which is in fact incorrect. Comparison with the work of other groups where learners have to justify their conclusions can be a more powerful checking strategy than simple validation from the teacher.

Collaborative learning situations tend to have a shared goal of producing an end product, such as a poster, a presentation to the group, or a set of questions for other learners. Discussion of the similarities and differences between posters from different groups can be a very effective way of addressing errors.

Why fractions?

Many learners identify fractions as an area of maths that they find difficult, despite often using concepts of sharing effectively in their daily lives. The key question as to why so many people perceive fractions as difficult is something we need to consider.

One reason may be the notation of fractions. Another may be the formal vocabulary. Learners may be drowning in the language of fractions, even before thinking about their properties.

Learners may be able to draw and label fractions correctly, but not be able to put them in order of size, or use them to solve problems.

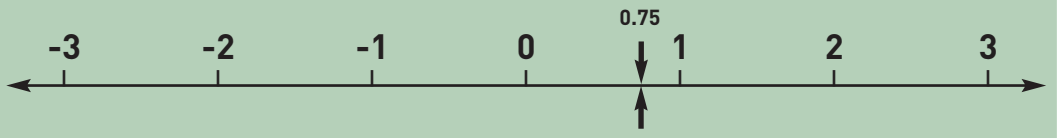
Fractions may also be confusing because they do not behave like 'normal' numbers.

Fractions sometimes represent an amount, something that can be visualised, and sometimes an operation, e.g. 3/4 can mean a shape with 3 equal pieces shaded out of 4; it can mean the result of dividing 3 by 4, or part of an instruction to find, say, 3/4 of 16.

Approaches to teaching about fractions need to give learners a chance to explain how they see them, and the teacher needs to take this into consideration in their approach.

What is a fraction?

A number in its own right



Fractions can be shown on the number line, (e.g. 3/4 is a number between 0 and 1). Learners need to understand that the number is the result of dividing the top number by the bottom number.

A proportion of a whole

Fractions can also be thought of as proportions/parts of a whole, (e.g. 2/3 of the people in this group wear glasses). The teacher can talk about what this means in terms of 'two in every three people wear glasses' and look at examples with the class.

Some learners may have been introduced to pictorial representations of fractions which still leave them confused.

For example, the diagram on the left is fine to explain 2/3 as a proportion. However, be careful not to use it to explain 2/3, meaning two things divided into three parts, as there are clearly not two things.

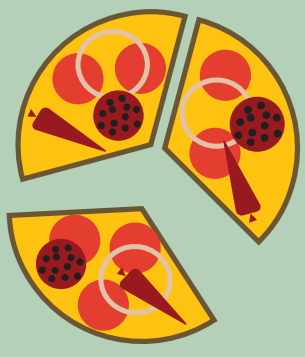
Relates to sharing objects

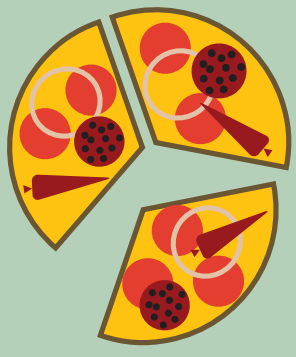
The third way of thinking about fractions is that they are about sharing (e.g. sharing two pizzas between three people).

Using the example of pizzas, we show how we might share two whole pizzas equally between three people (i.e. 2 ÷ 3):

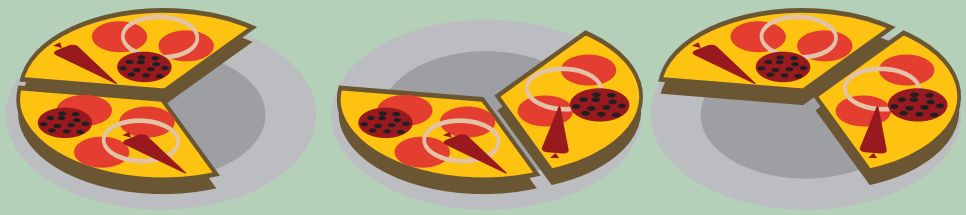
The top picture **(A)** shows two whole pizzas each divided into three slices, and the bottom picture **(B)** represents each person's share when the two pizzas have been shared between three people.

A





B




1/3

Introducing fractions

One of the first places to start is to ask learners to think of some fractions they have encountered in an everyday context, as a way of collecting up some possible definitions of the meaning of 'fraction'.

Some fraction vocabulary is used in common parlance, sometimes with rather different meanings, or less accuracy, and this can be usefully explored. For example, a "fraction" may sometimes mean "only a very small part" of something, as in "a teacher earns only a fraction of a professional footballer's salary". (An interesting question to ask learners is whether they think ¼ of a million is a big or a small number.)

Before dealing with the written symbolic form of any fractions, we can name some of them and talk about what they mean.

We can raise some questions about fractions and encourage learners to think of their own questions, e.g.:

- **When do people use fractions?**
- **Do fractions matter if they are only small parts?**
- **Is a half always the same size?**
- **Can a fraction be bigger than one whole unit?**
- **Is it possible to have three halves?**
- **Are fractions anything to do with division?**

Teaching points

- Learners should understand that one way of thinking about a fraction is to see it as the result of dividing the top number equally into the number of pieces shown by the bottom number.
- A key point is that the denominator (bottom number) of a fraction shows how many equal parts a number, or an object, or a set of objects, has been divided into. The numerator (top number) tells us how many of those parts there are.
- Learners need to be familiar with multiple representations of fractions, and should always be given more than one representation. These can include: area diagrams using a range of different shapes, number lines, words, symbols, some decimal equivalents and percentages, fractions as a result of division.
- Pictorial representations of a particular fraction may be of different sizes and different shapes. For example, don't always use shaded sections of circles, and interesting discussions can be had from drawing half of a small square and a quarter of a larger square and asking which is the larger fraction (and this means you have to be careful when using areas to explain fractions!).
- Compare unit fractions with different denominators (e.g. $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$).
- Compare fractions with the same denominator (e.g. $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$).
- Encourage strategies for deciding whether a fraction (unit or non-unit) is less than half, equal to half or greater than half.
- Consider the difference between a unit fraction and a whole unit (e.g. $1-\frac{1}{4}$ or $1-\frac{1}{5}$).
- Show that each fraction can be written in an infinite number of equivalent forms.
- Show that fractions can be equal to, or bigger than one whole.

The language of fractions

Much of the language involved in working with fractions needs to be taught explicitly in context.

Learners need to be encouraged to use the vocabulary which describes the concepts they are exploring. Initially, this should include:

- **'whole numbers'**
- **naming of fractions: e.g. 'half', 'quarter', 'third', 'tenth'**
- **'divide', 'share'**
- **'equal parts'**
- **'out of'**
- **'halves and doubles'**
- **comparison vocabulary: 'more than', 'less than', 'equal to', 'the same as'**
- **'left over', 'remainder'**

Some formal fraction language may, for some learners, be linked with mechanistic notions of following rote-learned 'recipes' for fractions and may serve to confuse or distract them from thinking about the meaning of what they are doing. We suggest that it is usually a good idea to delay use of these terms until a later stage, once the basic concept of a fraction is reasonably secure and the need for identifying procedures arises:

- **'cancel', 'reduce','simplify'**
- **'lowest terms'**
- **'denominator'**
- **'numerator'**
- **'lowest common denominator'**
- **'highest common factor'**
- **'top heavy'**
- **'equivalent'**
- **'proper', 'improper'**
- **'mixed numbers'**

Making connections

All too often learners think of 'fractions' as being a discrete (and often difficult) topic that has no real connection with any other area of maths. However, meaningful connections make learning more powerful. We can use the knowledge and experience that all adult learners already have of fractions, particularly halves and quarters, and also the fractions that are part of everyday language.

Work on fractions needs to be integrated into other maths topics; number, shape, data handling, and particularly every sort of measure of weight, length, capacity, time, and simple probability. Learners will encounter fractions throughout their work at all entry levels of the numeracy curriculum, e.g. solving money problems, sharing a bill, comparing prices, calculating journey times, cooking, interpreting data in pictograms and bar charts, using a metre rule, measuring a room, comparing each other's heights, and checking the weight of ingredients.

Learners should be encouraged to see that developing their skills in multiplication and division is an integral part of understanding and using fractions. Learning about fractions involves learning about relationships between numbers, exploring number patterns and sequences, developing estimating skills, using measurement and problem solving.

Instead of feeling that 'decimals' or 'percentages' are completely different topics, learners need plenty of experience, even at an early stage, of seeing that these are simply other ways of representing fractions.

Learning about decimal place value, and the relationship between metric units, or between pounds and pence, can be one of the starting points for talking about fractions. It is important for learners to see that decimal notation is another representation of tenths and hundredths, and to develop familiarity with these fractions.

Learners may need to know how to input a fraction into a simple calculator and read the decimal fraction. They should have plenty of experience doing this to explore the connections, rather than trying to learn these by rote.

Any work on fractions, such as matching equivalents, should include some basic decimal and percentage representations as well (e.g. 0.5, 50%, ½, see http://www.bbc.co.uk/skillswise/numbers/fractiondecimal percentage/comparing/comparingall3/)

Although the Adult Numeracy Core Curriculum identifies specific skills and knowledge about fractions as elements at each level, this should not be seen as a set of hard and fast rules. If learners are encouraged to understand and explore fraction concepts, their work on fractions may well spread across more than one 'level'.

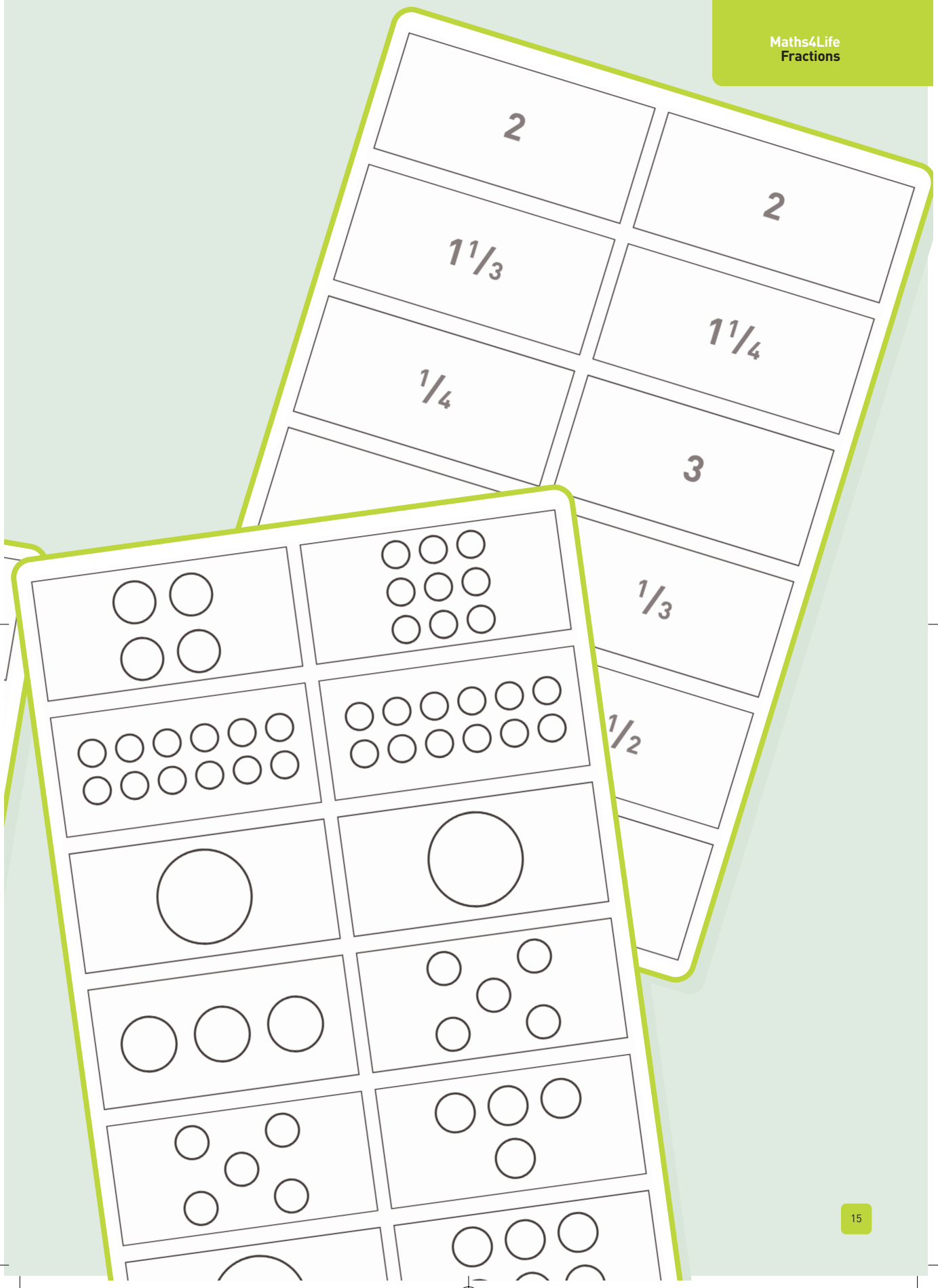
Activities

SHARING CAKES

This activity includes four sets of cards, all to be cut up and matched. The learners themselves can do the cutting up, as the sheets are arranged so that the answers are not all in the same sequence.

One set has diagrams of the cakes. On these cards, learners would need to show, by shading parts of whole cakes, or drawing lines between the cakes, how the cakes would be shared so that each of these cards matches one from each of the other sets.

To download these activities go to www.maths4life.org


2
2
1 1/3
1 1/4
1/4
3
1/3
1/2

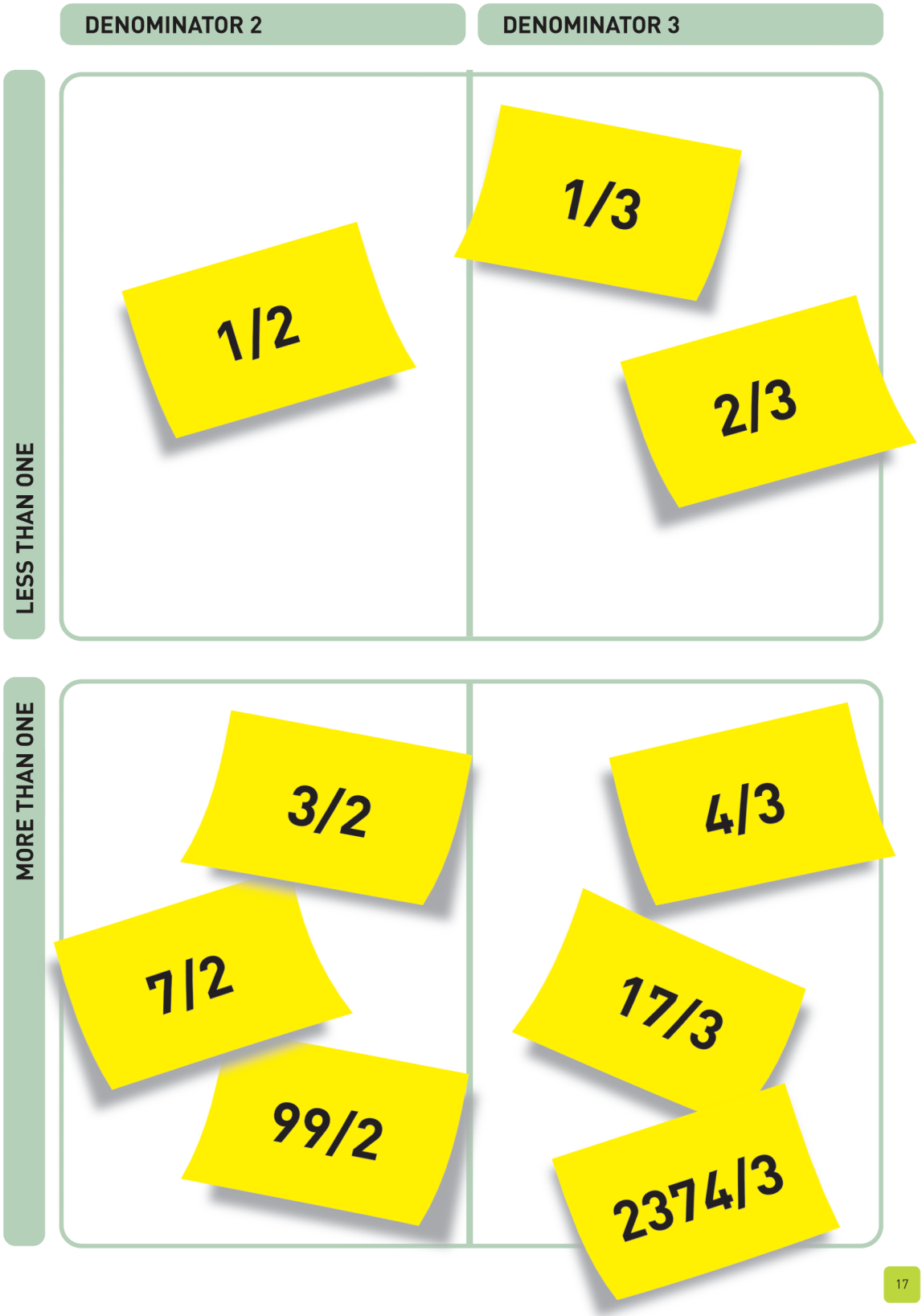
Classifying fractions

Classifying different representations of fractions, or statements about them, can be a very effective method of encouraging learners to reflect on and discuss their properties. Learners may group together different representations of the same fraction: in a picture, in words, on a number line, as a decimal. They may classify them according to their size, or classify statements about fractions as true or false. (See example activities at www.maths4life.org)

This is an approach that lends itself to differentiation within the group, with learners using different classifications depending on previous experience of fractions.

One possible activity is for all learners in a group to be given fraction cards and, working in pairs, to sort them into different categories (opposite). This might prompt a discussion as to whether all fractions with denominators 2 and 3 would be included on this grid (no, those equal to 1 are excluded). Alternatively, they could choose their own fractions, and write their own cards, to go in each category.

As a follow-up learners can choose their own categories for classification. In addition to mathematical categories, it is interesting to encourage learners to include categories like 'easy' and 'hard' and explicitly discuss why some fractions are harder than others. More challenging problems can be devised for others by putting the fractions in spaces on the classification grid so that other learners must guess the headings used.


DENOMINATOR 2
DENOMINATOR 3
LESS THAN ONE
MORE THAN ONE
1/2
1/3
2/3
3/2
7/2
99/2
4/3
17/3
2374/3

Interpreting fractions

Given their different representations, and the way they sometimes refer to a number and sometimes an operation, it is important to be able to discuss fractions in the many ways they appear. A multiple representation activity, including different numerical and visual representations, is one way of doing this. (See example activities at www.maths4life.org)

Sharing food is a good way to introduce various concepts aboput fractions. For example, using a chocolate bar and dividing it into pieces. This can be highly motivating if learners can eat it afterwards!

A clock face shows clearly what halves and quarters look like, and can be extended to other fractions with discussion about why some are easier to show than others. We can find a third of an hour, but what about a fifth?

A paper tape measure (like those from IKEA) is a valuable illustration of different fractions. For example, learners can write on 1/2m, 0.50m and 50cm for their own portable equivalence chart.

I have ten bars of chocolate, and I share them equally between four people. How much will they each get?

We recommend that teachers explicitly use the language of fractions in other parts of the curriculum for reinforcement. For example, when looking at shapes, talk about 'half a square' and 'third of a circle'. You could also talk about when fraction talk is not appropriate, for example, "it is half as hot as yesterday" does not make sense.

Dealing with remainders

Learners can often be confused about what to do with remainders after division. They may not be sure when to ignore remainders, to round them up, or to show what is left over as a fraction or a decimal. Different decisions need to be made about how to interpret the remainder, and what makes sense, depending on the context.

Learners need to explore problems in a range of situations, all involving the same division calculation, e.g. a problem which involves dividing 10 by 4, depending on the context, may have as an appropriate solution 3, 2, 2.50, 2½ or as "2 remainder 2".

Ten people need to travel by taxi from the airport to the city centre. A taxi can only take four passengers. How many taxis will be needed?

You want to buy CDs costing £4 each. You have £10. How many of these CDs can you buy?

You are sharing £10 between four people. How much will they each get?

I have ten bars of chocolate, and I share them equally between four people. How much will they each get if I don't split the bar? And how much will they each get if I do split the bar?

Learners can practise writing their own sets of contexts for division problems that will involve different decisions about what to do with the remainder.

Evaluating statements about fractions

Learners are given some generalisations about fractions, perhaps printed out on separate cards, and are asked to choose whether they consider these to be 'always', 'sometimes' or 'never' true, and to justify their choices, with examples and convincing explanation. The statements may deliberately include common misconceptions. This activity needs to be an in-depth discussion, initially in pairs or small groups, and then with the whole group.

Each learner in turn should choose one statement. Others should be encouraged to argue and challenge, and to refine their reasoning.

Once they have agreed on a verdict, they can make a poster for display in the classroom. They could also think of some statements for other learners to consider in the same way.

Here is a sample: (for an example of these see www.maths4life.org)

A fraction is a small piece of a whole

When you multiply one number by another the answer must always be bigger

You can't have a fraction that is bigger than one

Five is less than six so one fifth must be smaller than one sixth

Any fraction can be written in lots of different ways

Fractions don't behave like other numbers

Decimals and fractions are completely different types of numbers

Every fraction can be written as a decimal

Every decimal can be written as a fraction

Links outside the classroom

Experience has shown us that many learners do not use their understanding of fractions outside the classroom, and are unwilling or unable to transfer it to 'real life' problems. For example, a learner could work out 1/3 of 30 million, but had no idea how to work out 2/3 of 30 million (from a news story about women with AIDS in Africa).

As suggested in the curriculum, take a headline or advert and make a poster to explain what it means. For example, a July 2005 headline says that one in three 11-year-olds have smoked. What fraction is this? How many people does that represent in an average school? How many in the UK? Should we worry about this? To link with the problem above, encourage learners to think about the 11-year-olds that have not smoked.

A healthy diet should include no more than 60g of fat in a day. Collect food labels and other nutritional information and find out what fraction of the daily fat allowance is in a bag of crisps. Using a grid of 60 squares, and by rounding, learners can work out the fraction of their daily limit in different foods, and express this using equivalent fractions. A bag of crisps, for example, has about 1/6 of the guideline daily amount.

The proportions of the human body provide links with art, and with dressmaking/tailoring. For example, artists assume the eyes are half-way down the face, the nose half-way between the eyes and the chin. A tape measure and some sketching can check the truth of these rules.

Assessing understanding of fractions

Assessment can take many forms. In many numeracy classes assessment of learning is summative - checking that a learner can successfully complete a worksheet on a topic independently, and pass a test.

The majority of adult learners have 'done' maths before, and this probably included some work on fractions, yet they sometimes still identify fractions as an area of difficulty. This suggests that we need a much broader approach to assessment.

Our formative assessment tools need to find out what learners have covered before, rather than assuming they are meeting fractions for the first time. They need to identify what has been mislearned or is difficult to conceptualise. Class questions, which everyone has a chance to think about and answer, can provide

a valuable starting point for discussion.

One of our most valuable assessment tools is silence. Standing back and listening to learners explaining their thinking can be a more powerful assessment tool than any number of written diagnostic tests.

In addition, we can make creative use of summative assessment: for example, learners can write their own exam-style questions. By inserting their own figures, or rewriting questions, they may become confident at writing their own new questions from scratch.

Assessment by questioning

Questioning can be used by teachers to find out very specifically whether a particular learner knows the answer to a particular closed question, e.g. drawing a shape on the board and asking what fraction is shaded. However, it can be used much more broadly for formative assessment and to encourage deep mathematical thinking.

Before introducing a topic, a few well-chosen questions can help to identify what learners already know, or what they learned from previous sessions (e.g. asking them all to show something that means 'half'). We have had valuable conversations in class, addressing a number of misconceptions, using learners' correct and incorrect answers as starting points.

Having asked questions, teachers need to consider what to do with learner responses. It may be appropriate to try to work out what has led to an incorrect response. Some flexibility is needed in deciding how far to follow a line of enquiry which was not planned for the lesson.

Questioning to learners about why they are doing something is a good way of uncovering their thinking processes. Devil's advocate questions (e.g 'isn't remainder 5 the same as 0.5?), or 'What if...?' questions can help to see whether learners have developed a general understanding of a concept.

Learners may already feel comfortable asking questions, but it is also possible to set up situations where they need to question each other. In all situations, ensure everyone has time to think before they respond.

Some possible questions about fractions

1. Using mini whiteboards

"Show me a fraction (encourage naming in words, using numbers and diagrams). Show me a harder fraction."

"Show me a question where the answer is 6. Now use ½ in the question. Now use ¼. Now make a really hard question. Show me a question where the answer is 2½"

"Here is half a shape (drawn on board), what could the whole shape look like? Similarly for ¼, or ⅓ as appropriate." (When collecting answers on the board, ask learners to describe shapes as a way of reinforcing idea of equal pieces)

"Show me a fraction bigger than ¼. Show me a fraction between ½ and 1, between ¾ and 1, bigger than 1..."
(Encourage learners to draw diagrams and represent on number lines)

"Which is the odd one out: ½, ¼, 2/4? or ¼, 2/5, 0.4? Can you make each of them the odd one out?"

2. To understand reasoning

"Why are ⅓ and 2/6 the same?"

"Why did you change ¾ to 9/12? Suppose you were comparing ¾ and 5/8: What would you do then?"

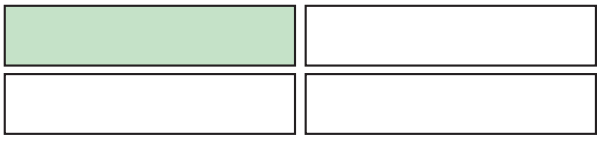
"How did you work out that 2/3 of 60 million was the same as 40 million? How would you explain your method to someone who hadn't done this kind of thing before?"

Analysing errors and misconceptions

Some misconceptions about fractions may be immediately apparent; however, it is also important to find strategies for uncovering learners' thinking processes and seeing errors that might lie below the surface. Sometimes learners appear to give a correct response, but their reasoning misfires.

It is important to encourage learners to voice their ideas, even if they are based on misconceptions. It is only when these are really out in the open that they can be effectively addressed.

Some learners may identify this diagram as representing 1/3 because they see it as one shaded over three unshaded.



Some learners see some fractions, e.g. 1/3 and 1/4, as interchangeable. This may be because the words 'quarter' and 'third' do not suggest the numbers 4 and 3. It may be worth checking to see if your learners have these misunderstandings.

Often visual representations of fractions may have been used only in a limited way. Some commonly used fractions tend to be shown in certain shapes. So learners may have seen 1/4 shown in a square, but 2/3 only shown in a circle. Diagrams need to be used carefully so as not to confuse learners and to enable them to make meaningful comparisons. Representations of fractions on number lines, reinforcing both their size and decimal equivalents are just as important.

Even when the same shape has been used to help comparison, learners may find it difficult to reconcile what they see with the way they read the combination of two numbers in a fraction. Some explain that although a diagram clearly shows that 1/8 is bigger than 1/16, the 16 in their minds somehow takes over and tries to tell them 1/16 is a bigger number.

Looking at two positive whole numbers it is clear which is bigger. With 1/16 and 1/8 this may also be clear. However, moving away from unit fractions, even this

'rule' does not apply. For instance, $^3/_8$ is bigger than $^5/_{16}$, but $^3/_{16}$ is bigger than $^1/_8$. Learners trying to use the size of the top and bottom numbers as the key to comparison could feel they were on very shaky ground by now.

Here are some more examples of common mistakes:

"$^2/_3$ – that's two and three"

Seeing the numbers in a fraction as two unrelated whole numbers separated by a line

"$^1/_3 + ^1/_4 = ^2/_7$"

Treating fractions in the same way as whole numbers

"$^1/_4$ = 1.4"

Being influenced by appearances

"$^4/_5 > ^1/_3$ because 5 > 3"

Thinking that it is only the denominator that determines the size of the fraction

"$^1/_2 + ^1/_2 = ^2/_4$"

Not being able to judge that an answer does not make sense

"Anything less than a half is a quarter" or "$^1/_3$, that's the same as $^1/_4$ isn't it?"

Not understanding the concept of fractional parts

"$^7/_2$=2.1 because three goes into seven twice with one left over"

Not understanding what to do with a remainder and what 0.1 actually represents

"$^1/_3$ of 30 is ... 3 ?"

Not understanding that one third is the same as dividing by three

"$^{3}/_{4}$ of 12 pens is ... four because that's quarters ...?"

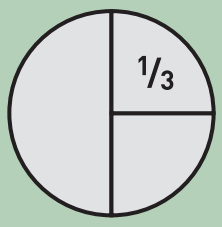
Not having sufficient experience of fractions as parts of sets of objects

"There are three quarters in a whole because two is half"

Not understanding the relationship between the fractional part and the unit

"$^{2}/_{10}$ – that's two tens"

Confusion about "tens" and "tenths", "hundreds" and "hundredths" because they sound the same



Unequal partitioning of area diagrams to represent fractions other than half or quarter, not understanding that the divisions need to be equal.

Suggestions for resources

- **Readers are advised to read the background to these approaches. Full details of the work undertaken by Malcolm Swan of the University of Nottingham and Susan Wall of Wilberforce College, Hull, together with the DfES Standards Unit, can be found at http://www.maths4life.org/content.asp?CategoryID=1068**
- **Mini-whiteboards and whiteboard pens**
  These enable learners to easily jot down responses, and work out ideas, freeing them from worry about crossing out mistakes.
- **Sets of fraction cards with fractions in numbers, area diagrams, number lines, percentages and decimals**
  These can be cut up and laminated if appropriate, or they can simply be printed out for each session and cut up by the learners themselves.
- **Number lines, both numbered and blank**
  A useful way of modelling fractions. Blank number lines which learners can annotate themselves are useful.
- **Counting sticks, metre sticks, rulers, tape measures**
- **Fraction wall (see BBC Skillswise www.bbc.co.uk/skillswise/)**
- **Fraction dice (use ordinary dice with fraction stickers)**
- **Calculators**
- **2D and 3D fraction sets**
- **OHP resources including transparent coloured fraction blocks, number lines, clock faces, calculators**
- **Fraction dominoes**
  These can be custom-made, using a basic template, for matching fractions in various representations.
- **Sets of cubes, both separate and interlocking**
- **A range of measuring equipment, e.g. scales, balances, weights, measuring jugs and beakers of different capacities, calibrated in different ways**
- **Digital clocks with moveable hands, blank clock faces**
- **1 cm and 2 cm squared paper**
- **Tangrams**
- **Coloured counters, Post-It notes, index cards, tracing paper, scissors, card, glue sticks, string.**

Some do's and don'ts

Do

Do
Find out and start from what learners know
Be sensitive to the fact that many learners may have previously found work on fractions difficult and frustrating
Talk about how fractions are used in everyday life
Encourage learners to estimate with fractions
Make sure any activities are enjoyable, stimulating and include group work
Show fractions in a variety of representations
Encourage learners to talk about fractions
Support learners in checking their own work
Give lots of thinking time when you ask questions
Delay using formal fraction vocabulary until learners are ready
Use tenths and hundredths and encourage learners to see decimals as another representation of fractions
Make connections with other maths topics
Use lots of visual aids

Don't

Don't
Introduce formal fraction symbols too early
Teach learners to memorise processes and rules
Teach just halves and quarters, even from the start
Allow learners to compartmentalise fractions or to see them as 'separate' from decimals and percentages
Give endless drills and 'practice'
Tell learners all the answers

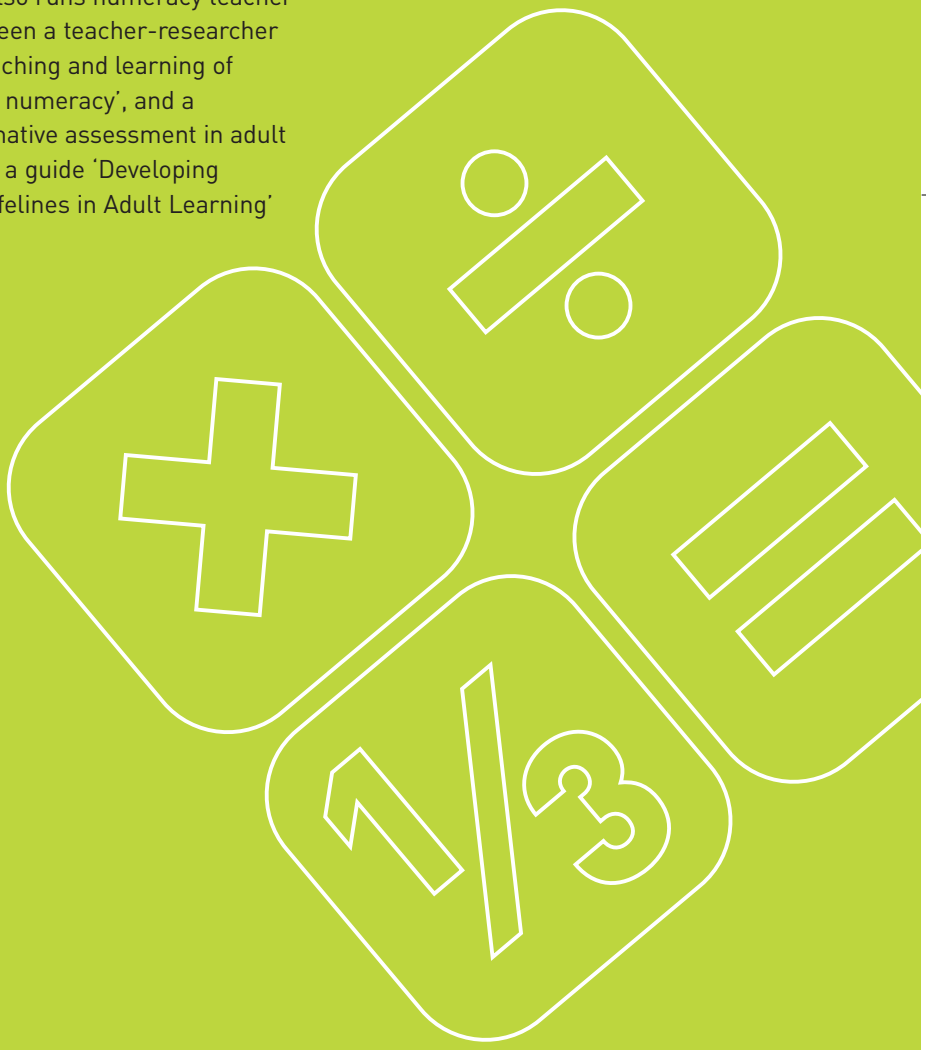
Notes

Notes

About the authors

Rachel McLeod trained as secondary maths teacher. She started working at Tower Hamlets College in 1991, and had a variety of different roles. After two years in Japan, teaching English to business people and mathematics to young people at an International School, she returned to Tower Hamlets as Adult Numeracy Coordinator in 2004. Rachel has recently been working on a level 4 numeracy subject specialist course and is involved in Standards Unit pilot and the Maths4Life pathfinder project.

Barbara Newmarch teaches numeracy/mathematics in two London colleges, and also runs numeracy teacher training courses. She has been a teacher-researcher on a NRDC project, 'The teaching and learning of common measures in adult numeracy', and a Maths4Life project on 'Formative assessment in adult numeracy'. She has written a guide 'Developing Numeracy' in the NIACE 'Lifelines in Adult Learning' series.



This booklet is produced by Maths4Life to provide teachers of adult numeracy with some ideas about how to teach fractions. The aim is to examine why learners may find it difficult and to describe ways which the reflective teacher can overcome these difficulties. Accompanying sample resources can be found at **www.maths4life.org**

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