Primary Magazine

Issue 28

National Centre for Excellence in the Teaching of Mathematics

Welcome to the 28th issue of the Primary Magazine. Our famous mathematician from the past is John Napier, we look at the designs of Orla Kiely, and our CPD opportunity looks at the effective use of number lines and 100 squares. *It's in the News!* features orangutans.

Contents

Editor's extras

We'll start with a date for your diary – the NCETM national CPD conference Professional Learning Networks: learning better through learning together, on 1 December at the Megacentre in Sheffield.

Join teachers from across the country to explore the benefits of networking and collaboration to enhance your mathematics teaching and learning. Hear from practitioners who have created networks of all sizes across their department, school or college, local cluster group, HEIs and industry to discover how collaboration by individuals and organisations can help tackle issues, deliver practical resources and increase pupil attainment.

The day will include:

- an exhibition showcasing NCETM-funded projects that focus on creating networks to share ideas between individuals, departments and institutions, tackle issues in mathematics learning and support professional development
- interactive group sessions to explore the power of working and learning together
- workshops to present examples of collaboration and networks from schools, colleges, subject associations and organisations
- keynote presentations from inspiring individuals who utilise networks.

Details of the programme will be published next month. The conference is free to attend and is open to teachers, lecturers and advisers from all sectors. To book your place, please email events@ncetm.org.uk.

We'd also like to tell you about an exciting pilot project that took place earlier this year and to give you the opportunity to consider applying to be part of the next one before the work is rolled out nationally:

The Architects in Residence (AiR) initiative, developed between the RIBA Trust and Arts Inform, has recently run a primary and secondary school pilot to explore how mathematics can be taught through focusing on the built environment.

This programme encourages architects and teachers to work together in practitioner partnerships in both primary and secondary schools. The focus of this project was mathematics and architecture – a brilliant way to link mathematics to 'real life'. The pilot came to an end last term with a fabulous display at RIBA's headquarters in Portland Place, London. You can read more about it on the Engaging Places website, and here are some photographs of the presentations:

Photography by Andy Hamer, Imperative Productions Ltd.

We looked at the feedback from the children in Year 6 at Tower Bridge Primary School, and from the architects and teachers involved. You might be interested in taking a look at some of their comments too!

They are currently developing another project and are keen to get more schools involved. If you are based in the SE or SW areas of London, Kent, Surrey or the East of England and would like to be considered, please email Christine Leung at RIBA.

Georgina and Lesley, Year 4 teachers from a three-form entry junior school in Whitton, have completed a regional project involving mathematics across the curriculum. They explored effective ways of integrating maths into their humanities topics to enhance the learning of those pupils who are working below age-related expectations. Their case study is now on the portal and is very interesting.

We are still offering funding for regional projects. If this has inspired you to take part in one to develop mathematics across the curriculum in your school, please contact your local regional coordinator, who will give you details of how to apply and provide any help you require.

Chris Watkins from the Institute of Education, London, has recently completed a research project which concluded that children do better in their exams when their teachers focus on learning rather than on test results. You might be interested in reading more about this on the IoE website.

In this issue, we have some Facebook number facts that you might like to incorporate into a starter or group activity:

- Facebook has more than 500 million active users
- 50% of active users log on to Facebook in any given day
- the average user has 130 friends
- people spend over 700 billion minutes per month on Facebook
- there are over 900 million objects that people interact with (pages, groups, events and community pages)
- the average user is connected to 80 community pages, groups and events
- the average user creates 90 pieces of content each month
- more than 30 billion pieces of content (web links, news stories, blog posts, notes, photo albums, etc.) are shared each month
- about 70% of Facebook users are outside the United States.

Facebook has many more statistics that you might like to investigate. Don't forget - you can follow the National Centre on Facebook and Twitter!

Primary Magazine

Issue 28

National Centre for Excellence in the Teaching of Mathematics

It's in the News!

In this issue, we look at the plight of the orangutan. There is much concern among conservationists, campaigners and the general public about their future. They were once found all over Asia but now they are just found in Sumatra and Borneo. The numbers in these two countries are dropping mainly due to the clearance of large areas of rain forest for palm oil plantations. Before using these slides you might find it helpful to look at these websites for some background information:

- Mongabay.com
- metro.co.uk
- ABC News

These slides give opportunities for work on a variety of mathematical concepts including measurement and number. They also provide cross-curricular links to geography, art and science. If you made use of most of the ideas you could have a week's theme on rainforests and teach all of your maths, literacy and other areas of the curriculum through this.

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 those of you who have looked at it 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.

Primary Magazine
Issue 28

National Centre for Excellence in the Teaching of Mathematics

The Art of Mathematics
Orla Kiely (1964 -)

You may not know the name, but it is likely that you will be familiar with the designs of Orla Kiely (pronounced *Kylie*), a modern designer. Born and raised in Dublin, Orla qualified as a textile designer from the city's National College of Art and Design (NCAD) before completing a Master's degree in knitwear at the Royal College of Art (RCA) in London in 1993.

Kiely's career began when her collection of hats was snapped up at her graduation show from the Royal College of Art by Harrods. It was her father who advised her to move into designing handbags, after noting that during London Fashion Week, everyone was carrying a handbag, but no one was wearing a hat!

Her popular patterns are clean and bold in their design, with a 1960s influence. Many are covered with stem patterns and retro flowers, repeated in a very structured way. Before forming the now famous 'Orla Kiely Partnership' with her husband Dermott Rowan in 1997, she worked for Esprit, Marks & Spencer, Habitat and Debenhams. Orla creates two new designs each year, which are then printed onto fabric, bags, clothes, household accessories and stationery items. Today, flagship stores are open across the world, in London, Hong Kong and Paris, with 12 shops in Japan and a burgeoning export business to the US and Middle East

Wikipedia hosts a short biography of Orla Kiely, while the official Orla Kiely website displays her latest designs.

Orla Kiely in the classroom

Show the children a selection of images of Orla Kiely's work. Try to include two of her signature designs, 'car park' and the 'stem print'. Do they like them? Why/why not? What can they tell you? Can they use any mathematical words to describe the patterns she has created? Encourage them to consider the size and spacing between each part of the design, as well as the symmetrical properties, including reflection, rotation, translation and overall scale.

Explain that Orla Kiely is a modern designer whose popular patterns are now design classics. Show images of her patterns being used on mugs, clothing, bags, furniture and wallpaper.

What is the pattern?
Look closely at the 'stem' print above. The overall pattern is extremely regular, but do the colours repeat? If so, can the children describe how they repeat e.g. when will the next red/pale blue set of petals/leaves appear? Or are they randomly chosen?

Ask them to create their own stem colour system using the outline resource sheet. They should colour the petals/leaves according to a pattern of their choice and write down their 'rule', for example *'pink grey petals repeat if you move right one stem and down four petals'*. Encourage them to think carefully about their

positioning of the various colours, as others will then try to work out their 'rule'. A similar activity could be carried out with Kiely's car outlines – or indeed any shape.

Extend the activity by providing additional constraints. State that designs MUST contain exactly five different colours. Petals in any colour must be at least three petals away from another in the same colour. Is this possible with only four different colours? Three colours?

Paper the room

- The 'stem' wallpaper is produced in strips seven stems wide, although only six of these are complete with double petals. The seventh stem is split, with half along each of the side edges, to help when matching strips of paper together.

- The wallpaper comes in rolls that are 56 cm wide and nine metres long.
- A room measures five metres by three metres, with walls three metres tall.

Assuming the decorator always gets a successful pattern match, how much wallpaper would be needed to paper the whole room (walls only)?

What would the minimum wastage be?

How many 'stems' would we be able to see?

Solution: the decorator would need to use ten rolls of paper. There would be one piece of full width (56 cm) of paper, three metres in length, and a smaller strip measuring 3 m x 24 cm remaining.

28 strips of paper would show 196 stems (seven stems per strip). The last strip of paper would only be 32 cm wide, and so would only show four stems. A total of 200 stems would be visible.

Let us know about any other ideas you have – and we can help you share them with others!

Primary Magazine
Issue 28

National Centre
for Excellence in the
Teaching of Mathematics

Focus on…Black History Month


Carter G. Woodson

The story of Black History Month begins in 1915. In September of that year, historian Carter G. Woodson and minister Jesse E. Moorland founded the Association for the Study of Negro Life and History (ASNLH) in Chicago to research and promote achievements by black Americans and other peoples of African descent. In 1926, the group sponsored a national Negro History Week to celebrate the achievements of black Americans. The second week of February was chosen because of the birthdays of abolitionist and editor Frederick Douglas and President Abraham Lincoln. Fifty years later, the ASNLH, which had been renamed The Association for the Study of African American Life and History (ASALH), voted to extend Negro History Week to a month and to rename it Black History Month. This was thanks in part to the Civil Rights Movement and a growing awareness of black identity. The aim of the ASALH was to celebrate the achievements of black Americans and to recognise the central role of African Americans in American history. President Gerald Ford officially recognised Black History Month in 1976, calling upon the public to "seize the opportunity to honour the too-often neglected accomplishments of black Americans in every area of endeavour throughout our history." Since then, every American President has designated February as Black History Month and approved a specific theme. In December 1995, the Canadian Parliament unanimously passed a motion to officially recognized February as Black History Month.

During slavery, most black slaves were denied formal education and many laws were passed in Southern America prohibiting slave literacy after various slave rebellions. Even free blacks were limited in their access to good quality education and vocational training. This limited education and training meant that blacks were almost completely shut out of professional occupations and confined to roles such as domestic services, some manual trades and agriculture. Nevertheless, a small number of exceptionally talented blacks were able to obtain an education and, through their life's work, make significant contributions to American life. This story is echoed in any country touched by slavery and apartheid.

In the UK, Black History Month aims to:

- promote knowledge of black people's history, culture and heritage
- heighten the confidence and awareness of black people about their cultural heritage
- disseminate information on positive black contributions to British society.

October is Black History Month, chosen primarily because young people, the future generation, are refreshed after their summer break. October is a significant month in Africa – harvest and a time of tolerance and reconciliation. The first event was held on 1 October 1987, launched by a strategic partnership of the GLC, Inner London Education Authority, and the London Strategic Policy Unit. This was followed by a series of conferences across and outside of London, as 1987 was also part of African Jubilee Year. Ken Livingstone commented at an event at the Royal Albert Hall, *"In order to further enrich the cultural diversity of the Greater London area, it is imperative that Londoners know more about African influences on medieval and renaissance European music and more about the roots of Greek music so that accepted ideas about European music is changed. Despite the significant role that Africa and its Diaspora has played in the world civilisation since the beginning of time, Africa's contribution has been omitted or distorted in most history books."* It has taken some years for events to spread from London to the rest of the UK. Black History Month has now grown to over 6 000 events, giving many people across the UK the opportunity to celebrate and share African and Caribbean history.

Shorter activities

Biography.com has a black history section with a feature called 101 Fast Facts. These fascinating facts are well worth a read. The collection has been broken down into four sections: Inventions and Discoveries, Records Breaking, Little Known and Firsts. Which section is the largest/smallest? Ask the children to order the sections from largest to smallest. Can they draw a simple pie chart, labelling each section appropriately? Extend to a more difficult exercise by using the 350 Famous African-Americans instead.

This year 1 October 2010 is a Friday. Ask the children to design a calendar page for October. Add any important dates – local Black History Month events, children's birthdays, half-term dates etc. Once the calendar page has been made, ask a series of questions, for example: How many Wednesdays are there in October? What day of the week is the 12th? What day of the week is the 23rd? Invite the children to ask each other questions too.

On the left hand side of the Black History Month webpage, there is a window showing tweets on black history. How long does it take for a tweet to reach the webpage? Observe for one minute. What was the shortest/longest time taken? Extend the activity by taking a note of all the times given in one minute. Calculate the mean, median and mode. Is the result dependent on the time of day? How could you find out?

Twitter restricts messages (called Tweets) to 140-character messages. The 140-character limit originated so tweets could be sent as mobile text messages. These have a limit of 160 characters, leaving 20 characters for author attribution. If you only use three-letter words, what is the maximum number that you can tweet? Don't forget the spaces between the words. What about four-letter words? Five-letter words? Is there a pattern to the number of words? If so, can the children use it to predict other arrangements?

Nelson Mandela, one of the best-known African statesmen, was 92 years old on 18 July 2010. Ask the children to design a birthday cake for him with 92 candles on it.

Longer activities

The Abolition of Slave Trade Act was passed on 25 March 1807, although many enslaved Africans had to wait up to a further 30 years before slavery stopped completely throughout the British Empire. Ask the children to work out how many days have passed since the Act. Remind the children to be careful of leap years. In America, the 13th Amendment to the Constitution abolished slavery on 18 December 1865. How long was this after Britain abolished slavery?

The Black Achievers' Wall in The International Slavery Museum is a celebration of black achievers, both past and present. From the well known to the completely unknown, the list is by no means complete. Anyone is invited to make a case for adding further names to the wall. Download the current list. Use the list as an information source to answer a variety of questions. For example, is there a gender bias in the list? Which profession or occupation occurs most frequently? Is there any evidence of a particular period of black achievement? Children could also ask their own questions and answer them by using a time line, bar chart, pie chart or by representing the data in a different format.

Pig in the Pen is a quilt made by Arlonzia Pettway. Born in Alabama, USA, her great-grandmother was an enslaved African. Arlonzia is a member of Gee's Bend, a small rural community close to the Alabama River. Over the centuries, the women there have developed a distinctive quilting style based on traditional American and African American quilts. Display the picture of the quilt and ask the children to describe what they see. How many different fabrics have been used to make the quilt? Have all the possible combinations been made? Are there any 'rules' which may have been used to prevent all possible panel designs from being used (for example, only plain fabrics have been used for the outer layer of each panel)? Could one or more panels be the 'pig'? If so, which one or ones? Why? How could you describe the 'missing' panels? How many are there? Ask the children to design a quilt using three different fabrics and using all the possible combinations. How many big squares would you need to make this quilt? What shape could the whole quilt be?

African Americans by the Numbers provides all sorts of information from the U.S. Census Bureau. Use the short pieces of information to generate starter questions, for example:

Information	Question
41.1 million As of 1 July 2008, the estimated population of black residents in the United States, including those of more than one race. They made up 13.5% of the total U.S. population. This figure represents an increase of more than half a million residents from one year earlier.	*If 41.1 million was 13.5% of the population of the United States in 2008, what was the total population?*
30% The proportion of the black population younger than 18 as of 1 July 2008. At the other end of the spectrum, eight per cent of the black population was 65 and older.	*How many black Americans were under 18 on 1 July 2008? How many were 65 or older?*
65.7 million The projected black population of the U.S. (including those of more than one race) for 1 July 2050. On that date, according to the projection, blacks would constitute 15% of the nation's total population.	*What is the projected population of the U.S. in 2050?*
67 000 The increase in Georgia's black population between 1 July 2007 and 1 July 2008.	*Assuming none of the black population died during the period, what is the average number of children born each day?*

There are many more timelines on the web which could be used as a source of data to question and analyse. Findings could be shown in a variety of forms.

Further information from:

- blackhistorymonthuk.co.uk, the official UK guide to Black History Month, where you can also order a Black History Month Teacher's Pack
- black-history-month.co.uk, an independent comprehensive portal, publishers of the Black History 365 newspaper
- International Slavery Museum, Liverpool
- biography.com, a comprehensive American site, which also has a Black History timeline
- history.com is an American history site
- enchantedlearning.com has a simple timeline of African-American history, as does infoplease.com, which also has information about African-Americans by number.

Primary Magazine
Issue 28

National Centre for Excellence in the Teaching of Mathematics

A little bit of history
Famous Mathematicians – John Napier

John Napier was born in 1550 in Merchiston Tower, also known as Merchiston Castle, which at the time was just outside Edinburgh, Scotland. He was the eighth Laird of Merchiston.

Merchiston Tower is now inside the city boundaries. In fact, it is part of Edinburgh's third university, Edinburgh Napier University,which is named after this well-known Scottish mathematician, physicist, astronomer and astrologer. He was known as the 'Marvellous Merchiston', because of his genius and imaginative vision. He is on a par with some of the greatest mathematical thinkers, such as Archimedes, Newton and Einstein.

His father Archibald, the seventh Laird of Merchiston, married at 16 and his wife gave birth to John when he was just 17!

In those days, it was quite common for children of noble birth to be educated at home until the age of 13. John was no exception. In 1563, when he was 13, he started school at St Salvator's College in St Andrews. He left after three years without graduating. There is no proof, but it is thought that when he left he travelled in Europe for five years, maybe studying in Paris or Holland.

At the time, Scotland was going through a difficult period; whether this had an effect on his decision to leave school or not we don't know. Mary, Queen of Scots was on the throne, her first husband died and a year later she married her first cousin, Lord Darnley. Their marriage was unhappy and in February 1567, there was a huge explosion at their house, and Darnley was found dead, apparently strangled, in the garden. She married James Hepburn, fourth Earl of Bothwell shortly afterwards. He was generally believed to be Darnley's murderer. There was an uprising against the couple and Mary was imprisoned and forced to abdicate. Her 13-month-old son was crowned King James VI, and he went on to become James I of England.

In 1571, when John was 21, he returned to Scotland. The following year he married Elizabeth Stirling, the daughter of James Stirling, the fourth laird of Keir and of Cadder. John bought a castle for them to live in, and they had two children. Sadly, Elizabeth died in 1579.

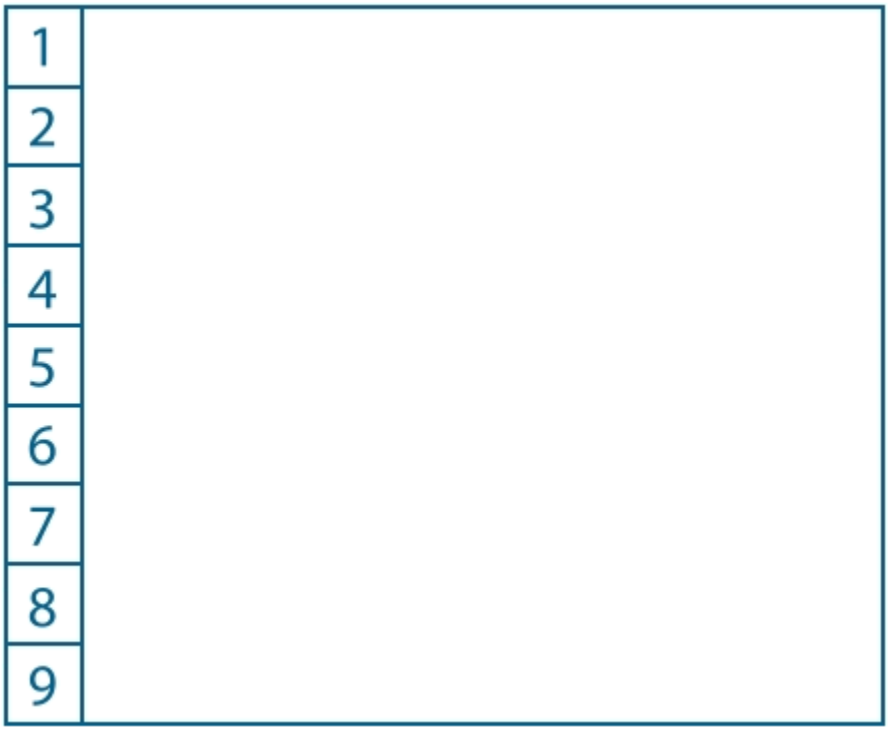
John later married Agnes Chisholm, and they had ten more children. When his father died in 1608, John and his family moved back into the family home and he lived there for the rest of his life. He died in 1617 and is buried in St Cuthbert's Churchyard, Edinburgh.

John is most renowned for discovering the logarithm - do you remember them from your school days? If so, are your memories filled with affection or mystification? He didn't actually invent them but did a lot of work developing them. He produced a work called Mirifici Logarithmorum Canonis Descriptio, which contained 37 pages explaining how they work and 90 pages of tables. These tables have been very important in the advance of astronomy, dynamics, physics and astrology, not to mention the works of Kepler and Newton.

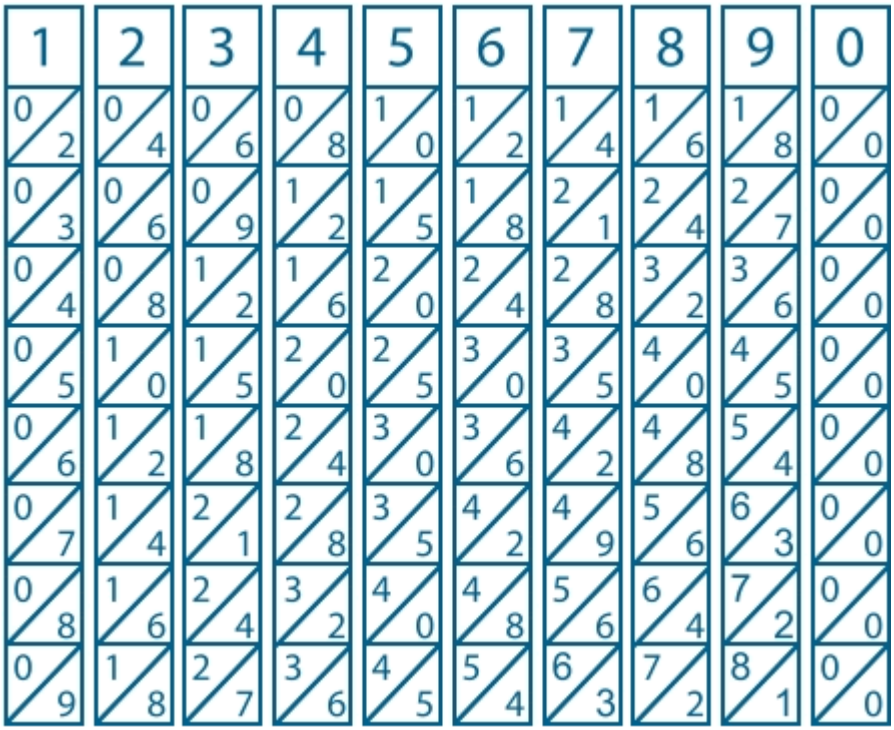
John's logarithms were tables designed to ease the process of multiplying and dividing large numbers. These days, generally, calculators have taken over from log tables! However, logarithms are still used in science and measurement, for example, measuring the light intensity of stars, planets and comets, the intensity of sound, the Richter scale and radioactive dating. To find out more watch this YouTube clip. He also invented a simpler way to multiply using a set of special numbered rods. This was based on an

Arab lattice multiplication system, which was used by Fibonacci. It came to be known as Napier's Bones. You could try this with your class - it's a fun way to multiply!

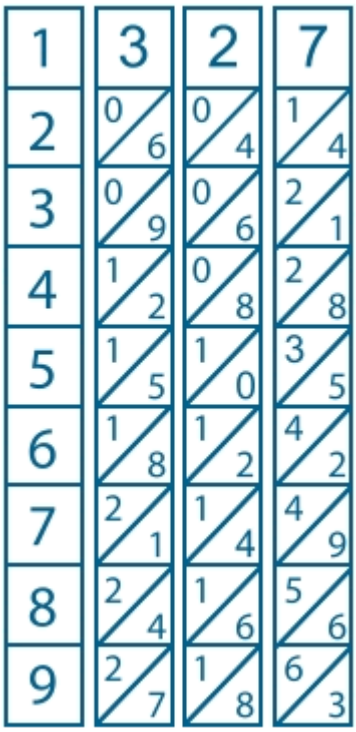
John started with a board that looked similar to this:



He then made some rods that looked like this:



If you wanted to calculate 327 x 4, you would take the 3, 2 and 7 rods and put them on the board:



Next, write down what you see along the fourth line:

Read the numbers along the diagonals – 1 2 0 8 2 8, add the numbers on each diagonal to give 1 2 10 8, sort out the place value i.e. take the one from the 10 to the 100s to give 1 3 0 8 and that is your answer!

I have used Napier's Bones with children in Years 5 and 6 and they loved it! It is also a fun way to practise times tables.

Try this one: 298 534 x 8:

Did you get 2 388 272?

This is how:
Write down the numbers in order from the 1 through to the 2: 1 6 7 2 6 4 4 0 2 4 3 2, next add the diagonals: 1 13 8 8 2 7 2 and adjust: 2 388 272
You can also use this method to divide – can you work out how? A good problem to set the confident mathematicians in your class!
Further explanations of how this works with examples can be found on the NRICH website and Coolmath4kids.

John developed another method of multiplication and division using metal plates, which is the earliest known attempt at a mechanical means of calculation. This makes him the grandfather of our modern day calculator!
He also improved the use of Simon Stevin's decimal point. In Scotland, he is thought to be its inventor.

John was commonly believed to be a magician and is thought to have dabbled in alchemy and necromancy. It was said that he would travel about with a black spider in a small box, and a black rooster that was said to be his 'familiar spirit'.

One reason his 'magician' status developed was due to his discovery that a servant was stealing from his home. He used his rooster to find the culprit. He shut the suspects one at a time in a room with the bird, telling them to stroke it. The rooster would then tell Napier which of them was guilty. Actually, what happened was that he secretly coated the rooster with soot. Servants who were innocent would have no qualms about stroking it but the guilty one would only pretend he had, and when Napier examined their hands, the one with the clean hands was guilty.

Among many other things, he is known for making some 'Secret Inventions' to defend Scotland from Philip of Spain. These included:

- a round chariot which enabled its occupants to move fast while firing through holes in its sides – a precursor of the tank
- a ship which could travel under water
- a burning mirror which would consume enemy ships
- an artillery piece which could destroy a whole field of soldiers.

This article highlights the main inventions of John Napier but they are by no means the only things he was known for. You can find out more about his life and works on thse websites:

- Wikipedia
- Scotland's Source.

Primary Magazine
Issue 28
1 2 3 4
National Centre for Excellence in the Teaching of Mathematics

Maths to share – CPD for your school

Using number lines and hundred squares

This issue will not tell you how to use number lines and hundred squares (there are lots of sites that will do that!) but it will help you to develop a critical understanding of the use of number tracks, numbered number lines, hundred squares, and empty number lines. These resources can be used to support learning and teaching in counting in the Early Years Foundation Stage right through to aiding mental calculation strategies and looking for number patterns in early algebra in Key Stage 2.
Learning about number is a complex process for children and it begins with early principles of counting. Take time to refresh your memory of Gelman and Gallistel's principles of early counting, upon which much of the academic thinking about early counting and much Government policy is founded, in Ian Thompson's article in Issue 7 of the Early Years Magazine.

Tim Rowland et al. (2009) highlight the importance of teachers having sufficient subject knowledge to be able to select the most appropriate examples and resources to support learning and teaching in mathematics. Many teachers use number tracks, number lines, hundred squares, numbered number lines and empty number lines to support counting and calculation. However, all these resources are subtly different and have different uses. Have you ever really considered the subtle differences between each of these resources? Is there a natural progression from one to the other? Ian Thompson suggests in his article On the Right Track (Autumn 2003) that there is, although he does acknowledge that some of the later stages would overlap.
The Primary Framework site provides a set of posters that support the use of number tracks, number lines and the hundred square. You may want to print them off to support your planning when you have finished reading the rest of this article.

Number tracks

Number tracks with no zero are an essential starting point for children in developing their understanding of the ordinal and cardinal value of number, as they aid the understanding of 1-1 correspondence between numbers and squares.

1	2	3	4	5	6	7	8	9	10

As children develop their understanding of larger numbers, they are often introduced to the hundred square, which when starting with one, is merely an extension of the number track:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

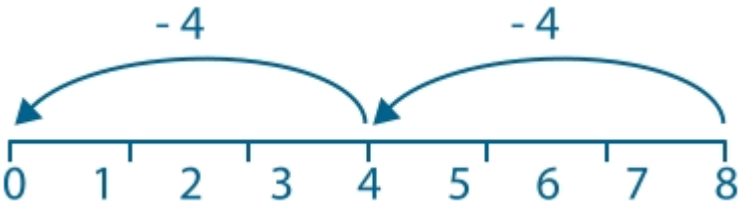
The hundred square has the added benefit of being able to count up and down in tens as well as sideways in ones. You might be interested in reading the Mathemapedia entry Ways of working with a 100 square, which gives suggestions for a possible progression of its use. Also, Leicestershire LA provides a range of grids and ideas for hundred square activities.

Number line

As children's understanding of the ordinal and cardinal value of numbers becomes more secure, it is often considered time to move on to the use of a number line.

This differs from the number track in that it starts from zero. It is a more flexible tool for counting and calculating as it has an important role in developing children's understanding of the importance of zero. If you are an EYFS and KS1 practitioner, it may be worthwhile putting the quantity of items underneath the number line to support the concept of cardinality.

Number lines starting from zero develop children's understanding of the ordinal value of number supported with questions like, 'What is the number before 5?' 'What numbers are between 7 and 10?' 'What is one/more/less than 15?' 'Which is bigger, 13 or 15?' They can also be used to support the introduction of addition and subtraction and multiplication and division, and then help develop mental calculation strategies.



It is often considered helpful to display number lines in the classroom that include negative numbers, for example -20 to 100, so that the children in KS1 are aware and begin to understand that zero isn't the start of numbers, but that numbers go on and back below zero. We often, unintentionally, build in a misconception for some children when we only go 'on' from zero and that makes negative numbers quite a mystery to them. Young children are aware of these through temperatures during our winter – or spring (!) months so it is helpful to capitalise on this in order to aid future understanding. You could begin with a line from -5 to 20 and gradually increase in both directions weekly.

Later on, number lines can be used flexibly to facilitate the understanding of negative numbers and non-integer numbers i.e. fractions, and decimals. A number line encourages the shift from counting to measuring i.e. from counting squares for number track, to 'measuring' intervals on a number line.

Empty number lines

Once children have mastered number lines with marked intervals, they are ready to use empty number lines. When they first start to number empty number lines it is important that they realise it is the marks not the spaces that are numbered.

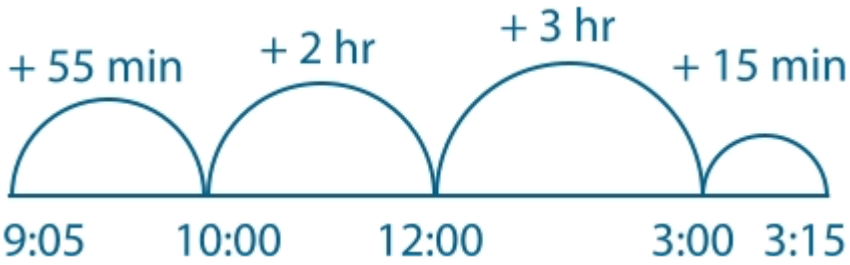
Empty number lines were first introduced by the 'Dutch school' (Gravemeijer, 1994). An empty number line is a particularly useful tool to support children's mental calculation strategies. For more on this take a look at the new version of the QCA [now QCDA] mental calculation document, which came out from

the National Strategies Primary in July of this year. You could also look at the original version Teaching Mental Calculation Strategies: Guidance for Key Stage 1 and Key Stage 2 Teachers and compare the two.

It is worthwhile remembering that a counting stick can also be considered part of a continuous or 'empty number line' with clearly marked intervals along the stick to represents specific points. Don't forget you can hold the stick horizontally and vertically.

Have you ever thought of using an empty number line to support the teaching of time duration?

Imogen arrives at school at 9.05 and leaves at 3.15. How much time does she spend at school?



Back to the hundred square...
As discussed, the hundred square is an extension of both the number track and the number line, depending on whether it starts with zero or one.

Does the hundred square in your classroom start with zero or one? What impact might this have on children's learning? Can you think of advantages and disadvantages to starting with one or the zero?

What is the position of the first number? Is it in the top left hand corner? How could this lead to confusion for some children? How does your hundred square support learning when numbers bridge through 10? Have you ever considered cutting a hundred square into strips and putting them side by side to make a number line? Might this link help children that struggle to find their way around the square to know where to look as they count on in ones from the end of its right hand side?

You might find it interesting to look at two articles published by the ATM in Mathematics Teaching in which the authors discuss the merits and disadvantages of a hundred square starting with 0 or 1 respectively. In 0 - 99 or 1 - 100? Midge Pasternack argues that teachers should be using a 0-99 grid as it helps with the understanding of zero, rounding and adding and subtracting, particularly with numbers that equal zero and place value. In 1 - 100 rules OK? Ian Thompson argues that a 1-100 square is a more effective resources, as it reinforces cardinality and bridging through multiples of ten.

Why not get involved in the Great Hundred Square Debate, which discusses a resource that claims to be an extension of the hundred square called number cylinder. It is argued that this can help avoid some of the issues above.

Try not to restrict children to using the hundred square in the standard orientation. The Primary Framework has one, which they call the number grid that can be used flexibly, including changing the orientation and reducing and increasing the number of columns.

Why not extend the use of the hundred square further by turning it into a 0 to 1 square with tenths and decimals? Children should be encouraged to examine grids of different layouts, for example a spiral grid or a zig-zag grid to look for patterns in numbers.

For some challenging problem-solving activities, you could visit the NRICH website.

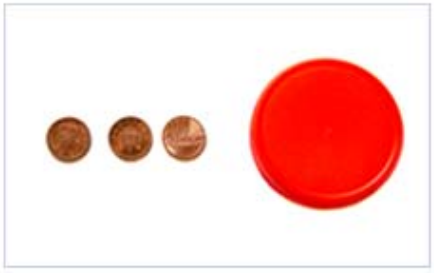
References

- Gravemeijer, K (1994) *Developing realistic mathematics education*. Utrecht CD-B Press
- Rowland, T. et al. (2009) *Developing Primary Mathematics Teaching: Reflecting on Practice with the Knowledge Quartet*. Sage UK

ICT in the Classroom - ICT to enhance the plenary

Whether embedded at strategic points within a lesson to review progress and move learning forward, or as the conclusion of a lesson to evaluate and consolidate, the plenary is a good opportunity to focus the children on the most important aspects of their learning and crystallise understanding. ICT can be used to make more efficient use of the limited time usually available for this part of the lesson.

Using the plenary for prepared group feedback can give purpose and an audience for the children. Unfortunately those who are not presenting can sometimes become passive or disengaged. This can be solved by the group not just feeding back, but challenging their class mates, which is particularly empowering for children working at a lower level. For example, in a differentiated problem solving lesson such as 'Lollipops' from Problem Solving with EYFS, Key Stage 1 and Key Stage 2 children: Finding all Possibilities, the children can take photographs with a digital camera of the different ways of making 6p with coins. One feedback challenge could be for a group to show a photograph of the coins, with some covered, on an interactive whiteboard so that other children could decide what might be under the cover to make the total up to 6p, and if there are other possibilities:



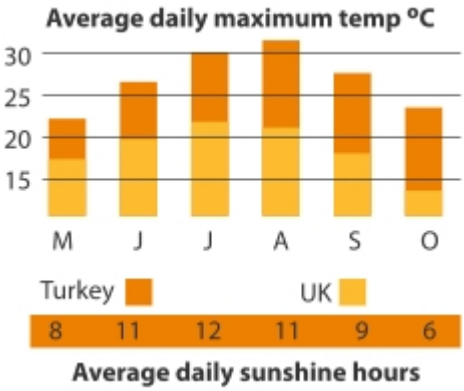
To encourage discussion about being systematic, a group could display their first three possibilities by having the photographs embedded in a presentation, then challenging the others to work out their pattern and decide what arrangement of coins comes next:

In either example, ICT can be used to quickly show a number of pieces of children's work, and allows an instant reveal of the solution which all the children can see. Taking this a step further, learning can be consolidated by a group preparing and video recording an explanation of a mathematical process or skill they have learned, with the purpose of it eventually being used with another class. This should

involve high-level discussion about the steps needed to be successful in that aspect of mathematics. In the plenary, the whole class can review the video, suggesting improvements that would make the

concept clearer. A collection of these videos would make an excellent resource to be used again and again. Examples of mathematical concept videos can be found online, which start children considering concise explanation and good use of mathematical vocabulary, images and resources. Try the BBC Learning Zone for clips such as Numberline 0 to 1, showing ordered fractions by converting them to fractions with a common denominator.

The plenary offers the opportunity to bring a concept that is being rehearsed and consolidated into 'real-life' situations, so developing the skills of using and applying the mathematics. A visualiser is a type of document camera that will send images of anything placed on it directly to appear on screen. A similar effect can be produced using a video camera or webcam. With this resource, any page from a newspaper, sales brochure or takeaway menu can be immediately shared and annotated with the whole class to solve problems. Here are a couple of examples:



What is the average daily maximum temperature for the UK and Turkey in June?
Discuss and explain what "average daily maximum temperature" might mean.
In which month is there the biggest difference in temperature between the UK and Turkey?

(click each menu to see a larger version)

I am going to order king prawn fried rice, chicken chow mein and a mushroom omelette.
Which menu is the cheaper?

Objects can also be placed on the visualiser or captured through a video camera linked to the screen. Try numbers of objects to estimate or arrange into an array to make them easier to count. A selection of objects can be shown together for children to discuss how they could be sorted or to reason and explain which might be the odd one out.

Assessment for learning can be strengthened through thoughtful use of projecting children's work and examining it against success criteria. This will only work where evidence of the success criteria can be found through written work, for example, one part of success criteria in a lesson about measuring might be 'the measuring cylinder must be on a flat surface', clearly this will not be apparent in a child's book. However, a child's work about solving problems systematically or labelling a graph could be used and would be helpful in encouraging reflection from the class and consolidating learning in those areas. Plenaries are a great opportunity to celebrate success and progress in mathematics. Work selected to be analysed or photographs taken of children working successfully can be displayed in the classroom, after being shared, to develop confidence and promote positive attitudes to mathematics.

An IWB screen at the end of the lesson showing the learning objective and either traffic lights or smiley faces to enable pupils to drag their name to the relevant place, gives the teacher an opportunity to record pupils' self assessments easily.