Primary
& Early Years
Magazine 48

National Centre
for Excellence in the
Teaching of Mathematics

Welcome to Issue 48 of the Primary Magazine. In this issue we feature the American artist Grandma Moses. A little bit of history looks at another of the world's most famous travellers, Neil Armstrong. Focus on... explores some mathematical possibilities for St Valentine's Day and Maths to share looks at the research of Mathematics Specialist Teacher Yesim Soyel.

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A reminder of some events happening this term...

The NCETM Digital Technologies Conference, 27 February, London

Is your school considering buying iPads for use by your children? If so, you cannot afford to miss the NCETM conference Working together to integrate digital technology in mathematics teaching and learning: Putting the tools in the hands of the learners. This digital technologies conference is for primary and secondary school teachers, and takes place on Wednesday 27 February at the Institute of Education, University of London.

The aims of the conference are:

- to familiarise participants with a range of technologies that could be used to enhance mathematics teaching and learning and to showcase some new developments, initiatives and reports
- to prepare delegates on how to use digital technologies in mathematics by sharing successful strategies.

The NCETM will be working with teachers and those providing digital technologies to schools for use with mathematics to fill the conference with classroom and learner-focused activities.

There will be workshops presented by primary and secondary school teachers. The day will include a final panel session with members Vanessa Pittard, who is responsible for STEM in the Department for Education; Dr Alison Clark-Wilson of the University of Chichester, and Professor Richard Noss, co-Director of the London Knowledge Lab and one of the authors of the recent NESTA report, Decoding Learning.

This conference is free to attend, and you can find more details and book your place via the conference webpage.

The NCETM Professional Lead Development Support Programme

There are still a few places available on the PD Lead Support Programme, a series of national free face-to-face events for CPD leads in teaching schools and improvement agents. Events this term are in Nottingham, Peterborough, Exeter, Sheffield, Guildford and London. These events are for:

- Specialist Leaders in Education (SLEs) and other colleagues from Teaching School Alliances charged with organising and running mathematics PD opportunities;
- teachers based in schools with a remit for supporting colleagues in their own and other schools such as Mathematics Specialist Teachers (MaST) and ASTs
- other teachers who are charged with organising and running mathematics PD opportunities;
- mathematics and/or numeracy advisers and consultants from Local Authority teams;
- independent mathematics consultants and organisations offering mathematics PD;

- colleagues from HE institutions offering PD.

This programme consists of four elements:

- an initial 24-hour residential development day, beginning at 17:30 on the first evening and ending at 15:30 on the second day;
- planning, execution and evaluation of an interim task based on input offered in the first residential;
- a second 24-hour residential (with timings the same as the first);
- a commitment to plan and offer future PD opportunities drawing on the input, discussions and experiences gained during the programme and to offer regular (termly) feedback regarding reach and impact for at least a year following accreditation (a re-accreditation process is offered after one year).

Colleagues completing this programme will be accredited by the NCETM to provide professional development in the priority areas of arithmetic proficiency in primary schools and algebraic proficiency in secondary schools and colleges.

Accredited PD Leads will:

- receive a certificate indicating their status as an 'NCETM Professional Development Accredited Lead';
- be entered into a directory of Accredited PD Leads which will be held on the NCETM portal;
- receive an 'NCETM Professional Development Accredited Lead' logo which can be used on any relevant documentation to signal your accreditation.

There is no cost attached to attendance at the two residentials: accommodation and meals are included, but please note that travel and supply costs if appropriate, should be met by those attending.

If you are interested in taking part, you can find out more - including details of how to book your place – here.

Conferences

The conference season is on the way. Here is some information about three of them:

- booking is in progress for the NAMA conference, Mathematics Learning – Nature or Nurture, which will be held from 14 - 16 March at Aston University, Birmingham. Colleagues are invited to attend all or part of this great CPD opportunity. For full details of this conference, please visit NAMA's website
- would you like to hear top speakers on communicating and teaching mathematics? If your answer is 'yes', you must go to the MA's Annual Conference! Booking for Telling the Great Stories of Mathematics has now opened, and it takes place from 3 - 5 April at Loughborough University. The speakers are Rachael Horsman, Marcus du Sautoy, David Spiegelhalter and Art Benjamin. For details on how to book, visit their website;
- the ATM annual conference, Maths for Real, will take place in Sheffield from 2 - 5 April. As always there will be a wide range of sessions available, evening activities and, of course the ATM Workshop. Try out lots of practical mathematical activities, work through some problems together in the workshop and remember why you love mathematics. To find out more, visit their website.

Primary National Curriculum for Mathematics

Be sure to keep your eyes open for the draft of the primary National Curriculum for Mathematics. Your comments and feedback are needed! We will put a link in the Primary Forum as soon as it is published. You'll also be able to find out more from our News section and our Twitter and Facebook pages.

The Art of Mathematics
Grandma Moses

Anna Mary Robertson Moses, better known as 'Grandma Moses', was a renowned American folk artist. Folk art is made by people whose creative skills convey their community's cultural identity, encompassing a range of media, including cloth, wood, paper, clay and metal.

Grandma Moses was born Anna Mary Robertson in Greenwich, New York on September 7th 1860, one of ten children. She married Thomas Salmon Moses in 1887 when she was 27. The couple lived in Virginia where they rented a farm. They stayed there for 20 years and during that time had ten children, five of whom died in infancy. In 1905, they returned to New York with their five surviving children and settled on a farm in Eagle Ridge, where Thomas Moses died in 1927. After his death, Anna continued to run the farm with the help of her youngest son, until age forced her to retire to one of her daughters' homes in 1936.

Anna took up oil painting when she was 77, after arthritic hands prevented her from continuing with the embroidery that she spent much of her spare time engaged in. She began painting on old pieces of white painted board, thinking, initially, that she was painting only for herself and her family. After a couple of years she decided to sell her paintings (and the pickles she made) at a county fair. She also had a group of her works on display in the window of her local chemist's. It was here that collector Louis J. Caldor spotted her paintings. They were priced from $3 to $5 depending on their size. He bought them all, then drove to her home in Eagle Ridge to buy more. On his recommendation her work was included in the 1939 Contemporary Unknown American Painters Exhibition at the Museum of Modern Art in New York City. She didn't remain unknown for long. In 1940 Anna had her first solo exhibition called 'What a Farm Wife Painted', which was a huge success. This was the first of several exhibitions that year, and it was after this first one that she was called Grandma Moses.

Grandma Moses stamp 1969

She soon had the attention of collectors all over the world, and her paintings became highly sought after. During the 1950s, Grandma Moses' exhibitions were so popular that they broke attendance records all over the world. Art historian Judith Stein wrote this about her… 'A cultural icon, the spry, productive nonagenarian was continually cited as an inspiration for housewives, widows and retirees. Her images of America's rural past were transferred to curtains, dresses, cookie jars, and dinnerware, and used to pitch cigarettes, cameras, lipstick and instant coffee.'

Her paintings were reproduced on Christmas cards, tiles and fabrics in America and abroad. In 1946 her painting 'The Old Checkered Inn in Summer' was featured in the background of a national advertising campaign for lipstick. She painted mostly scenes of rural life and her paintings were used to publicise numerous American holidays, including Thanksgiving, Christmas and Mother's Day.

Although she never received a formal art education, she was awarded honorary doctoral degrees from Russell Sage College and the Moore Institute of Art, Science and Industry. She was honoured by Governor Rockefeller, who named her 100th and 101st birthdays state-wide as Grandma Moses Days. President Truman presented her with the Women's National Press Club trophy award for outstanding accomplishment in art in 1949. She continued painting until her death in 1961, producing nearly 1 500 paintings.

After her death, large travelling exhibitions circulated throughout Europe and Japan, where her work was particularly well-received.

In November 2006, her work 'Sugaring Off' (1943) became her highest-selling work at US $1.2 million. The work was a clear example of the simple rural scenes she is known for.

Today, Grandma Moses is remembered as the foremost American primitive painter of the 20th century.

Some mathematical ideas for the work of Grandma Moses

You can find examples of her work at WikiPaintings.

Show the children The Old Checkered House in Winter.

You could use this painting for counting activities. For example, you could ask the children to estimate and then check by counting, maybe in twos, the number of people. They could count the horses in pairs and also the trees and windows of the house. Ask them to tell you how many different colours they can see in the painting.

Focus on the windows and use these to rehearse work on multiplication through arrays. Some of the windows show a 4x4 pattern and others a 3x3. You could also use this to explore square numbers. They could draw a 3x3 array on squared paper and then investigate how many rectangles they can find altogether (not simply the nine obvious ones!).

What patterns can be seen in the walls of the house? Can the children estimate and then find out how many red and white bricks there are? What shape are the bricks? What are the properties of a square?

You could use this brick pattern to investigate tessellation. The children could make their own picture of a checkered house but instead of using square bricks can they use another shape that tessellates?

What temperature might it have been in the painting? You could use this as an opportunity to practice negative numbers as the temperature must be below 0°C for the snow to look so fresh.

Show the painting Sugaring Off.

In November 2006 this painting sold for US $1.2 million. You could make up a date in November and ask the children to work out how long ago it was sold. They could work this out in years, months, weeks or days, or a combination of all four.

Find the current exchange rate for sterling and US dollars. Can the children work out how much the painting was sold for in sterling?

You could carry out similar counting activities as suggested for 'The Old Checkered House in Winter'.

You could ask the children to estimate the height of one of the trees in the foreground of the picture. They could base their estimate on the heights of the people. This could be done in metres or feet and inches. You could use this as an opportunity to convert from metric to imperial or vice versa.

They could go outside and estimate the height of a real tree using this method:

> Walk away from the tree and at regular intervals bend forward and look through your legs back to the tree. Stop when you are at a point where you can just see the top of the tree and measure the distance along the ground from the tree to you. This is roughly equal to the tree's height.

Show the children Country Fair.

This painting provides plenty of opportunity for estimating and counting, and also for exploring shapes.

The children could make a tally of all the different animals that they can see.

They could design a flag for an imaginary (or real) school fair. Their design should be symmetrical and include shapes that can be seen in the painting.

You could print out the painting and cut it into 16 equal-sized pieces. Give pairs of children one piece. They reproduce their piece after scaling up to - for example - five times the size. Once they have reproduced all the pieces stick it together to make a large version of the painting.

Show the children Building a Barn.

What shapes can the children see in this painting? You could use this to reinforce triangles and quadrilaterals. The triangular shapes that make the roof of the barn are isosceles triangles. From their knowledge that a triangle has angles totalling 180° and that an isosceles triangle has two angles of the same size, can they estimate the sizes of the angles in the triangles that make the roof? You could give them a copy of the painting and ask them to measure the angles to check their estimates.

Using art straws and tape, can they make a structure similar to the framework of the barn? Once they have they could measure the sides of the triangles and rectangles used and then find their perimeters and areas.

What 3D shapes can they see that would make the main part of the barn and the roof? They could make a model of a barn by creating their own nets for a cuboid and triangular prism.

The ideas here are just to give you a taster of the mathematical activities that could be involved when looking at artists such as Grandma Moses. 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!

Information sources

- biography.com
- Wikipedia.

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Focus on…
St Valentine's Day

St Valentine's Day is commonly known as Valentine's Day or the Feast of Saint Valentine. As we all know, it is coming up in a few days' time, on 14 February. Today, Valentine's Day is celebrated in many countries around the world, for example, Australia, the US, Mexico, France and, of course, England.

The history of this day and the actual Saint Valentine it is named after is shrouded in mystery. We do know that February has long been celebrated as a month of romance and that Valentine's Day has links to Christian and ancient Roman tradition, but we don't know for sure who Saint Valentine is.

Saint Valentine

The Roman Catholic Church has at least three different saints named Valentine or Valentinus, all of whom were martyred, probably around 270AD.

One legend tells that Valentine was a priest who lived in the third century in Rome during the rule of Emperor Claudius II. Claudius decided that single men made better soldiers than married ones so he outlawed marriage for young men. Valentine felt this was a gross injustice: he defied Claudius and married young couples in secret. When he was discovered, Claudius ordered that he was put to death.

Another legend suggests that Valentine was imprisoned and then killed for attempting to help Christians escape from Roman prisons, where they were often beaten and tortured. During his imprisonment he sent the first 'valentine' greeting after falling in love with a young girl, possibly his jailor's daughter, who visited him in prison. Apparently before his death he wrote her a letter signed 'From your Valentine'. This is an expression that is still used today.

Despite not knowing the facts about him, Valentine is known as a sympathetic, heroic and romantic figure. He has become one of the most popular saints in England and France. Today, Saint Valentine's Day is an official feast day in both the Anglican and Lutheran Church.

Valentine's Day card

The day's association with romantic love possibly began at the end of the fifth century, when Pope Gelasius declared 14 February St. Valentine's Day. It grew in the Middle Ages when, in England and France, it was commonly believed that 14 February was the beginning of birds' mating season, which added to the idea that this should be a day for romance. By the 15th century, it had evolved into an occasion in which couples expressed their love for each other by presenting flowers, sweets, chocolates and other gifts and sending greeting cards. Valentine's Day symbols that are used today include hearts, doves, and the figure of the winged Cupid. Since the 19th century, handwritten valentines have given way to mass-produced greeting cards.

The oldest known valentine still in existence today was a poem written in 1415 by Charles, Duke of Orléans, to his wife while he was imprisoned in the Tower of London following his capture at the Battle of Agincourt. The greeting is now part of the manuscript collection of the British Library in London.

Today, according to the Greeting Card Association, an estimated one billion Valentine's Day cards are sent each year, making Valentine's Day the second largest card-sending occasion of the year, after Christmas when an estimated 2.6 billion cards are sent. Apparently, women buy approximately 85% of all valentines.

For more information visit History.com.

A few mathematical ideas for St Valentine's Day...

- you could explore the dates and number facts in the above article. The children could plot the dates and centuries on a number line and add other dates that are significant to them or history topics that you have studied. They could explore billions. You could ask percentage-related questions such as, if 1 200 Valentine's cards were sold in a village, how many were bought by women?

- you could ask the children to design their own Valentine's cards which have symmetrical designs that include a symmetrical heart in the middle and other shapes as a border. This could be an opportunity to rehearse properties of 2D shapes and symmetry

- the children could make cards with hearts that show rotations, reflections and translations. They could make a design for wrapping paper for a Valentine's gift that is made from tessellating shapes decorated with hearts. They could explore whether it is possible to tessellate a heart

- you might like to try the activity Number Pair Love Hearts from the NCETM microsite What Makes a Good Resource. This visual and creative activity has been designed by a teacher to help her children learn their number pairs to ten. It is a resource that can be used with the whole class or by a TA with small groups who need extra practice

- cooking is an activity that most children enjoy taking part in. It is also very mathematical, creating plenty of practical opportunities for estimating and measuring capacity and weight and also converting units of measure from metric to imperial and vice versa. So why not try out a few from About.com? Here are a couple of lists of recipe ingredients in mixed units to tempt you – or not! Follow the links (embedded in the titles) to find out how to make them.

  Love bug truffles
  240ml double cream
  12 oz chopped semi-sweet chocolate
  12 oz red candy coating
  4 oz chocolate candy coating
  2 oz white candy coating
  two piping bags or paper cones fitted with small round tips.

  Fudge Hearts
  720g chocolate chips
  14 oz sweetened condensed milk
  ¼ tsp salt
  1 tsp vanilla extract
  2 lbs fondant
  sprinkles and other decorations (optional).

Happy Valentine's Day!

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Valentine's card by karen horton some rights reserved.

A little bit of history – Neil Armstrong, the first man to walk on the Moon

Neil Armstrong was born in Wapakoneta, Ohio, on August 5, 1930. His love for flying started when he was a child and his father took him to an air show. Apparently he enjoyed building model planes and spent some of his spare time doing this. His first ride in a plane was in a Tin Goose when he was six years old. Unfortunately the future astronaut suffered from travel sickness when he was young but this didn't put him off his goal which was to become a pilot when he grew up. He was said to have been inspired by the Wright Brothers. At the age of 16, he got his pilot's licence – before he got his driving licence!

He was a bright student at school. The subjects that interested him most included science, mathematics, astronomy and cosmology.

Neil earned himself a US Navy scholarship which enabled him to begin his studies in aeronautical engineering at Purdue University in 1947. His studies were interrupted in 1949 when he was called to serve in the Korean War. He was a fighter pilot flying his planes from aircraft carriers. He flew 78 combat missions. At one point his plane was hit by enemy fire, but he was able to eject and was safely rescued. He left the service in 1952 and finished his studies earning his bachelor's degree in aerospace engineering. He later got his master's degree at the University of Southern California.

After graduating, he joined the National Advisory Committee for Aeronautics (NACA), which later became the National Aeronautics and Space Administration (NASA). His work included serving as a test pilot and an engineer. He tested many high-speed aircraft, including the X-15, which could reach a top speed of 4 000 miles per hour. It was a dangerous job, but very exciting. He flew over 200 different types of aircraft during his career.

He met Janet Shearon, who was four years younger than him, at university where she was studying Home Economics. They married on January 28, 1956 in the city of Wilmette, Illinois. They moved to southern California shortly afterwards where Neil was working. The couple's first child, a son named Eric was born in 1957, and a daughter, Karen was born in 1959. Sadly, Karen died of complications related to an inoperable brain tumour in January 1962. The following year, 1963, their second son, Mark, was born.

After 38 years of life together Neil and Janet divorced in 1994. During the last couple of years of his marriage Neil met Carol Held Knight in 1992. They were married two years later on 12 June 1994, just a short time after his divorce was finalised.

launch of Apollo 11

Neil applied to become an astronaut and in September of 1962 he was selected for the NASA Astronaut Corps. He had to go through a series of difficult physical tests, which he passed and was soon part of the 'new nine', or second group of nine NASA astronauts. He and his family moved to Houston, Texas so that he was closer to the space centre.

In 1966, he was command pilot for his first mission, Gemini VIII, with pilot David Scott. While in orbit, they were able to briefly dock their space capsule with the Gemini Agena target vehicle. This was the first time two vehicles had successfully docked in space. During this manoeuvre, however, they experienced some problems and had to cut their mission short. They landed in the Pacific Ocean nearly eleven hours after the mission's start, and were later rescued.

He was spacecraft commander for Apollo Eleven, the first manned lunar mission. He, Michael Collins and Buzz Aldrin were launched into space on 16 July 1969. Neil piloted the Lunar Module to the Moon's surface on 20 July 1969, with Buzz Aldrin aboard; Collins remained on the Command Module.

At 10:56 pm, Neil got out of the Lunar Module and became the first man to step onto the Moon. As he made his famous first step he famously said, 'That's one small step for man, one giant leap for mankind'. For about two and a half hours, Neil and Buzz collected samples and conducted experiments. They also took photographs, including their own footprints.


Lunar Module at Tranquility Base

Returning on 24 July 1969, the Apollo Eleven craft came down in the Pacific Ocean west of Hawaii. The crew and the craft were picked up and the three astronauts were put into quarantine for three weeks.

Neil stayed with NASA, as deputy associate administrator for aeronautics until 1971. After leaving NASA, he joined the University of Cincinnati as a professor of aerospace engineering. He remained at the university for eight years. From 1982 to 1992 Neil served as the chairman of Computing Technologies for Aviation, Inc.

Neil underwent a heart bypass operation in August 2012. A few weeks later, on 25 August he died of 'complications resulting from cardiovascular procedures' at the age of 82.

Shortly after his death, his family released this statement: 'For those who may ask what they can do to honour Neil, we have a simple request. Honour his example of service, accomplishment and modesty, and the next time you walk outside on a clear night and see the moon smiling down at you, think of Neil Armstrong and give him a wink.'

Mathematical ideas for Neil Armstrong and his trip to the Moon

You could copy and cut out the timeline statements, shuffle them and give them to the children to order. You could also ask them to add other significant facts for the years between Neil Armstrong's birth and death that are related to his life or to their own. They could then find differences between the different dates using their timeline as a number line.

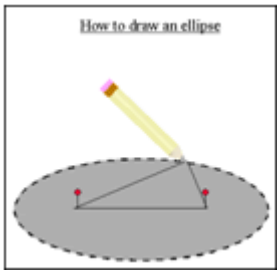
You might like to explore the following 'Moon facts' with your children.

The Moon takes 27 days, 7 hours, 43 minutes and 11.6 seconds to orbit the Earth

- you could ask the children to round this to the nearest number of days. How many orbits are made in a year?
- they could work how long this time is in seconds.

The Moon's orbit is an ellipse shape

- you could use this as an opportunity to explore ellipses
- the children could draw an elliptical orbit using string, a pencil, two drawing pins and a pin board as shown below:



A lunar month is the time the Moon takes to pass through a complete cycle of its phases. It is measured from New Moon to New Moon. A lunar month is about 29.5 days - or to be precise 29 days, 12 hours, 43 minutes, 11.6 seconds. This is slightly longer than its orbit time because the Earth is constantly moving as it orbits the sun. The Moon travels a little more than 360° from one new moon to the next

- you could give the children a calendar which states when the new moons can be seen. How many days are there from one new moon to the next? Can they find a month without a new moon? This can occur in February which will mean that either January or March will have two new moons. The second new moon is called a 'Blue Moon'
- you could explore 360°. After establishing that a square has four right angles and a right angle measures 90°, ask the children to work out the total of the angles inside a square. Ask them to draw a square, cut off the corners and put them together. They could then draw a circle or an ellipse around the point where all the corners meet to represent an orbit.

view of Earth, 21 July 1969

The Moon is about 250 000 miles away from Earth. If you travelled there by car without stopping it would take about 130 days. In a rocket it would take about 13 hours.

- you could ask the children to work out what 250 000 miles is in kilometres. They could also work out how many times they would have to cross a continent or a country to travel the equivalent distance.

- you could ask the children to work out at what speed they would be travelling to drive non-stop to the Moon in a car. Repeat this for a rocket.

The Moon orbits Earth at an average speed of 2 288 miles per hour.

- what is 2 288 miles in kilometres? You could ask questions relating to this fact that involve doubling, halving, addition etc - for example, how many miles would it travel over 10 hours / ½ an hour / ¼ of an hour

The Moon travels a distance of 1 423 000 miles around the Earth.

- what is this distance in kilometres? You could ask them to compare this with the circumference of Earth (40 075 km).

The Moon has a diameter of 2 000 miles. It has a surface with an area that is about the same area as the continent of Africa.

- you could use this as an opportunity to explore circles. The children could draw one by making a dot on a piece of paper and then draw radii coming out from it at the same length. Once they have drawn eight (in the same position as the eight compass points) they could join their ends to give a circle. They could then find the diameter of their circle. They could multiply this by three to give and approximate length for its circumference.
- the children could work out the radius and approximate circumference of the Moon.
- the area of the continent of Africa is approximately 30 220 000 km^2. What is this in miles?

Here are some other mathematical facts that you explore with your class:

- when Alan Sheppard was on the Moon, he hit a golf ball and drove it 2 400 feet, nearly half a mile
- in a survey conducted in 1988, 13% of those surveyed believed that the Moon is made of cheese
- the multi-layer space suits worn by the astronauts to the Moon weighed 180 pounds on earth, but thirty pounds on the Moon due to the lower gravity
- Apollo 11 had only 20 seconds of fuel left when they landed on the Moon
- Apollo 15 was the first mission to use a lunar rover. The top speed that was ever recorded in this four-wheeled land vehicle was 10.56 miles per hour
- the Apollo missions brought back 2 196 rock samples weighing 382 kg in total
- only 59% of the Moon's surface is visible from Earth
- the Moon rotates at 10 miles per hour compared to the Earth's rotation of 1 000 miles per hour
- the first spacecraft to send back pictures from the Moon was Luna 3 (built by the Soviet Union) in October 1959
- the Moon is about a quarter the size of the Earth.

You can find these and more at MoonConnection.com.

If you want to look at the planets of our Solar System in more depth why not take a look at Kids Astronomy? Click on the planets on their Solar System graphic and details of each one will be shown. You could ask your children to make up mathematical fact files about each one.

You could ask the children to search on the internet for pictures of Apollo Eleven. Ask them to find its dimensions. They could explore the shape of the rocket and then make a scaled down drawing and then a model. Younger children could make one out of junk.

We hope this has given you a few ideas to start you off on a mathematical journey with Neil Armstrong!

Information sources

- Biography.com
- Buzzle.com.

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Maths to share – CPD for your school

An Exploration of the Array as a Representation Used in Multiplicative Reasoning

In this issue of *Maths to share* we look at research into the use of arrays by Mathematics Specialist Teacher Yesim Soyel. You will need to print out copies of this research (the supporting documentation is available to download as a zip file) to give to colleagues to read before the meeting. You will also need a collection of counters and pieces of squared paper.

Yesmin refers to a video which is from the series of books 'Young Mathematicians at work' by Catherine Fosnot and Maarten Dolk. It is a very helpful series with some fascinating video clips of children working. Unfortunately we don't have access to them, but DVDs can be purchased should you wish to use it.

This article aims to give a few ideas for how you can use the research to encourage the use of concrete representations throughout the school from FS to Year 6, so that children gain a deeper understanding of the mathematical concepts that they are taught. We are sure that you can develop more ideas that are appropriate for your setting.

Discuss the first two paragraphs of Yesim's research.

- do colleagues teach multiplication using arrays?
- when do arrays cease to be used in your school?
- what methods for multiplication do colleagues use in Years 5 and 6?
- do colleagues agree that arrays should be a key representation for multiplication?
- have they ever considered them to be useful for showing:
    - the replicative nature of multiplication
    - its binary nature
    - the commutative and distributive properties of multiplication?

Share this statement from Yesim's assignment:

> *'It also became more and more clear to me that perhaps I had not thought about 'usable mathematical understanding' when I completed the NCETM self-evaluation tool and worse still, I had missed a trick in my efforts to explain so many mathematical concepts that were clearly related without linking them.'*

How confident are colleagues with the links between multiplication and the different mathematical concepts of addition, subtraction, division, fractions, decimals and percentages?

- you could spend some time exploring these during the meeting or, if they would benefit from more in-depth PD, arrange a further staff meeting. Being really clear on these links is essential in the teaching of mathematics. You might wish to explore the Self-evaluation Tool for multiplication with your colleagues
- it might be worth considering leading an INSET session using parts, or all, of the online primary CPD module which focusses on the progression from concrete to visual to abstract

- are colleagues familiar with the NCETM Self-evaluation Tool? If not, it might be a good idea to arrange a time or set them a task to explore the calculation section in Mathematics Content Knowledge.

Discuss with colleagues what they believe is meant by concrete representations or manipulatives and how often they use them. Make a list of what is used in each year group. It would be interesting to track this from the Foundation Stage to Year 6 to find out if there is a progression.

- which manipulatives are used throughout the school? Which aren't? Why might this be?
- do colleagues agree with Hiebert and Carpenter that 'mathematics is understood if its mental representation is part of a network of representations' and that if representations are not developed, a child's understanding of mathematics is incomplete?

Focus in more depth on the use of arrays. When do colleagues use arrays for:

- multiplication
- division
- relating multiplication to scaling so that children can answer questions such as the one Yesmin gives: if the ratio of red balls to green balls is 3:5, how many red balls are there in 56 balls?
- what about fractions such as ½ x ¼?

Spend some time exploring these using counters and squared paper.

- what are the benefits of using arrays with older children?
- how could working with arrays be developed throughout your school?

Together identify areas where teaching could be improved using manipulatives. You could carry out an audit of colleagues' confidence in using different resources so that support can be provided to those needing more help.

Finally, it might be a good idea to work out a progression of the use of manipulatives for multiplication from FS to Year 6 and add it to your school calculation policy.