Primary Magazine
Issue 25

National Centre for Excellence in the Teaching of Mathematics

Welcome to the 25th issue of the Primary Magazine. Our famous mathematician is Sierpiński, we look at the art of Giuseppe Arcimboldo, and our CPD opportunity aims to develop subject knowledge in multiplication. *It's in the News!* features the oil spill disaster in the Gulf of Mexico.

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From the editor

Are you ever frustrated by parents who teach their children the formal written methods at home when you are teaching partitioning, counting on, grouping or other such methods? It is a common problem. Some parents think they are helping their children when in fact they are confusing them! Dr Rosemary Russell, a teacher of junior, middle and senior school children researched why parents do this for her PhD during a career break from teaching. You might find her article interesting. Details of Rosemary's research are held on the CERUK database, and some of her findings are summarised in a paper she gave at the BSRLM conference in Bristol last year. Let us know what you think in our Primary Forum! Maths to Share in Issue 13 of the Primary Magazine has suggestions for working with parents. You might also be interested in reading the article Is society proud of being bad at mathematics?

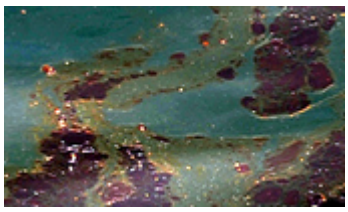
Ofsted has recently released a report Good professional development in schools. It considers what makes continuing professional development work so well in successful schools, identifying four key questions that effective school leaders regularly ask themselves about the quality of their arrangements for professional development. The report then sets out the key characteristics of good practice associated with the four areas and illustrates these to help all schools learn from the examples. It also identifies three barriers that confront schools.

We are keen to hear about your experiences of either receiving or delivering CPD in your local authority. Please let us know how you have been involved and whether it was worthwhile.

Talking of CPD, Serena, the mathematics subject leader at a primary school in Sutton, has recently been funded through our Regional Projects Programme to work with the Excellence in Mathematics Leadership (EiML) materials in order to improve the mathematics provision in their school: it is having a huge impact on all concerned and is proving to be a very worthwhile piece of CPD. We would like to share this with you, so please read Serena's article.

If you are interested in funding for a regional project to improve something in your school please contact your local Regional Coordinator.

Finally, Teachers TV has a series of outdoor learning activities to watch now that the weather is warming up. You may get a few ideas!



It's in the News!

In this issue we look at another disaster to meet our world – the oil leak in the Gulf of Mexico and its effects on human and wild life. It has now been declared the worst in US history. You may find it helpful to read a few of the suggested news articles for some background information:

- BBC Newsround
- BBC World News (Americas)
- BBC World News (US & Canada)
- BBC News in Pictures

Of course this is an on-going problem, so you might find it helpful to search for the latest news on the situation.

The slides provide opportunities for work with such mathematical concepts as measurement, data handling, compass points and coordinates.

This resource provides ideas that you can adapt to fit your classroom and your learners as appropriate. As always, we would be extremely grateful if you could give us some feedback on how you have used it, if it has worked well and how it can be improved.

Download this *It's in the News!* resource - in PowerPoint format.

Download this *It's in the News!* resource - in PDF format.

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The Art of Mathematics
Giuseppe Arcimboldo (1527 – 1593)

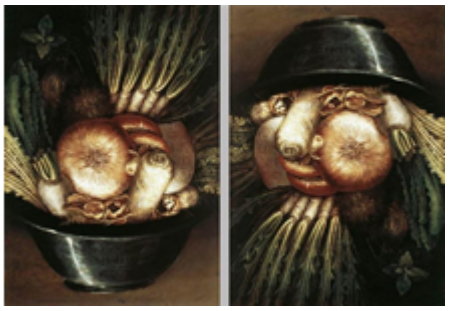
Giuseppe Arcimboldo was born in Milan, Italy, in 1527. His father, a painter, worked on the Duomo, Milan's Cathedral, where, in 1549, Giuseppe was commissioned to create stained glass window designs. He went on to create fresco and tapestry designs for other Italian cathedrals. In 1562 he became court portraitist to Ferdinand I, Holy Roman Emperor, and later to his son Maximilian II, and then his son Rudolf II in Prague.

He is best known for his portraits of human heads, made up of vegetables, fruits, sea creatures, tree roots and other everyday objects. His paintings are so unusual, that art critics still debate whether they are simply 'quirky' or the work of the mind of an unstable, disturbed man.

It was during the last phase of his career that he painted Vertumnus, a portrait of Rudolph II, his former employer. This is the starting point for four suggested activities for the classroom.

In the classroom…

Show the pupils a picture of Giuseppe Arcimboldo's Vertumnus, the Roman god of the seasons, painted in 1591. The portrait is made entirely of fruit and vegetables. Allow the children time to view the painting. Very young children could explore the concept of more than and less than, or sort and match real vegetables to those in the picture. Can they count the number of … that they can see? How many different fruits or vegetables can they see? Which is used the most/the least? This could be a good starting point for some exciting data handling work. *Maths to Share* in Issue 10 of this magazine explores the issue of data handling in more detail. Many of the ideas could be applied to this painting. The painting could also provide a different stimulus for exploring symmetry; both in the picture, and in real fruits and vegetables.



Show the pupils Vegetables in a Bowl – make sure the pupils can only see the left-hand picture, of the bowl. Can they describe what they can see? How is it similar to the last picture? How is it different? Pupils might refer to a difference in the number of vegetables, or refer back to their data collection from 'Vertumnus'. Now rotate the picture 180° (or show them the right-hand side of the picture). Discuss the figure shown. Explore what happens when other images are rotated by 180°, and use this as a starting point for introducing the notion of rotation.

Arcimboldo's Librarian, painted in 1570 can provide a good starting point for estimation work. Explain to the children that you will show the picture to them for just a few seconds, in which time you want them to estimate the number of books used. Once they have given their estimates, allow them more time to explore the painting. Count the books together – do you agree a total of 22? Focus on the open book, where the pages are representing 'hair'. How many pages does the book have? Does the thick, vertical, red bound book on the left have more or less pages – why do they think so? Which book in the picture has the most/least pages? Is it easy to decide?

A Department for Education initiative to enhance professional development across mathematics teaching

Provide the pupils with the following…

'Thicker books have more pages'

… and ask them to pursue the line of enquiry. A wonderful opportunity for digging deep and using those using and applying skills!

The website giuseppe-arcimboldo.org provides quality images of 32 of Arcimboldo's works, many of which could be used as starting points to explore all sorts of mathematical concepts; counting and comparing, symmetry, data handling, shape, measure – let us know what you get up to!

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Focus on…the first pre-sliced loaf: 7 July 1928

Do you know where the popular phrase, 'the greatest thing since sliced bread' comes from?

This month's issue celebrates the first pre-sliced loaf of bread. The first loaf-at-a-time, bread-slicing machine was invented by Otto Frederick Rohwedder. The first sliced loaves were produced on 7 July, 1928 by the Chillicothe Baking Company of Chillicothe, Missouri. The bread was advertised as, 'the greatest forward step in the baking industry since bread was wrapped' which led to the saying 'the greatest thing since sliced bread'!

Did you know?

- white bread was once more expensive than brown bread?
- in the US, during 1943, a ban on sliced bread was imposed as a wartime conservation measure.
- in England, during the war, bread was rationed and bakers were asked to sell bread that was a day old because it didn't taste as nice and people wouldn't eat as much.

For more history of bread making and interesting facts interesting facts you may want to have a look at The Story behind a Loaf of Bread.

Short activities
Ask children what their favourite bread is. Very young children could move to different parts of the room and jump into hoops you have positioned in different places labelled with pictures of the bread they are likely to have at home. Make a tally and ask children to predict what a bar chart of this information would look like.
Ask questions such as:

- what is the most/least popular bread?
- would these result be the same for class *x*? Why/why not?

Investigate:

- what would a pie chart look like?
- what fraction would illustrate favourite bread being white/brown/granary?

Gather some data on bread from the children by asking them to count the number of slices of bread they have in a loaf at home, make a note of the type of bread, the make, whether it is thick or thin and how much it cost to buy. You could ask them to research this on the internet by looking at those sold in well-known supermarket chains. Compare the number of slices of bread in each loaf. Which is the best/least value for money? Is it better to have fewer thicker slices or more thinner slices?

These activities link with the Year 5 QCA unit of work on bread.

Longer activities
EYFS/ Key Stage 1

Health and Safety: a risk assessment will need to be carried out for this activity

Baking bread

Give the children the opportunity to make a loaf of bread, there are many good recipes. You can find an easy bread recipe on the BBC Good Food website. The children could weigh out the flour and water, practising reading scales in a practical context. They can also measure out the salt and olive oil and discuss the difference between teaspoon and tablespoon. How may teaspoons in a tablespoon? They could then weigh the dough. The children could also help work out when the bread will be ready and set timers to support this. Finally, they could weigh the bread when it has been cooked and compare this to the pre-cooked weight.

Preparing for a picnic

Ask the children to share out slices of bread and items of filling needed for the number of children in the group. More able pupils could:

- predict how many slices of bread would be needed
- work out, if two slices of tomato for each sandwich, how many slices would be needed for all the sandwiches and then count to check.

Once the sandwiches are made, you could ask the children to share each between two or four children. Hopefully this would lead to a discussion about equal parts and halving.

For a more challenging activity suitable for older/more able pupils see No Lunch for the Driver.

This could be developed by linking with the QCA scheme of work on Sandwich Snacks Year 3.

Building on the activities in EYFS and Key Stage 1

These link again with the Year 5 QCA unit of work on bread:

- for one week, survey types and amounts of bread eaten and how it is eaten. Discuss how bread is used in different ways in meals e.g. for toast, for sandwiches, to eat with soup, to scoop up curry. Data collection activities could be developed to extend to handling data tasks using ICT Issue 22 of the Primary Magazine.

- based on data collected about the different types of bread, the children decide in pairs or small groups what kind of bread they want to make. They make and bake the bread according to the recipe, accurately measuring ingredients and cooking time.
- provide children with a list of ingredients and relevant and appropriate cost and ask them to work out as accurately as possible the cost of their loaf bread. This will involve work on fractions and proportion. The children should then compare this with the cost of an equivalent shop-bought loaf. For more able children you may want to consider aspects of purchasing the ingredients, for example, it is not possible to purchase 7g of yeast so a whole packet needs to be purchased even though it is not all needed. This activity will provide a forum for higher thinking encouraging children to think about economies of scale. They could use ratio to work out the cost and ingredient list for multiple loaves of their own bread.
- ask children to bring in wrappers from different loaves. Ask them to examine the nutritional value of bread. How many slices of bread could I eat to consume the same amount of calories/fat/sugar as a bar of chocolate? For how long would I have to swim to use the same amount of calories as a slice of bread etc?

Some problem solving activities

From NRICH:
Only one side of a two-slice toaster is working, so when two slices of bread go in side-by-side, each slice is toasted on one side after two minutes, but not on the other.

- what is the quickest way to toast both sides of three slices of bread?
- what about four slices? Five slices?

You could adapt the classic find all possibilities problem:

Georgina is making some sandwiches she has a choice of:

Bread	*Main filling*	*Extra*
White	Cheese	Tomato
Brown	Tuna	Cucumber
Granary	Ham	Lettuce

How many different sandwiches can she make?

So, as you eat your sandwiches today, consider how you can celebrate the anniversary of the first sliced loaf!

A little bit of history
Famous Mathematicians – Wacław Franciszek Sierpiński

Wacław Franciszek Sierpiński was a Polish mathematician, who was born in Warsaw. He was known for his outstanding contributions to set theory, the branch of mathematics that studies sets of mathematical objects, number theory (concerned with properties of numbers), the theory of functions (for example, how one quantity determines another), and topology, which is to do with geometry. He published over 700 papers and 50 books.
Sierpiński is well known for his work in fractals. A fractal is a shape that can be split into parts, each of which is a reduced-sized copy of the original. He had three named after him: the Sierpiński triangle, the Sierpiński carpet and the Sierpiński curve. We'll come back to them later as they provide opportunities for some brilliant activities to do with the children.

Sierpiński's father was a doctor. When he was a child, Sierpiński went to school in Warsaw and his talent for mathematics was quickly spotted by his first mathematics teacher. At this time, the Russians occupied Poland and it was difficult for the gifted Sierpiński to be educated there. Between 1869 and 1874, the Russians had forced their language and culture on the Poles, particularly in their secondary schools. The Russian aim was to keep illiteracy in Poland as high as possible, so they discouraged learning and therefore, the number of students attending schools fell.

Despite these difficulties, Sierpiński continued his education and entered the Department of Mathematics and Physics at the University of Warsaw in 1899, which was officially named the Czar's University at this time, because it had been taken over by the Russians in 1869. The lectures at the University were all in Russian and the staff was entirely Russian. While he was there he met and worked with Voronoy, a Russian mathematician who had a great influence on the young Sierpiński.

He graduated in 1904 and worked as a school mathematics and physics teacher in Warsaw. The school closed because of a strike, and so he decided to go to Krakow and attend the Jagiellonian University to work on a doctorate. While he was there, he studied mathematics, astronomy and philosophy. He received his doctorate and then got a job at the University of Lwów [now Lviv] in 1908.

When World War One began in 1914, Sierpinski and his family were in Russia. Sierspinski spent the war years in Moscow working with Nikolai Luzin, another Russian mathematician. At its end, in 1918, he returned to Lwów, but left again to work in the University of Warsaw, where he was quickly promoted to a professor. He spent the rest of his life in Warsaw.

Back to Sierpiński's fractals!

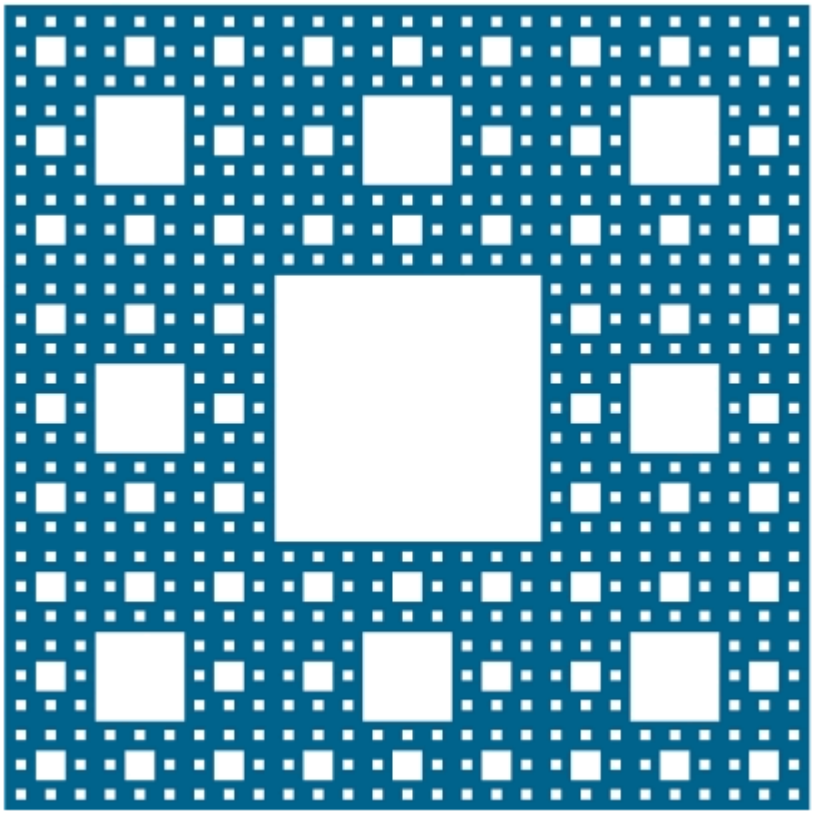
Firstly his triangle:

As you will notice, he used an equilateral triangle, but you can have a go with any type. You need to:

1. draw your triangle
2. make three copies of it but at half its height and base
3. place the three copies on the original so that each touches the other two at a corner
4. repeat step two as many times as you want!

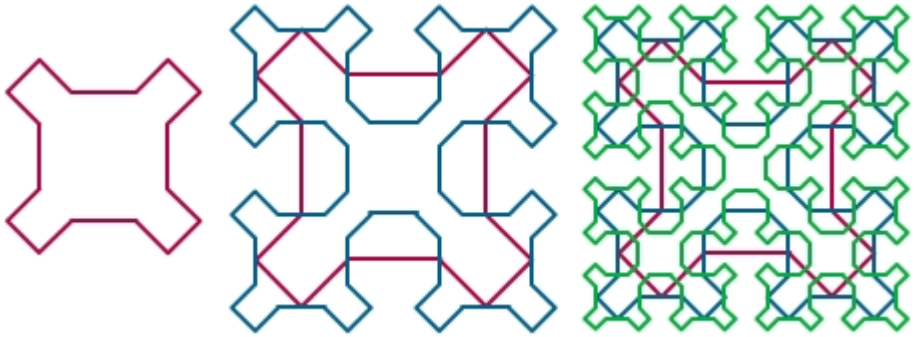
You could use this idea to explore area, fractions and percentages: for example, what fraction of the large triangle is this smaller triangle? One thing's for sure: it could make a really interesting and colourful display for your classroom.

His carpet is done in a similar way but using squares – you could try with a variety of quadrilaterals and see what happens. Sierpiński begins with one square. He then reduces its length and width by a third and positions eight copies around the edges of the original. He repeats this several times making 64, 512, 4 096 and finally 32 768 squares! You could challenge the children to work out the pattern of these numbers and find how many squares there will be in the next 'carpet'.



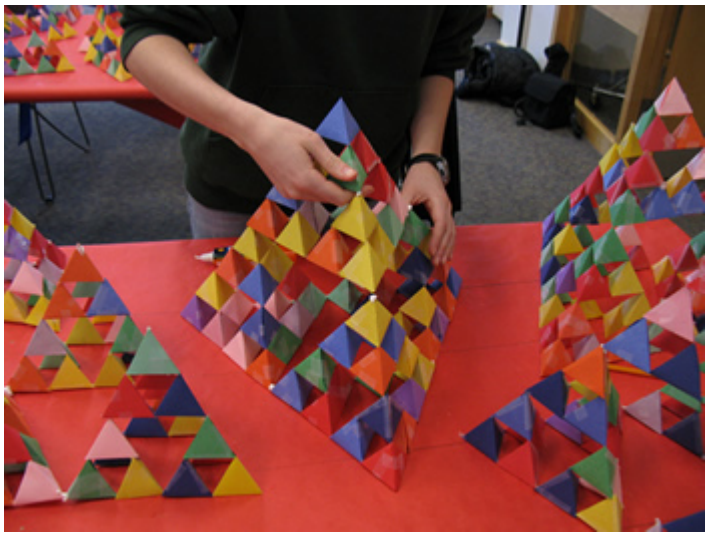
To see clearly how it grows, go to shodor.org.

Why not have a try making Sierpiński's curve which is built up like this:

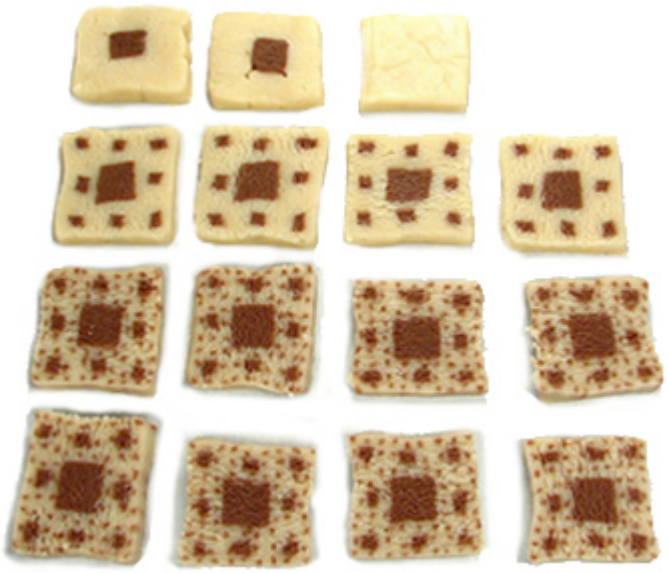


You could experiment with all the 2D shapes you might be covering with your children, circles included, and also link with the fractions you want to explore by reducing the shapes by different amounts. This would also be good for finding equivalences.

The children could use art straws to build a Sierpiński-style tetrahedron or maybe even a cube.



And then, there is always the link to D&T. You could have a go at making some Sierpiński cookies! Or how about a Sierpiński pizza?



Information from:

- University of St Andrews School of Mathematics
- Wikipedia.

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Maths to share – CPD for your school

Multiplication

This is the third in a series of *Maths to share*, focusing on the basic mathematics operations of addition, subtraction, multiplication and division.

Consider your own knowledge of learning and teaching of multiplication by completing the multiplication questions in the calculations section for your key stage of the Mathematics Content Knowledge section of the Self-evaluation Tools - you might like to ask colleagues to do this too. Perhaps the last fifteen minutes or so of a previous meeting could be given over to helping colleagues make a start.

Julia Anghileri (2009) tells us that 'Children's first experiences of multiplication arise when they make groups with equal numbers of objects and recognise the possibility of counting the groups rather than counting individual items.' There are many natural groupings. Children are quick to recognise pairs of (say) shoes, socks and gloves. The recognition that such items can be counted individually or in groups begins to establish the connection with multiplication. Other groupings such as wheels and animal legs are likely to follow.

A good understanding of multiplication is therefore important for teachers in all phases of the primary age range to ensure that early opportunities to support the development of multiplicative reasoning are not missed. Tracking the development of learning and teaching multiplication, complete with examples of what each stage might look like in the classroom, is therefore extremely useful professional development.

Unfortunately, there is no one agreed route to develop such understanding and even if there were, it is unlikely that all children would follow it in a linear fashion.

Begin the session by sharing Julia Anghileri's thoughts on children's first experiences of multiplication. Ask early years colleagues to describe what this might look like in their classrooms.

Ask colleagues how they develop multiplication from there. You are likely to receive suggestions such as grouping, repeating patterns, skip counting, arrays, numberlines and tables. Spend some time clarifying what is meant by each suggestion, listing ideas of what this might look like in the classroom and what language is used, for example:

- grouping: Noah's ark or similar activities; arranging objects in equal groups to aid counting; recognition of equivalent totals such as three groups of four and four groups of three
- repeating patterns: grouping beads to make necklaces; make pattern sticks with linking cubes. Use of the word 'each' e.g. three of each colour
- rhythmic counting in ones: emphasising a particular multiple; forwards and back

- skip (or step) counting: counting in twos, fives and tens initially, then in other jumps both forward and back. Children can often count in such patterns but do not relate their counting to multiplication. zOne way of helping children to develop the link is to use finger counting. If an additional finger is raised as children count in, say, twos (two – raise thumb, four – raise forefinger as well, six – raise middle finger too, and so on), then they can be stopped occasionally and asked 'How many twos have we counted' or 'How many twos in six?'

- numberlines: skip jumping along a numberline, marked and empty. Calculation policies often go into some detail about the development of the use of numberlines, but are unlikely to go into anything like as much detail about arrays or times tables. Both of these are worth exploring in more detail to clarify progression. Arrays are a key representation for multiplication, and also for division. Time spent exploring arrays helps children to gain an understanding of the concept of multiplication as well as developing techniques for performing a range of calculations.

Discuss arrays. What is an array? How do you use arrays? What language do you use?

Explore the following development of arrays:

5 + 5 + 5 = 15

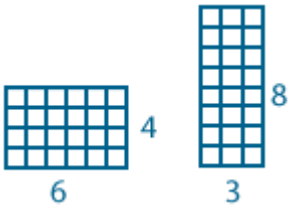
3 x 5 = 15 Language: rows, columns, multiple, factors, product...

5 x 3 = 15 Language: rows, columns, multiple, factors, product...

This is an open array. Use open arrays for factors and products, and later for area and perimeter. Open arrays can be manipulated to find factors.

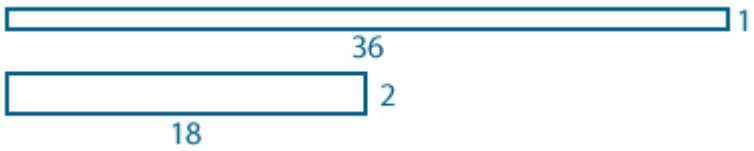
To explore factors of (say) 24, begin with a strip of squares:

Cut after the 12th square and rearrange to make a new array. Explore other cuts, though it is not helpful to cut into individual squares:



The factors of 24 are 1, 2, 3, 4, 6, 8 and 12.

Now explore a number without using squares:



Ask colleagues to either continue to explore 36 or to choose a number of their own. Can they find all the factors? Use paper or mini whiteboards.

Now that colleagues are familiar with open arrays, discuss the development of arrays illustrated here. Does it make sense? Is anything missing? Have colleagues used open arrays? What might this look like in the classroom? Once children have a good understanding of arrays, they can manipulate them to explore multiplication further. Read Chapter 7 in Fosnot and Dalk (2001) for more ideas on this topic.

If time permits, discuss how the children are supported to learn their times table facts. Work together to draw up a similar progression for learning times tables. It might be useful to update the school's calculations policy in the light of your discussions.

Further information and ideas on multiplication

Useful Primary National Strategies ITPs:

- multiplication arrays
- multiplication board
- multiplication facts
- multiplication tables
- multiplication grid

Models and images of multiplication

In the National Strategies Guidance paper: Calculation, sections 7 and 8 focus on written methods for multiplication and division of whole numbers.

QCDA booklets:

- Teaching mental calculation strategies, guidance for teachers at key stages 1 and 2
- Teaching written calculations strategies, guidance for teachers at key stages 1 and 2

References

Anghileri, J. (2009) Uses of counting in multiplication and division in Thompson (ed) (2009) *Teaching and Learning Early Number*, OUP: Maidenhead
Barmby P., Bilsborough L., Harries T. and Higgins S. (2009) *Primary Mathematics: Teaching for Understanding*, Open University Press.
Fosnot, C. T. And Dolk, M. (2001) *Young mathematicians at work*, Portsmouth NH USA Heinemann.

ICT in the Classroom

The Audio Recordings
Incorporating recorded sound into mathematics enables children to independently engage with the mathematics no matter how fluent their literacy skills. It can facilitate children hearing mathematical vocabulary in context, and using mathematical vocabulary purposefully.

Through these activities, consider how sound stimulates thinking and learning in a different way to the visual and kinaesthetic, and what experiences children need to have had, to visualise and apply what they hear.

Small devices which can record 10 or 30 seconds of sound can be purchased from education resource retailers, or some novelty items, found in high street stores and supermarkets, can also record small amounts of speech. You can also use the new facility in the Learning Journal in your NCETM Personal Learning Space if the children are able to sit near your computer or a laptop.

Sorting and matching
Provide opportunities for children to sometimes experiment individually, and other times collaboratively, to match objects, pictures, symbols, and even other recorded sounds or words, to a recorded mathematical word, and collect the set together in a tin. Alternatively, encourage reasoning and negotiating meaning through taking objects, pictures and symbols one at a time out of a tin and asking 'What do you think is recorded on the button?' This is particularly engaging and empowering for pupils when they have created their own recordings for sorting by their own criteria and can lead the activity themselves.

Giving precise mathematical instructions
Adults and children can both be involved in recording instructions for others to use. Try creating a 'treasure hunt' using recordable buttons hidden around the learning environment. Each button gives clues to where the next button is located. This could be early positional language such as 'look under the sand tray', to 'find the button located at co-ordinates (2, 3) on your map' or 'find the next button at 2m West, 1.5m North'. Time limits built into recording devices can be used to encourage concise and precise instructions when children are recording their own instructions.

Collaborative problem solving
Audio recordings can support collaborative problem solving by allowing all participants access to the problem, or clues, simultaneously. Individual clues to an ordering problem can be recorded onto different devices. Each child, or pair, listens to one piece of information. Because they receive the information aurally, there is greater necessity to summarise and prioritise the information relayed to the group, instead of reading it aloud with its original phrasing from a piece of paper. Encourage children to listen to the clue more than once to identify what might be important to solving the problem.

Try this example in the context of rebuilding an accidentally destroyed shop display before the manager gets back. The four items on the display were a set of pens, a skipping rope, an elephant statue, and a teddy bear. What order were they arranged on the shelf?

- the set of 24 gel pens in a plastic case was next to the large, grumpy teddy bear
- the elephant statue was faded on one side because it was on the end of the shelf, next to a window

- the pink, extra long skipping rope was not on the end of the shelf, and it was to the left of the teddy bear.

Solution: elephant statue, skipping rope, teddy, pen set.

Giving a purpose for problem solving
Messages can be pre-recorded onto mobile phones and answer machines to direct or encourage mathematical thought in role play situations and areas. Enterprise style contexts, a type of engaging "real-life" problem solving opportunity where the children work together to develop and market products or services at an appropriate level for their development, can be further enhanced by the children receiving telephone message orders from "real" customers. It's even richer if the message gives the criteria the children need to meet to satisfy the customers needs and asks them to recommend the most suitable product or develop a product to meet the need.

Patterns and sequences
To explore pattern through pitch, volume, rhythm or number, provide children with recorded sounds to sequence. Give the children reasoning sentence stems such as "I think the pattern is … because …" to support them in explaining the sequences and patterns they have made. Encourage children to continue given patterns and create their own.

CPD and research
Try sorting a set of numbers into numerical order when written down, then compare the experience to ordering numbers that are only heard. What additional skills do you draw upon? How do you remember the numbers? How could you model your own methods to children?