Primary & Early Years Magazine 60

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 60 of the Primary Magazine, and a very Happy New Year to you all! In this issue, The Art of Mathematics features the American artist Georgia O'Keeffe. A Little Bit of History continues its series on inventions: in this issue we look at adhesives. Focus On... features the final article on place value by Barbara Carr, and Maths to Share looks at multiplication.

Contents

Editor's extras

In *Editor's Extras* we have a reminder of the NCETM PD Lead Support events and the growing NCETM suite of videos to support the implementation of the new primary curriculum, and the National Curriculum Resource Tool, which has started to go live.

The Art of Mathematics

In this issue we explore the life and work of the American artist Georgia O'Keeffe who was one of America's most important artists. If you have an artist that you would like us to feature, please let us know.

Focus on…

In this issue we have the final article by Barbara Carr on whether we really make the most of our wonderful number system. If you have anything that you would like to share, please let us know.

A little bit of history

This is the penultimate article in our series about inventions. In this issue we look at adhesives, which includes two items which are a must-have in the classroom – sticky tape and glue! If you have any history topics that you would like us to make mathematical links to, please let us know.

Maths to share – CPD for your school

In *Maths to Share* we look at the development of the column method for multiplication to ensure conceptual understanding and the importance of encouraging children to look at calculations and make decisions on the most efficient methods to use to solve them. If you have any other areas of mathematics that you would like to see featured please let us know.

Editor's extras

The National Curriculum

- **The NCETM Resource and Planning Tool**
  We have recently started publishing sections of a new area on our site, dedicated to helping teachers plan lesions in line with the new curriculum. At this stage, this new resource and planning tool includes material for teachers in Years 1, 5 and 6. Other year groups will follow soon. This complements the new curriculum 'Essentials' page, published last term, which is a 'one-stop shop' with links to resources on the NCETM portal that will be helpful to subject leaders who are beginning to consider how to support teachers in readiness for the new programmes of study. Both of these are linked to from our central new curriculum page that will keep you up to date with relevant news of the new curriculum as it becomes available.
- **Video material to support the implementation of the National Curriculum**
  As part of this support we have produced a suite of 16 videos focusing on calculation and the associated skills and understanding (for example, the concepts of place value and exchange). The videos seek to demonstrate how fluency and conceptual understanding can be developed in tandem. One of the aims of the new National Curriculum, that children should 'reason mathematically', is demonstrated throughout. Each set of videos has an accompanying presentation to stimulate thought and discussion about teaching and learning. We hope you enjoy the videos and find them helpful in supporting teacher professional development. We'd be delighted to receive your feedback and to learn how you use them. In the near future this suite will include videos focusing on fractions, algebra and division, and including footage from secondary classrooms as well. So keep a look out for these! The videos are also available on a new DVD, which gathers together, in one convenient place, all relevant video material currently on the website, together with a complementary PowerPoint presentation, containing notes to stimulate thought and discussion among teachers in CPD situations. Find out more, and details of how to order your copy, here.
- **Getting ready for the new Curriculum? A two-day programme for MaST teachers and Subject leaders**
  Following the success and oversubscription of our pilot programme last autumn, this programme is now being repeated across the country. It is designed to help primary school maths coordinators and specialist (MaST) teachers prepare for the introduction of the new National Curriculum, and will cover key mathematical themes of the new curriculum, also introducing participants to some new materials to support teaching. Find out more - including details of how to book your place.

The NCETM Professional Development Lead Support Programme (PDLSP)

We're pleased to confirm more new dates for our programme of national free face-to-face events for Primary CPD leads, the NCETM Professional Development Lead Support Programme (PDLSP).

Those who complete the programme are accredited by the NCETM to provide professional development in the priority areas of arithmetic proficiency in primary schools; to date over 140 participants in the programme have been accredited, with more to come.

The dates and locations for the new Primary cohorts are:

Places	Date	Location	Region
20	14 March	Nottingham	EM
	9 May		

Note: the event above is being run as two one-day events, times to be confirmed.

The PDLSP microsite has full details of the programme - including support materials, and information about how to book your free place.

Colleagues who have completed the first cohorts have said about the programme:

> *"I really valued the input from experienced colleagues and the diversity of viewpoints was very refreshing."*
>
> *"One of the main criteria for successful PD is that it stimulates new thinking – it certainly did that for me."*
>
> *"The course is definitely impacting on my daily work."*

New online material for subject leaders to support high attainers in mathematics in primary schools

Have you seen the section of our website which aims to support schools in evaluating and supporting their provision for high attaining pupils in mathematics in primary school? High Attaining Pupils in Primary Schools will help subject leaders, senior leaders and teachers to identify and support pupils who are attaining higher than expected standards in mathematics, not just in Year 6 but from the time they begin school.

And finally…

I heard this on the radio recently and thought it worth sharing…the record for the most babies born to one woman is 69, and 67 of them survived!! The woman concerned was the first wife of Feodor Vassilyev, a peasant from Shuya, Russia who lived from 1707 to 1782. Most women only have about 30-ish years during which they can have babies. The puzzle I give to you is this (maybe you would like to share this with your class) – how is it possible? How many different combinations of children could she have had in 30 years? I'll give you the actual answer next month!

The Art of Mathematics
Georgia O'Keeffe

Georgia Totto O'Keeffe was born in Wisconsin, US on 15 November 1887. Her parents, Francis Calyxtus and Ida Totto O'Keeffe were dairy farmers. Her father was of Irish descent and her mother was the daughter of a Hungarian count who came to the US in 1848. Georgia was the second of seven children and the eldest daughter.

Georgia O'Keeffe

By the time she was ten, Georgia had decided she wanted to become an artist. She and her younger sister were taught art by a local water colourist. In 1902 her family moved to Virginia but she stayed in Wisconsin with her aunt to continue her studies for a year before joining her family again in 1903. During her childhood she went to several schools sometimes as a day pupil and sometimes as a boarder.

From 1905 to 1906, Georgia went to the School of the Art Institute. In 1907 she attended the Art Students League in New York, where she studied under William Merritt Chase, an American impressionist painter and teacher. In 1908, she won the League's William Merritt Chase still-life prize for her oil painting 'Dead Rabbit with Copper Pot'. Her prize was a scholarship to go to the League's outdoor summer school at Lake George, New York.

In the same year, she went to a Rodin watercolour exhibition at the famous art gallery 291 on Fifth Avenue, New York which was owned by photographer Alfred Stieglitz, her future husband. At this time she began to feel that the techniques and styles she had been taught during her studies were at odds with the vision she had for art which was based on finding essential, abstract forms in nature. She therefore decided to give up the idea of becoming an artist. She took a job as a commercial artist in Chicago and didn't paint her own works again for four years. However, in 1912 she attended a class at the University of Virginia Summer School and was inspired when her tutor encouraged her to express herself using line, colour, and shading harmoniously. She began to paint landscapes, flowers and bones which recorded subtle nuances of colour, shape and light. All her images were drawn from her life experiences and related generally or specifically to places where she lived,

In 1914 she went to the Teachers' College of Columbia University where she took classes from Arthur Wesley Dow, the man whose work inspired her at the summer school she went to in 1912. She spent a few years as a teaching assistant and then a teacher of art. It was while she was teaching that she was first noticed by the New York art community. The art works that caught their attention were large paintings of enlarged blossoms as seen through a magnifying glass and paintings of New York buildings.

During this time Alfred Stieglitz exhibited ten charcoal drawings that she had made. He considered them to be the 'purest, finest, sincerest things that had entered 291 in a long while'. He also organised Georgia's first solo show at his gallery in 1917 which included oil paintings and watercolours. With his encouragement and promise of financial support, Georgia left teaching and began a career as an artist. The two soon fell in love and became inseparable, despite Alfred being 23 years older than her and a married man with children.

In 1924, after Alfred's divorce came through, he and Georgia were married. They both continued working in their individual fields. In 1923, he began to organise annual exhibitions of her work. By the mid-1920s, Georgia had become known as one of the most important American artists.

In 1938, when Georgia was 51 and her career appeared to be stalling, for various reasons, an advertising agency offered her work creating two paintings for the Hawaiian Pineapple Company to use in their advertising. This seemed to be the opportunity she needed and as a result she went to Hawaii for nine weeks. She visited several islands one of which was Maui. On Maui, she was given complete freedom to explore and paint. She painted flowers, landscapes, and traditional Hawaiian fishhooks. When she arrived back in New York, she completed a series of 20 paintings of what she had seen on Maui, but not the requested pineapple! The Hawaiian Pineapple Company eventually sent a plant to her New York studio and she finally completed her work for them.

Sadly, in 1946, Alfred died after suffering from a cerebral thrombosis. In the years after his death she continued painting and continued to make a name for herself.

Ghost Ranch Valley

In 1972, Georgia's eyesight suffered macular degeneration and left her with only peripheral vision. She stopped oil painting, but continued working in pencil and charcoal until 1984. In 1973 Juan Hamilton, a young potter, appeared at her ranch house looking for work. She hired him for a few odd jobs but soon employed him full-time. He became her closest confidante, companion, and business manager until her death. Juan taught Georgia to work with clay, and with assistance, she produced clay pots and a series of works in watercolour.

In 1976, she wrote a book about her art and, in 1977, allowed a film to be made about her. In this year she was presented with the Presidential Medal of Freedom by President Gerald Ford. This was the highest honour awarded to American citizens. In 1985 she was awarded the National Medal of Arts.

In 1984, in her late 90s, Georgia, who was by now quite frail, moved to Santa Fe, where she died on 6 March 1986 at the age of 98.

Information sourced from:

- Metropolitan Museum of Art
- Wikipedia.

Now for some mathematics!

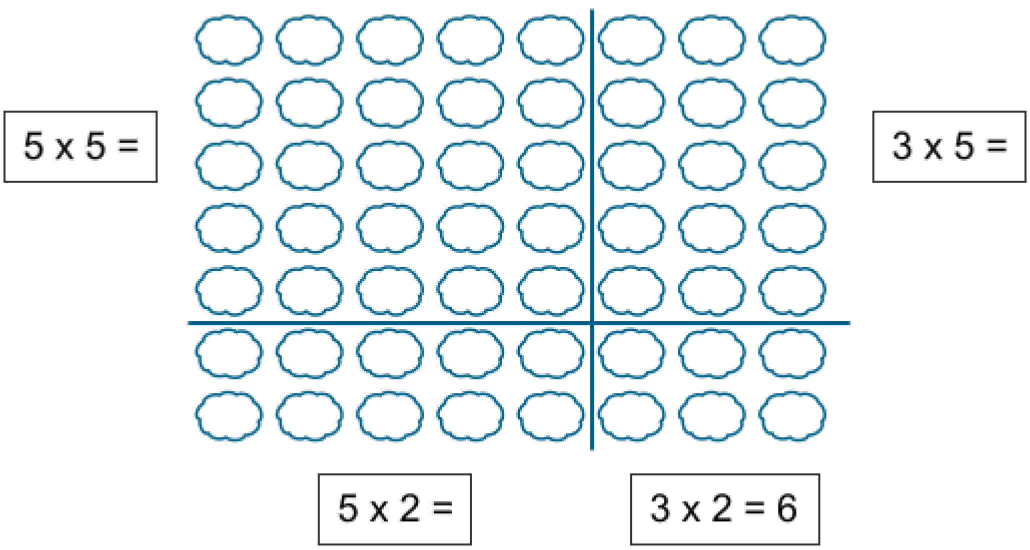
Show Above the Clouds 1

This painting was completed in 1963. Ask the children to work out how long ago that was by plotting that year and our current year onto a number line and counting on. Alternatively, ask them to use their number pairs to 10 and 100 and make jottings.

The dimensions of the painting are $36\frac{1}{8}$ by $48\frac{1}{4}$ inches. You could discuss why the painting is measured in imperial units and not metric (we only used Imperial in the days Georgia was living). You could explore the fractions $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$. This could involve folding strips of paper into 2, 4 and 8, labelling the fractions, comparing and ordering them and finding equivalences. You could also use the strips to find halves, quarters and eighths of quantities.

You could ask the children to convert these inches into centimetres using the conversion 1 inch = 2.45cm or round to 2.5cm. They could then work out the perimeter of the painting. Encourage them to use the formula 2(l + w). They could use a calculator to work out the area of the painting or round the measurements to the nearest whole number and use a mental calculation strategy. This would be a good opportunity for discussing the most efficient strategies. They could then scale the measurements down by a fraction such as $\frac{1}{4}$ or $\frac{1}{8}$ and draw a frame of that size. Once they have they could then recreate Georgia's painting inside their frame.

You could ask the children to estimate the number of clouds that they can see and discuss why it is difficult to be exact. What do the clouds in the front of the painting remind the children of? Ask for their suggestions. If arrays are not suggested bring these to their attention. Can they see the 4 by 2 array? Ask them to write down the four multiplication and division sentences that describe this. You could ask them to work with a partner and make cloud arrays of the same size on paper, for example one each that is 8 x 7. Once they have they could use straws to explore different ways of working out how to find 8 x 7, for example:



They could then put their arrays together to make either 16 x 14 or 14 x 16 and create a model for grid multiplication.

Discuss what might be seen above the clouds, for example stars and planets…and the Aurora Borealis (Northern Lights). You could show this video clip and ask them to look for the patterns that they can see. They could estimate the length of time that the video lasts for. The video was taken in Iceland. You could ask the children to research Iceland and make a fact file about the country which includes population, temperature, rainfall, currency, heights of the volcanoes and anything else with a mathematical flavour!

Show From the River - Pale

You could repeat the second and third activities from the previous painting. This painting is $41\frac{1}{2}$ by $31\frac{3}{8}$ inches.

Ask the children to tell you what they can about rivers. You could cut out the information about the world's 25 longest rivers and distribute copies to pairs and ask them to order these from longest to shortest. They could also convert the measurements from miles to kilometres. You could ask them to work out the difference between the Nile and the other rivers using a counting on strategy.

Give each child a piece of string and a copy of the painting and ask them to measure the river from where they think the source might be to the mouth. You could give them a scale, for example, 1cm is approximately 5km and ask them to work out how long the length of river they measured is. If using this scale, encourage them to multiply by 5 using the strategy multiply by 10 and halve. First discuss why this strategy works.

You could ask them to measure and compare the lengths of the tributaries that they can see. You could ask them to draw, colour or paint their own river, similar to Georgia's and make up a scale. They could then work out its length. As a class order these lengths and find out who has the longest and why, for example, did they draw a longer river or use a greater scale?

Show Series 1 White and Blue Flower Shapes

Can the children recognise the parts of the flower in this painting? How many petals can they see? Discuss the symmetry of the flower and where the line of symmetry is. They could create their own painting with one or two lines of symmetry.

Again, you could repeat the second and third activities for the first painting. This one is $19\frac{7}{8}$ by $15\frac{3}{4}$ inches. You could develop some good fractions activities from these measurements!

You could copy the painting and cut it into small rectangles – one for each member of your class. Scale the size up so that each part can be drawn on A4 paper. Once the children have drawn their piece to the scale given, you could then put all the pieces together to make a very large version of the painting. Alternatively you could ask the children to make their own copy after scaling the size down.

Show Ram's Head, Blue Morning Glory

This painting is 20 by 30 inches. Repeat the activities relating to converting to centimetres and finding its perimeter and area.

Discuss the symmetry of the ram's head. What needs adding/taking away to make it perfectly symmetrical? You could give each child a picture of half an animal's head and ask them to stick it onto a piece of paper and then draw the other half, making it as symmetrical as possible.

Look at the flower. Can the children identify its shape? If you look closely you will see that it is a decagon. You could ask the children to draw flowers that are shaped like equilateral triangles, squares and other regular shapes. Of course, as always, you will need to name and discuss the properties of regular and irregular shapes.

Show Morning Sky with Houses

This painting is $7\frac{7}{8}$ by 12 inches. You could repeat the activities previously mentioned relating to fractions, conversion of units and perimeter and area.

You could explore the shape of the house. What 3D shapes do they think it is made from? You could then explore the properties of cuboids and triangular prisms and discuss their similarities (for example, they are both prisms) and their differences. They could make these shapes with plasticine or something similar and then work out how to make them with card. Depending on the age of the children, they could explore nets or, if you give them actual shapes, they could draw round the faces and stick them together.

You could do a paint mixing activity which involves finding the ratio of two different colours of paint to make a colour similar to one that Georgia has used. If small groups children work together and each takes a particular colour they could write a 'recipe' for the ratios made – using the correct notation. They could then copy the painting using their new colours.

Show Pink Shell with Seaweed

This painting provides a great opportunity to explore the Fibonacci sequence. You could try Making Spirals from NRICH.

You might be interested in sharing some information about Fibonacci and also some Fibonacci-style number puzzles, which can be found in A Little bit of History from Issue 20 of the Primary Magazine.

The ideas here are just to give you a taster of the mathematical activities that could be involved when looking at artists such as Georgia O'Keeffe. We know you can think of plenty of others! If you try out any of these ideas or those of your own, please share them with us!

Explore further!
If you've enjoyed this article, don't forget you can find all the other *Art of Mathematics* features in the archive, sorted into categories: *Artists*, *Artistic styles*, and *Artistic techniques*.

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Primary
& Early Years
Magazine 60

National Centre
for Excellence in the
Teaching of Mathematics

Focus on…
Do we really make the most of our wonderful number system?

In this, the final of a three-part series, Barbara Carr discusses the place value of our measurement system and the powers of 10.

Just as the children need to memorise the family place value names of numbers, I believe the place value headings of the units of our measurement system need to be memorised too. In the same way young children cope with terms like digraphs and phonemes, there is no reason why they can't master the prefixes associated with the metric system.

The Latin prefixes are as follows:

- k = kilo = thousand
- h = hecto = hundred
- da = deca = ten
- d = deci = tenth
- c = centi = hundredth
- m = milli = thousandth

The SI standard units of measure are the kilogram, the litre and the metre.

It is uncommon to use the terms decametre (10 metres) and hectometre (100 metre) but we do use the term kilometre (1000 metres). It is my belief that not having heading names for the multiples of 10 and 100 metres and litres adds to children's confusion.

Kilometre	Hectometre	Decametre	Metre
1km	100m	10m	m
Th	H	T	U

Decimal notation

The Arabic system used powers of ten to create new columns.

1 x 10 = 10 (Tens column) 10^1

10 x 10 = 100 (Hundreds column) 10^2

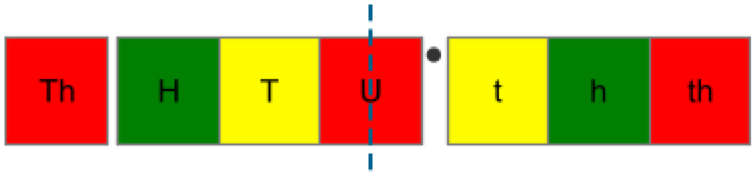
10 x 10 x 10 = 1000 (Thousands column) 10^3

This is easy to remember because there is one zero in 10^1, two for 10^2 and three for 10^3.

One is 10^0, 1 with no zero.

It makes sense then that another column to the right could be called 10^{-1}, which is a tenth or 0.1. So 10^{-2} is a hundredth or 0.01 and 10^{-3} is one thousandth or 0.001. As a visual learner, I find colours help me to see the pattern.

There is a bit of a glitch to our HTU colour system. Positive (whole) numbers follow the HTU HTU HTU pattern but we don't start our decimals with a unitth but with a tenth. This is really confusing until we look at the pattern a different way. You may find the diagram below really helpful.



There is a line in the units/ones column followed by the decimal point. I teach the children that the units/ones column and the decimal point should be seen as one.

So 1 ÷ 10 = 0.1 and we can write 1 ÷ 10 as a fraction 1/10 (a tenth)
1 ÷ 100 = 0.01 and we can write 1 ÷ 100 as a fraction 1/100 (a hundredth)
1 ÷ 1000 = 0.001 and we can write 1 ÷ 1000 as a fraction 1/1000 (a thousandth)

The use of colour supports this idea. Yellow is used to represent the tens that are positioned one place to the left of the units/ones and the tenths are positioned one place to the right of the units/ones. It is easy to work out what comes next: hundreds and hundredths represented by green, then thousands and thousandths represented by red. Next are tens of thousands and tens of thousandths represented by yellow again and hundreds of thousands and hundreds of thousandth represented by green and so it goes on ad infinitum. This can help the children appreciate the infinity of number.

As usual, if we draw children's attention to pattern in mathematics it makes sense. If something makes sense then it is remembered.

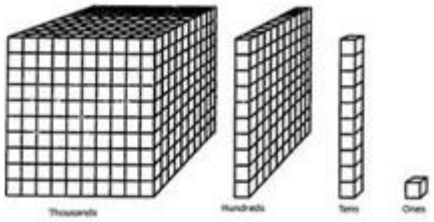
Please note that there is some diversity in how the decimal point is represented. It is worth making children aware of this. In the UK some people place the point above the line, others place it on the line. In the US it is placed on the line and in France and some other countries a comma is used to represent the decimal point.

Unlike many of us who were taught to move the decimal point when we multiply or divide by a power of ten, primary school children are taught that the decimal point never moves. In the same way as our place value headings do not switch position, the decimal stays firmly in place to the right of the units/ones. This is really important when children have to start converting units of measurement.

Williams and Shuard (1980) recognise the importance of representing numbers:

- We can carry figures in our head as well as write them on paper.
- We can see the way a number is organized
- We can see what structures it contains
- We can see how it is related to other numbers
- We can work out what will be the effect upon it of operations we carry out mentally

Structured apparatus helps a child to understand the multiplicative reasoning required to understand our base 10 number system.



Base 10 equipment like this, is based on a cube with six square faces. A small cube represents one.
10 small cubes can be built upwards to form what is termed a 'long' or a ten.
10 'longs' can be stacked backwards to form a 'flat' or a hundred.
10 'flats' can be stacked sideways to form a 'cube' or a thousand.

It is vitally important to call each piece of equipment by its correct name. Base 10 equipment is proportional equipment that can be used to represent digits in any number based on powers of ten.

Decimal measurements

Base 10 blocks can be used flexibly.

If we take two digits 2 and 1 and sit them side by side.
We know that the digit to the left is ten times bigger than its neighbour.
We could make 21 using 2 'longs' and a 'one/unit'.
We could also make 2.1 using the same equipment with a decimal point in between.
Why is this? Will this not confuse the children?

The one (cube) is ten times smaller than the 'long'.
The long could be cut into 10 equal smaller pieces.
The smaller pieces would represent one tenth of the 'long'
So if the 'long' represent a whole number or unit, we can show tenths using a 'one'.

Decimal notation can confuse children.
If we use Base 10 equipment to help them there should be no problem.

U £	•	t 10p	h 1p
£3		2	1

Consider, for example, money. Children would represent 321p using 3 'flats', 2 'longs' and 3 'ones'. The same equipment can represent decimal notation because of the relationship between the powers of ten.
£1 is ten times larger than 0.1 (tenth of a pound) and one hundred times larger than 0.01 (hundredth of a pound).

Asking children to build up decimal notation helps them to recognise that decimal place headings are just an extension of whole number headings. The multiplicative relationship becomes clear. They just need the opportunities to explore!

As children are introduced to measurement they work with numbers to 3 decimal places.
If you ask a child to build 1234 using Base 10 equipment they will use 1 large cube, 2 flats 3 longs and 4 small cubes.

When asked to build 1.234m the same equipment can be used.

Th	H	T	U	•	t	h	th
			1		2	3	4

Let's take 1 234 and look at the value of each digit in terms of powers of ten:

- 4 is 10 times smaller than the digit 3 in this number
- 1 is 1000 times bigger than the digit 4 in this unit

If we represented the number 1 234 mm using Dienes we would use 1 cube, 2 'flats' 3 'longs' and 4 'ones'. 1 234 mm is equivalent to 1.234 metres.
The same equipment can represent one unit (using the large cube), 2 flats representing two tenths, 3 longs representing 3 hundredths and 4 small cubes representing 4 thousandths.
Try it out before attempting to teach this to children.

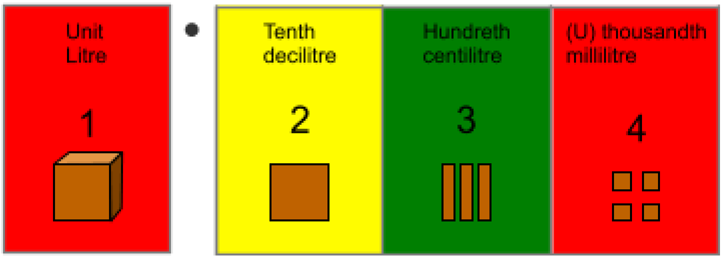
Representing SI units of measurement on a place value board.

I mentioned earlier that it is not helpful to NOT teach children the names of place value headings and that I believe we should. Having recently spoken to a one-to-one tutor, she said that every pupil she works with struggles with converting units of measurement. She believes that this is because the children are currently taught by rote and expected to memorise facts through rehearsal.

If we could teach children these prefixes using the headings on a place value board, this will support understanding.

U	•	t	h	th
Litre Metre Gram Kilogram		decilitre decametre decigram decagram	centilitre centimetre centigram hectogram	millilitre millimetre milligram gram

Once children have mastered heading up place value boards for measures they can then see the value of the tenth, hundredth and thousands using base 10 equipment.

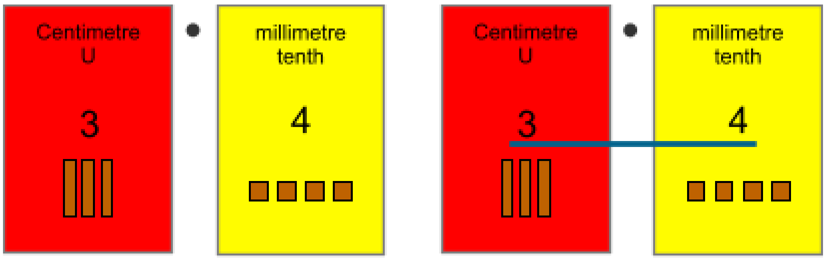


Converting units of measurement

Trying to explain this is tricky… the unit of measure is expressed verbally and by a symbol.

3 kilograms is represented 3kg. 1 metre is represented as 1m. The symbol is the unit of measurement. So for 3.4cm, the centimetre is the unit of measurement.

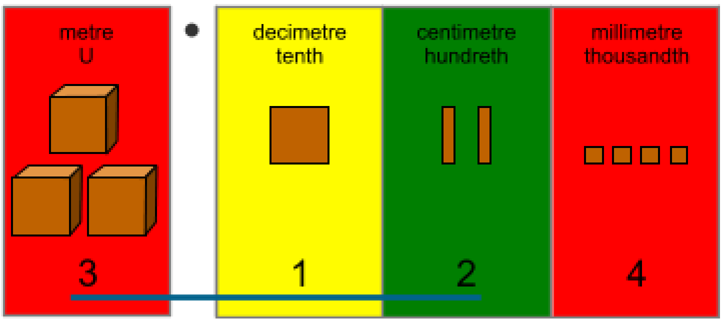
This is helpful to know because we can now build this number using base 10 equipment on a place value board.



When asked how many millimetres are in 3.4 centimetres we know that the 3 next door to the 4 is worth ten times more ie 30. So there are 34 millimetres in 3.4 cm.

So if base 10 and powers of ten are not taught as soon as possible, children will find all of this rather overwhelming (as may you when you read my attempt to explain all of this!!!).

Here is a harder example.
How many centimetres are in 3.124m? The metre is the unit of measure, followed by the dm, cm and mm headings. Build this using Dienes.



Now underline everything to the right of the centimetre heading. Ignore the decimal point and you have 312. This may look odd, but the proportional relationship between each piece of Dienes is correct.

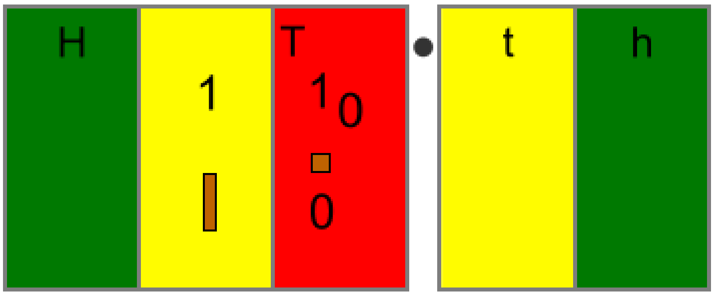
312 is represented by 3 large cubes and 1 'flat' and 2 'longs'
We need 10 'longs' to make a 'flat' and 10 'flats' to make a 'cube'.
We need 100 'longs' to make a 'cube'.

Play around with this as reading this is confusing.

Multiplying by a power of ten

The place value board is often used to model dividing or multiplying a number by 10, 100 and 1000.

1 x 10 = 10
Take a one cube and multiply this by 10 to make 10 ones.
Exchange these for a 'long'.



Give children opportunities to explore the effect of multiplying one by ten, and ten by ten then dividing a one by ten and ten by ten, exchanging and talking about what they notice.

Now that the new curriculum mentions powers of 10 I wonder if it may also provide an opportunity to explore multiplying and dividing by powers of 10.

$10^3 \div 10 = 10^2$ which is the equivalent of $1000 \div 10 = 100$

$10^{-2} \times 10 = 10^{-1}$ which is equivalent to $0.01 \times 10 = 0.1$

Summary

It is my belief that by over-simplifying the primary curriculum over the years, we have lost some key 'tools' that help us to understand what is going on with our base 10 number system.

The problem is that it is written in such a precise format that this will not be fully understood by many primary teachers. It has taken me all morning to write an explanation of my understanding of it all and I am lucky enough to have time to get to grips with this as a mathematics specialist during SATS week!!!

"Our number notation and the measures in daily use are so closely bound up with our history that new meaning is given to them if their origins are known. There is some considerable value in letting children read for themselves about the inventions that have gone to the making of our number system." (Williams and Shuard,1980:163)

I was listening to Thought for the Day on the way to work one day last year by the (then) Chief Rabbi, Lord Sacks. He was talking about a man who had lost his memory and the difficulties he faced. He finished his talk by saying "Today needs a yesterday if we are to plan for tomorrow. If we as individuals or as a humanity are to shape a better future, we need to take time to remember the past."

Many thanks to Barbara for sharing her article with us. We hope that you found the series interesting. If you have anything you would like to share with us, please let us know.

You might be interested in exploring in more depth the ancient number systems which were written about in early issues of the Primary Magazine. They can all be found in the NCETM Essentials.

Explore further!
If you've enjoyed this article, don't forget you can find all previous *Focus on...* features in our archive.

A little bit of history – adhesives

Glue sticks, sticky tape: we all use them from time to time, children too. So in the penultimate article in our series of classroom equipment we look at adhesives of which these are two.

One dictionary definition for adhesive is 'a substance capable of holding materials together by surface attachment.' Such a simple definition for a multi-million pound grossing product!

Glue was first used many thousands of years ago. It was made from natural materials such as beeswax, egg whites, bark, tar, blood, bones, hide, milk, cheese, vegetables and grains. Earliest findings date back to hunters joining feathers to their arrows, using beeswax, in order to improve their aim when trying to catch animals for their food.

Here are some other examples of archaeologists' discoveries of the early uses of adhesives:

- broken clay pots repaired with resin were found at a burial site thought to date back about 6000 years
- statues from Babylonian temples were found with ivory eyeballs glued into eye sockets
- carvings in Thebes from around 1300BC show a glue pot and brush being used to bond a veneer to a plank of sycamore
- a casket removed from the tomb of King Tutankhamun shows the use of glue in its construction
- our museums today contain many art objects and furnishings from the tombs of Egyptian Pharaohs that are bonded or laminated with some type of animal glue
- from 1 – 500 AD, the Romans and Greeks developed the art of veneering and marquetry, which is the bonding of thin sections or layers of wood.

The development of modern adhesives began in 1690 with the founding of the first commercial glue plant in Holland. These glues were produced from animal hides. In 1750 the first British glue patent was issued for fish glue. Apparently variations on these were developed over the following decades.

In 1839, Charles Goodyear (of tyre fame) discovered that a mixture of rubber and sulphur became elastic when heated. This discovery was developed and eventually used, in 1927, to produce a solvent to bond metal and rubber.

In the 1920s, 1930s and 1940s due to the World Wars there were great advances in the development and production of new plastics and resins. Synthetic adhesives began to replace many of the natural substances owing to their stronger adhesion. However some of the natural ways to stick things together continued to be widely used and still are today, including naturally occurring asphalt materials.

Tape

Sellotape began as a British brand of transparent, pressure-sensitive adhesive tape, used for joining, sealing, attaching and mending things. It became the leading brand of tape in the UK and so well known that the word Sellotape is now a commonly-used generic name for any clear form of sticky tape.

Sellotape is sold to many countries around the world, for example, Ireland, Australia, New Zealand, India, Japan, Greece, Zimbabwe and Bosnia.

The tape was originally manufactured in 1937 by Colin Kinninmonth and George Gray, in West London. It proved to be the right product at the right time. Two years after it was first produced, during the war, it was used for sealing ammunition boxes and taping up windows to minimise potential bomb damage.

It was a sad use of the product in those days but these days it has more positive associations, particularly as a key component in present wrapping!

From the 1960s to 1980s, the Sellotape Company was part of a British packaging and paper conglomerate. In 2002, it was sold to a German company. The company was warned that whatever they might change in the product they mustn't tamper with the name! Apparently it has cultivated an 'affectionate image due to childhood memories'.

Although adhesives have been around for about 6000 years, most of the technology of adhesives has been developed over the last 100 years.

Information sourced from:

- Autonopedia
- BBC.

Now for some mathematics...

You could collect all the glue sticks and rolls of sticky tape in the classroom and count how many there are altogether. How many more of one type are there than the other? Choose either type of adhesive and compare their sizes, for example heights, diameters. Next repeat this for the other type.

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You could ask the children to look online for the different prices of each product. They could order these on a number line and then compare prices of different brands.

You could ask the children to solve and make up problems: for example, a box of 25 glue sticks costs £40.75. How much does each glue stick cost? You could give the price of one, for example, £4.05, and ask the children to work out if it is cheaper to buy in bulk and if so, by how much.

You could make up a scenario such as, Mr Stick needs to order tape for each class in the school. There are 14 classes altogether. He will order each class 12 rolls. Each pack that he wants to order contains 15 rolls and costs £36.50. How many packs does he need to buy and how much will it cost?

What 3-D shapes are glue sticks and rolls of sticky tape? You could carry out a shape activity with plasticine where the children make a sphere, describe its properties and discuss where it can be found in real life. They then flatten their sphere to make faces and create a cube. Again they describe its properties and where they would be seen in real life. Repeat this for a cuboid and then a cylinder.

Can they identify which of the shapes they made are the same as the sticky tape and glue stick? You could ask them to explore nets of these shapes. Can they make a cylinder? Once they have, you could ask them to make cuboid shaped packing boxes to put these into. What would be the best size for one cylinder? What about 10, etc.?

You could use the rolls and sticks to explore circles. Ask the children to draw around them to create circles. They could then measure their diameters and compare sizes. They could measure these in centimetres and millimetres (e.g. 3cm 5 mm) and then convert to millimetres (35mm) and then to centimetre measurements (3.5cm). They could also convert these to imperial measurements.

You could ask the children to use a strip of paper and tear it to the size of the circumference of a roll of sticky tape. They could then explore the relationship between this and the diameter of the roll. By folding the strip they should be able to find that circumference is just over 3 times the diameter. They could measure each to the nearest centimetre and check by multiplying the length of the diameter by three.

You could give the children investigations such as Overlapping Circles, Change Around, or Intersecting Circles (all from NRICH).

You could ask the children to make repeating patterns using the circle shapes that can be made by either or both.

You could ask the children to explore the Sellotape Company website and make a table of the products they produce. They could then find prices for these items online and add these to their table.

The children could also explore the time line on the website and make up their own with dates and interesting facts. They could then work out the differences between these dates and make up problems for a friend to solve.

The children could make a list of the different makes of glue sticks that are in the classroom, then find out their prices and compare them.

Sellotape comes in two main sizes: 24mm x 50m and 16mm x 33m. Ask the children to draw lengths on paper to show their widths. Using a metre stick can they visualise how long 50m and 33m are? They could explore how many times around the playground, classroom or field the lengths of Sellotape would go. You could give them the dimensions of each so that they can try to calculate this using a mental calculation strategy. Alternatively, let them practically try this out with a trundle wheel.

We often use sticky tape to make up or secure boxes. You could ask the children how they could secure a box without sticky tape - or glue or string! Let them experiment by making nets of cubes and adding tabs to over- or under-lap. They then cut them out and fold them to see which tabs can be successfully used.

We hope that this article has inspired you to make a mathematical use of your classroom glue sticks and sticky tape! If there is any area of history that you would like us to make mathematical links to, please let us know.

Explore further!
If you've enjoyed this article, don't forget you can find all previous *A little bit of history* features in our archive, sorted into categories: *Ancient Number Systems*, *History of our measurements*, *Famous mathematicians*, and *Topical history*.

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Maths to share – CPD for your school

This is the third of our series of four explorations of ways in which you can help your children to develop their conceptual understanding of the four operations. In Issue 58 we looked at addition, in Issue 59 we looked at subtraction, and in this issue we explore multiplication. For more about this operation see Issue 25, which explores the basics of this concept. In this issue we will focus on the development of the written columnar method.

The National Curriculum requires teachers to teach multiplication of two-digit numbers by a single digit number, using mental methods and also progressing to formal written methods in Year 3. In Year 4 the children should be taught to multiply 2 and 3 digit numbers by a single digit using formal written layout. In Year 5 they should be taught to multiply numbers up to 4 digits by a one- or two-digit numbers using a formal written method, including long multiplication for two-digit numbers. In Year 6 the children should be taught to multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication. However, as mentioned in Issue 57, so long as the formal methods are taught, it is up to colleagues in individual schools to decide when these are taught.

For the meeting you will need copies of the multiplication and division sections of the National Curriculum and equipment such as straws and base ten equipment.

If you have them, place value counters would be helpful, or simply sets of three different coloured counters to represent hundreds, tens and ones.

You will also find it helpful to provide squared paper or wrapping paper that shows arrays, counters, paper and straws.

Begin your staff meeting by writing these calculations on the board:

- 24 x 50
- 24 x 4
- 24 x 15
- 136 x 9
- 245 x 1.6.

Give colleagues a few minutes to discuss ways to solve each calculation. Take feedback, discussing the different strategies they have used.

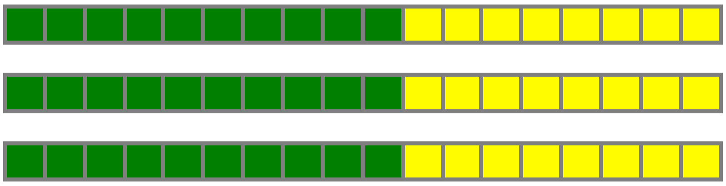
There are several ways to answer these calculations, including some efficient mental calculation strategies. It might be worth highlighting the more obvious methods, such as:

- 24 x 50: multiply by 100 and halve
- 24 x 4: double and double again, or partitioning
- 24 x 15: multiply by 10, halve that and add the two together
- 136 x 9: multiply by 10 and subtract 136, grid method, formal method
- 245 x 1.6: multiply by 16 by doubling four times and then dividing by 10, grid method, long multiplication.

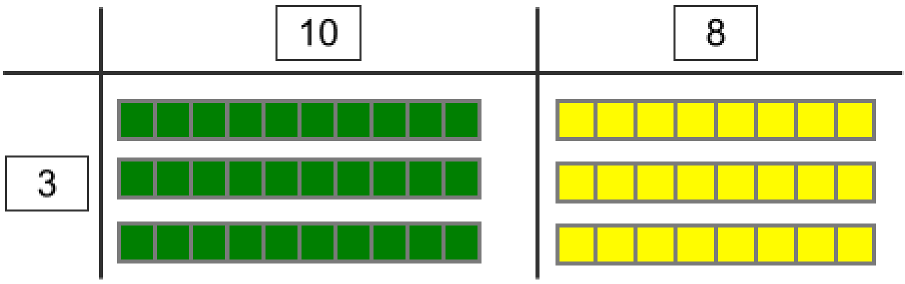
Ideally, we would all want our children to develop the ability to look at a calculation and decide which method is the appropriate one to use for multiplying numbers. Sometimes it might be that a mental calculation strategy is the most efficient, sometimes it might be the column method. Remind colleagues that this means teaching mental calculation strategies remains important. In the notes and guidance section of the National Curriculum for each year group there is an expectation that children use mental calculation strategies; for example, in Year 6 it states that 'they undertake mental calculations with increasingly large numbers and more complex calculations'.

As with addition and subtraction, it is probably wise to begin teaching the column method with a simple calculation, such as 18 x 3. Begin by exploring this using base 10 equipment and place value counters, and model the approach in a similar way to this…

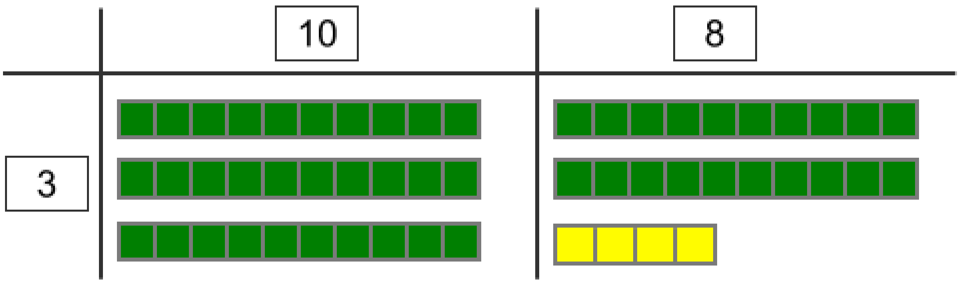
Ask colleagues to make 18 using the equipment that you have available. They could do this three times, placing them underneath one another:



Ask them what they notice about their arrangement. They should notice that it forms the basis for the grid method. Give out straws and paper (for labels) and ask them to create a grid:



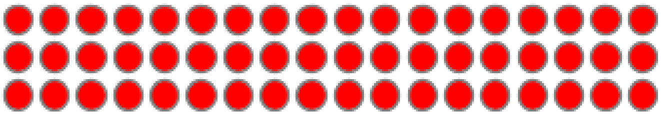
Next, ask them to re-group the ones into tens and ones and to show the answer linking it to the way in which the children would solve the calculation



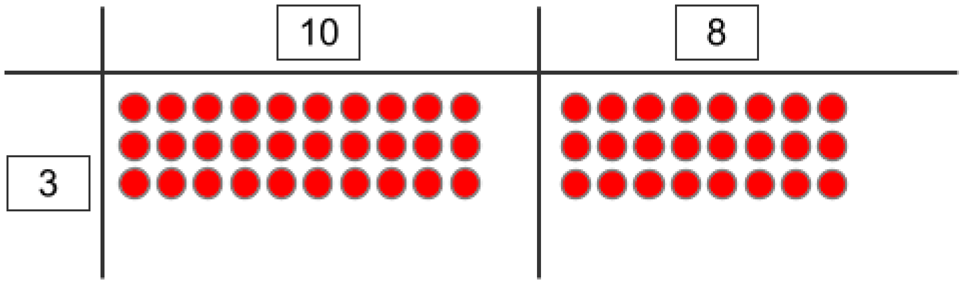
30 + 24 = 54

You could point out that before adding the two numbers together their answer was 30 24.

Now use counters or squared or wrapping paper and ask colleagues to make an array for 18 x 3:



Repeat the process from above:



Next, ask what is the same and what is different about the two. Agree that both show the commutative element of multiplication and both show the inverse between multiplication and division. Base 10 clearly shows the 10s and ones but the counters don't until they are marked. The base 10 loses the array element when the ones are grouped into tens. The counters remain ungrouped so don't lose the array.

Using these models, demonstrate how the array can be transferred to the partitioning method for multiplication and then progress to the formal method using columns:

1 8	1 8
x 3	x 3
2 4	5 4
3 0	2
5 4	

Ask colleagues to tell you what is the same and what is different about these methods. This is a great question to ask the children, helping to develop their reasoning skills. It is important to stress that the children's recording needs to be developed alongside the kinaesthetic manipulation of whatever resources they use.

Finish your meeting by leading a discussion on when the children in your school should be taught to move from partitioning or the grid method of multiplication to the written method of column multiplication. Compare colleagues' thoughts with the expectations from the National Curriculum. As a group make a decision to write into your school calculation policy.

You might like to show one or more of these video clips that have been produced by the NCETM; the titles are self-explanatory.

Multiple representations of multiplication shows a Year 2 class exploring different representations for multiplication statements in order to help them develop an understanding of their multiplication tables

The commutative law for multiplication shows a Year 2 class using manipulatives to describe a multiplication statement and then moving on to explore the commutative law using arrays.

Grid method as an interim step shows a Year 4 class using manipulatives to deepen their understanding of the grid method.

Moving from grid to column method shows a Year 6 class developing their understanding of the column method by exploring the similarities and differences between this and the grid method.

We hope that you have found this article helpful. If you decide to use it for staff professional development, please let us know - we'd love to hear what you did.

Explore further!
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