Primary Magazine

Issue 16

National Centre for Excellence in the Teaching of Mathematics

Welcome to the 16th issue of the Primary Magazine. Our famous historian is Archimedes and we explore the art of William Morris. Up2d8 considers the panda – should it be protected or allowed to become extinct?

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From the editor

Are you fed up with the bad press targeted at primary schools and the continued failure to help children to reach the expected level in mathematics by the time they are 11? If so, you might find this particularly encouraging.
Since 1995 the Trends in International Mathematics and Science Study (TIMSS) has reported reliable and timely data on mathematics and science achievement of US 4th and 8th grade students compared to that of students in other countries. Their data has been collected in 1995, 1999, 2003 and 2007. In 1995, England's fourth graders (10- and 11-year-olds) were towards the bottom of the TIMSS 'league table', below several countries in Europe. In 2007, they came top in Europe and well above some of those countries who beat them 14 years ago. Not only that, but the students in England have made the best progress of all the countries over those years. We must be doing something right! What a pity that news can't be celebrated by the newspapers and the powers that be!

Ever heard of Bowland maths? It's a resource that has been developed and piloted in KS3 for the last two years. It makes mathematics fun and absorbing for pupils aged 11 to 14 but has the potential for use in Year 6. The aim is to help change pupils' views of maths by increasing their motivation and enjoyment, which should help increase their confidence and competence. A second aim is to help teach maths in a different way. Take a look at the resource and let us know what you think.

Have you been using the Maths to Share CPD for your school at all? If so, we would appreciate some feedback on how it went, please make your comments in the Primary Forum. If you didn't, maybe because of time or maybe you didn't think any were appropriate for your whole school, it might be useful to point individual teachers towards them so that they can have a little of their own CPD. You can find all the maths to share opportunities in the Primary Magazine Archive.

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Up2d8 maths

In this issue of Up2d8, we consider the debate surrounding the world's much-loved pandas – should they continue to be protected or, in view of the amount of money it costs, be left to die out and become an extinct species of bear? This resource provides ideas that you can adapt to fit your classroom and your learners as appropriate.





In addition to the ideas on the spread, here are some more that you could adapt and try:

- when discussing the numbers 1 500 and 150, you could make a display of straws to show these numbers tied together in 1 000, 100, 10 and build the numbers up so that the children can visualise these amounts and also hold them in order to get a real feel for the difference in quantities.
- alternatively, you could use the Partitioning ITP from the National Strategy to demonstrate hundreds, tens and ones/units.
- look at the photo of the panda and discuss symmetry.
- construct a panda timeline and compare with child's own timeline. Younger children could simply order pictures, while older children could include height and weight.
- borrow or buy a toy panda for the class. Make 30 one pound bundles of straw (you could just label the bundles as such, they do not need to be a pound in weight as the panda will presumably not be full size either) or similar and hide them around the room and outdoor area. Can the children find all the bundles so that the panda does not go hungry?
- do you eat more or less than a panda? Agree a typical day's food and drink, collect and weigh. Were you right?
- if you had the same meal (bamboo) for 99 meals and the 100th meal was something different, how long would it be before you got a taste of something different? What do you need to know to work out the answer? How many meals a day, for example.



Download this Up2d8 maths resource - in PowerPoint format.

Download this Up2d8 maths resource - in PDF format.

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The Art of Mathematics
William Morris (1834 - 1896)

William Morris was born in East London to a wealthy family, and is best known for his repeating patterned fabric and wallpaper designs, many of which were based on a close observation of nature. His vast range of skills also included his lesser-known writing of poetry and fantasy romance fiction.
In 1852, Morris attended Exeter College in Oxford, which is where he began to reject the industrial manufacturing of decorative arts in favour of hand-crafted designs and goods. After college, Morris became apprentice to architect G.E.Street, but after marrying Jane Burden, co-founded his own design firm, *Morris, Marshall, Faulkner & Co.* with several colleagues from his study days. Their wide repertoire of skills provided carvings, stained glass, metal work, paper hangings (wallpaper), printed fabric and carpet.

With the knowledge and skills of these friends he built and decorated 'Red House' in Bexleyheath, his wedding present to his wife. In the house, Morris painted his intricate designs on the ceilings, designed and worked on wall hangings, and painted the original hand-carved furniture. The Red House is now owned by the National Trust and is open to the public.

Throughout his life, he continued to work for himself, although company names changed often. Morris and Company is probably the best known of all. His designs are still sold today, under the licence given to *Sanderson & Sons* and *Liberty of London*. Original works by Morris can be seen at the William Morris Gallery in Walthamstow, and the former 'green dining room' at the Victoria & Albert museum in London is now known as the 'Morris Room'.

For further information on the life and works of William Morris see:

- Wikipedia
- The William Morris Gallery in Waltham Forest is the only public gallery devoted to the work of William Morris
- Artpassions is a website driven by the sheer passion of its authors for various worldwide artists. Some wonderful images and detail of the methods undertaken by Morris and his partners
- KidsNet is a bright encyclopedia aimed at children, with some useful weblinks

Key Stage 1
Show the children an image of Morris' tapestry The Woodpecker, as large as possible without distorting the image. The full tapestry is available on The Tapestry House website and, with the central detail only, on Wikimedia. Explain that this is one of very few created entirely by William Morris alone, and shows a woodpecker sitting in the branches of a fruit tree. The inspiration for the piece was the legend of Picus ('woodpecker' in Latin), an ancient Italian king who was turned into a woodpecker by the witch Circe. The inscription reads *"I once a King and Chief: Now am the tree-bark's thief: Ever 'twixt trunk and leaf: Chasing the Prey"*.

Ask the children to look closely at the image and tell you something about what they notice. Explain the story of the tapestry to them. Encourage them to count the number of 'fruits' in the tree. Can we find half of the number of fruit? If they have a total of 18, point out the partially hidden fruit at the top of the tapestry. This image allows one to zoom in and 'hover' over various features. Can we find half of 19 fruits? Show pupils 19 pieces of fruit, e.g. oranges, apples, plums etc. and carry out the 'halving' action practically. Discuss the 'odd' fruit, and how we might halve it. Ask pupils how they might do this exactly. Give pupils balls of plasticine to represent the 19th fruit and allow them time to experiment with finding exactly one half. Discuss strategies as a group. Suggestions might include weighing or measuring the fruit before halving, 'rolling' the fruit into a 'sausage' or 'worm', before measuring its length and halving. When managing the discussion, encourage pupils to think about 'exactness' and what 'half' actually means. Even very young pupils arrive at school with their own understanding of 'half', even if there are sometimes more than two!

Key Stage Two

Display the image of tiles designed by William Morris for Membland Hall. Click on the tiles and then press F11 for the image to fill the screen. Allow the pupils time to discuss what they can see. Can they see anything 'mathematical'? Ask them to draw in a line of symmetry. Is the image exactly symmetrical? How can we check? Discuss how we might measure the distance of objects from the mirror line.

Now show an image of the Snakeshead Printed Textile. What do they notice about this piece? Is the symmetry the same? If necessary, point out the three vertical lines of symmetry. Ask the children to focus on the pairs of red and yellow 'tulip-like' flowers towards the corners of the image. How could the upper flowers match to those at the bottom? Is it a reflection? Discuss the idea of translation. Now focus on the trios of red and yellow 'tulips' in the centre of the tapestry. How can they be matched to each other? Is it reflection? Is it translation? Use this as a way of discussing rotation with the pupils. Where could the centre of rotation be? Why?

Pupils of any age will be intrigued by the spiral of a William Morris design created using an online fractal tool. Show them the image and let their (and your!) imaginations run riot!!!

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Focus on…World War II

November 11 brings another opportunity to focus our attention on the wars of the past and present and contemplate the sacrifice made by many men and women. Our Focus is a reminder of World War II.

Hitler invaded Poland on 1 September 1939, an act which was to develop into a war embracing almost the entire world and causing the deaths of some 55 014 000 persons, military and civilians.
For almost six years, from 1939 to 1945, Britain fought the toughest war it had ever experienced. World War II was total war – every person, every business, every service was involved. About 85 million – men and women of all nationalities – served as combatants. Britain did not fight alone; the war involved 61 countries with 1.7 billion people – three quarters of the world's population. World War II ended on 8 May 1945, when the Allies accepted Germany's surrender.





Did you know?

- the first shot of World War II in Europe was fired on 1 September 1939, 20 years, 9 months, 19 days and 18 hours after the last shot of World War I was fired
- more than twice as many civilians died than did uniformed soldiers.
- the British Broadcasting Corporation (BBC), located in Bush House on the Strand, London, was the most respected and listened-to radio station in the world
- the nerve centre of British planning and conduct of the war was the War Cabinet Rooms. Situated at Storey's Gate in London, close to the houses of Parliament, the Foreign Office and Downing Street, its location was one of the best kept secrets of the war
- during the war, a total of 2 250 000 Anderson air raid shelters were erected in Britain. Named after its designer, Dr David A. Anderson, they cost seven pounds for those earning over £250 per year, free for those earning less
- between 23 August and 2 September 1939, Britain's art treasures and other historical artefacts were removed from the National Gallery and transported to Wales for safe keeping
- between 1939 and 1945 the Allies dropped 3.4 million tons of bombs, an average of about 27 700 tons of bombs each month. Over 100 000 Allied bomber crewmen were killed over Europe
- there were 433 Medals of Honour awarded during World War II; 219 of them were given after the recipient's death
- although a member of the British Commonwealth, Ireland (Eire) remained neutral throughout the war
- the women's branch of the Royal Air Force was formed on 28 June 1939. Their tasks were: general duties, office clerks, operation room plotters, radar operators, telephonists etc. In September of that year it comprised 230 officers and 7 460 airwomen. By 1945 its ranks numbered around 170 000.

All facts sourced from George Duncan's Historical Facts of World War II website.

Using codes
One of the major breakthroughs in World War II was when code-breakers at Bletchley Park managed to break the Enigma code and read all the messages sent by the Germans. Many historians believe that having this information shortened the war by two years.

As long ago as the Ancient Greeks, warring armies have encrypted their communications in an attempt to keep their battle plans a secret from their enemies. However, just as one side invented an ingenious new way to encipher its messages, so would its enemies discover a clever way of cracking that code. The result has been that codes and ciphers have become more and more complex and increasingly difficult to crack over time, as, throughout history, an intellectual battle has raged between code makers and code breakers.

The battle of wits was never keener than during World War II, when the Germans used the famous Enigma machine – which they believed uncrackable – to encode messages. Enigma's complexity was bewildering. Typing in a letter of plain German into the machine sent electrical impulses through a series of rotating wheels, electrical contacts and wires to produce the enciphered letter, which lit up on a panel above the keyboard. By typing the resulting code into his own machine, the recipient saw the deciphered message light up letter by letter. The rotors and wires of the machine could be configured in many, many different ways. The odds against anyone who did not know the settings being able to break Enigma were a staggering 150 million, million, million to one.

Code-breaking

Ancient Runes

Here is a table containing all the letters of the alphabet:

A	B	C	D	E
F	G	H	I	J
K	L	M	N	O
P	Q	R	S	T
U	V	W	X	Y
Z				

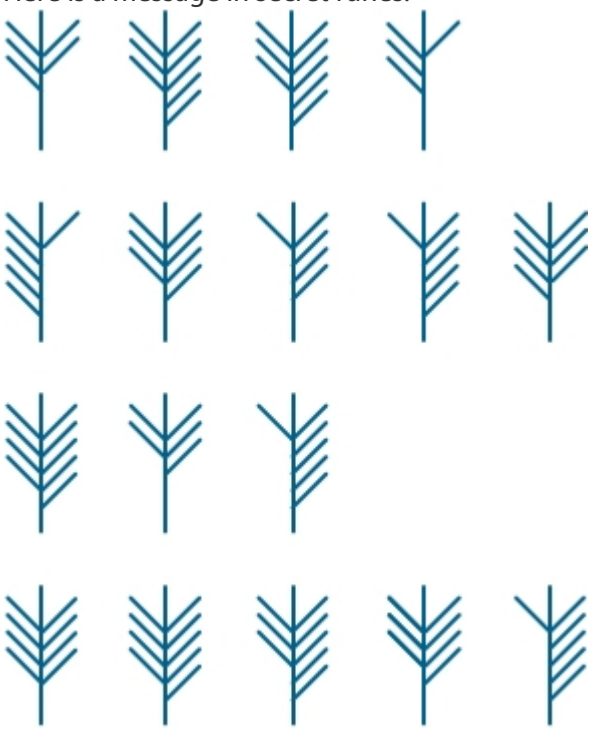
It has six rows (going from left to right) and five columns (going from top to bottom). The Vikings communicated in writing by making simple scratches on wood or stones called runes. Sometimes they were written in a secret or coded way. Here is 'was' written in NRICH's coded runes:

Hint: each symbol has a line drawn vertically (from top to bottom). Can you see a connection between the number of lines drawn off the left of this vertical line and the row where the letter is in the table? Perhaps there is a similar connection between the lines off the right and the column position?

Can you work out how the code works using the table of the alphabet?

National Centre for Excellence in the Teaching of Mathematics

Here is a message in secret runes:



Can you decipher it?
Perhaps you can make up your own message. You can download this as a pdf.
This task is available on NRICH.

The Babbington Plot

Another way of coding massages is to use a symbol or a picture, for example, instead of an 'A' we could write *, instead of a 'B' write + etc. This type of code was used by Mary Queen of Scots when she was plotting against Elizabeth I. Mary wanted to kill Elizabeth so that she could become Queen of England and was sending coded messages of this sort to her co-conspirator Anthony Babbington. Unfortunately for Mary, there is a very simple way of cracking this code that doesn't involve trial and error, but which does involve, surprise, surprise, maths. Letters in a language are pretty unusual because some get used more often than other letters.

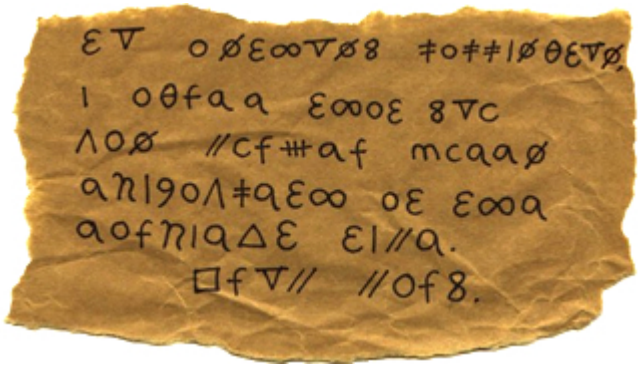
Try this easy experiment that the children can do to test this out:

- choose a page of a reading book
- make a frequency table of the alphabet
- count 100 letters and tally how many of each letter
- compare the results of the whole class (perhaps they could combine all their results in a spreadsheet using Excel)
- calculate the mean for each letter, rounded to the nearest whole number.
    - which is the most common letter used in your sample?
    - which are the next four most common letters?
    - which letters occur most rarely?
    - what two letter words are used most frequently in the sample?
    - do some letters start words more often?
    - what letters often appear as double letters, eg. oo ?

Using the same system of tallying the frequency of the symbols they should be able to de-code the message sent between Mary Queen of Scots and Anthony Babbington below.
By tallying the frequency of the symbols of the message, children should be able to identify the most commonly used letters in English (E, T, A and N) and then should be able to use reasoning, familiarity with the English language and their knowledge of the story to work out the rest of the message. Letter frequencies fit those that you might expect in the English language.

Some facts about the English language that may help:

- the most common two-letter words in English are: of, to, in, it, is, be
- the most common three-letter words in English are: the, and, for, are, but
- the most common starting letters for words are: t, o, a, w, b
- the most common ending letters for words are: e, s, t, d, n
- the most common repeated letters are: ss, ee, tt, ff, ll, mm, oo.



Hints to give pupils as needed:

- what are the most common symbols in the coded message? Perhaps they match the most common letters in English, which are E, T, A and N
- can you guess any parts of the message? Who might it be to and who might it be from?
- focus on any one-letter words. What words have only one letter?
- focus on any three-letter words. What are the common three-letter words in English?
- if you know the story of Mary, who might she talk about in the message?

You may wish to download this grid as a pdf for the children to work on.

Solution

To Anthony Babbington, I agree that you can murder Queen Elizabeth at the earliest time. From Mary.

Further activities and information

- for more challenging code-breaking activities go to CRYPTO CD-ROM by Simon Singh. This resource is available as a free download
- to find put more about the Enigma Code breaker visit The Enigma Project
- there are some further code breaker activities in the National Strategies Primary Framework for Mathematics, for example No. 72.

For more interesting facts about World War II visit these sites:

- BBC History
- The Imperial War Museum Terrible Trenches exhibition
- BBC Schools Primary History, for life as a child during the war.

Starter of the Month

Code cracking!

As long ago as the Ancient Greeks, warring armies have encrypted their communications in an attempt to keep their battle plans a secret from their enemies.
One of the major breakthroughs in World War II was when code-breakers at Bletchley Park managed to break the Enigma Code and read all the messages sent by the Germans
Cracking codes and unravelling the true meaning of secret messages involves loads of maths, from simple addition and subtraction, to data handling and logical thinking.

Key Stage 1
Present the code breaker line and ask children to use the code to find the answers to the calculations:

A	B	C	D	E	F	G	H	I	J
1	2	3	4	5	6	7	8	9	10

B + E =
E - A =
C + C =
G + B =
D + D =
J - D =
You can make up the calculations to meet the needs of your class.

Here is a lovely activity from the New Zealand Fire, Ambulance and Police services.

Key Stage 2
Codes have been with us for centuries. When Julius Caesar was increasing the Roman Empire over 2 000 years ago, he would write messages to his generals in code.
Can you work out how to crack the code? Complete the table to find out how Caesar would encode the following message:

Caesar's message	A	T	T	A	C	K		A	T		D	A	W	N
Coded message	D	W									G			

Have a go at trying to work out these messages which could have been sent by Caesar or his generals.
You may need to devise a table to help you.

hqhpb dssurdfklqj
wkluwb ghgd
uhwuhdw wr iruhvw

(from NRICH)

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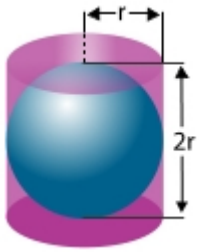
A little bit of history – Archimedes

In this issue's article we look very briefly at some of the works and achievements of Archimedes, a world-renowned Greek mathematician, physicist, engineer and astronomer. He is considered by some to be the greatest mathematician of all time. His work is still used in maths and science education today, for example, the famous Archimedes spiral and use of pi for finding the area of circles.

He was born in 287BC in Syracuse, Sicily, and died in 212BC. He died during the Siege of Syracuse when he was killed by a Roman soldier despite orders that he shouldn't be harmed. One of the stories of his death records that he was commanded to go with the soldier to meet the Roman General in charge, but he refused because he was too busy studying a drawing of circles and wanted to finish solving the related problem he was working on. The soldier was furious and killed Archimedes with his sword. It has been reported that the last words he said were 'do not disturb my circles', a reference to the drawing he was studying when he was killed.

His father was an astronomer and it was believed that Archimedes was related to King Hieron II, the ruler of Syracuse. Not much else is known about his life apart from his mathematical and scientific discoveries. A biography was written about him by his friend Herecleide but over time this has been lost.



We do know however, that he thought his greatest mathematical achievement of all was to prove that a sphere has two thirds of the volume and surface area of a cylinder of the same height and diameter.

A sculpture of a circle and a cylinder was found on his tomb.

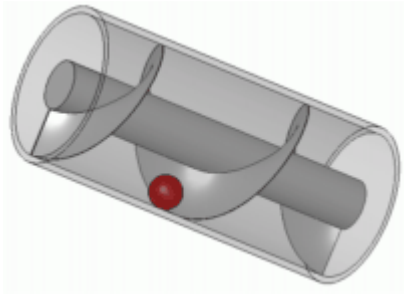
To most people, Archimedes is probably best known for his 'eureka' moment and subsequent run through the streets naked, when he discovered the principal of buoyancy! According to the Roman writer, architect and engineer Vitruvius, a new crown in the shape of a laurel wreath had been made for King Hieron II. The king wanted to be sure that it was made of pure gold and not a cheaper version of gold mixed with silver. He gave it to Archimedes and told him to find out without damaging the crown. This was a bit of a problem for Archimedes because clearly he couldn't melt it down to calculate its density and thereby its quality, so he had to come up with another idea. While he was having a bath he noticed that the level of the water in the tub rose as he got in and he realised that this could be used to determine the volume of the crown. He figured out that as water in this state is incompressible the submerged crown would displace an amount of water equal to its own volume and, by dividing the weight of the crown by the volume of water, the density of the crown could be found. If this density was lower than that of gold, the crown would be a cheap one.

He was so excited by his discovery that he leapt out of the bath and ran around the streets shouting "eureka!" ('I've found it'), but – he forgot to get dressed first! Great story, but sadly probably not true! The

same principle would have been used, but Archimedes' method would possibly be to balance the crown on a balance scales with a piece of gold and immerse the lot in water. If the crown was less dense than the gold it would be more buoyant and the scales would tip accordingly.

A large part of Archimedes' work in engineering arose form the needs of his home city of Syracuse. For example, he was asked by King Hieron II to design a ship that could be used for luxury travel, for carrying supplies and as a naval warship. It is said that this ship was the largest built at that time and for many years to come. Apparently it could carry 600 passengers, had a gym, garden and a temple for the goddess Aphrodite. A ship of this size in those days would have leaked a lot of water through the hull and so Archimedes invented his 'screw' which could remove a lot of the water that leaked in.

Archimedes' screw is still used today for pumping liquids and solids such as coal and grain. You can find details about how it worked from the Tiscali encyclopedia.



Why not let the children have a go at making one? Follow the instructions on NRICH. Archimedes invented various ways to defend his city from attack, for example, the 'ship shaker'. It was a machine with a crane-like arm from which a large metal grappling hook was suspended, the claw was dropped onto an attacking ship, which then lifted it up and possibly sank it. It might be fun to try to design a version of this device that could be made into a model – it would be a great mathematics link to DT: scaling down, estimating and measuring. He also used mirrors to make a parabolic reflector in order to burn the ships attacking Syracuse.

Although he did not invent levers and catapults, he is responsible for their development through his invention of the odometer, a cart with a geared mechanism that dropped a ball into a container after each mile travelled – subsequent inventors used this idea to develop the milometer for measuring distances.

Some of his other inventions can be found on Wikipedia.

One of his major contributions to mathematics was pi (π), which we use today as part of a formula for finding the area of a circle. He worked this out using the 'method of exhaustion' for finding the circumference of a circle. This involved repeatedly drawing polygons outside a circle and smaller ones inside. As the number of sides of the polygons increased, the more like a circle they became and so more accurate. When they had 96 sides each, he calculated the lengths of their sides and from this was able to show that the value of π was between 31/7 and 310/71, giving a value of approximately 3.14.

From this, he was able to prove that the area of a circle was equal to π multiplied by the square of the radius of the circle. Try asking the children to find the areas of some circles that they draw using the formula πr^2 using a calculator.

This and his other contributions to geometry revolutionised the subject. More about his achievements and work can be found on the MacTutor History of Mathematics website.

Maths to share – CPD for your school

Mathematics Subject Knowledge – Time

Before the meeting, ask your colleagues to read Charlotte's Clock. This article by Vikki Horner, from the May/June 2005 issue of 'Special Children', explains how she had to find a new way of teaching her daughter how to tell the time.

In addition, ask everyone to bring their most useful 'teaching the time' resource, **excluding** the analogue clock face.

Before the meeting prepare a photo quiz to identify the location of a selection of the clocks in your school. Make this by taking photographs of up to nine clocks around the school and copying and pasting them onto paper. Crop the shots to ensure that you don't give too much away. Include the odd timer and perhaps the clock in the headteacher's office. Try to get a mixture of analogue and digital clocks. If all the clocks in school are almost identical, then focus on watches on wrists instead and ask colleagues to identify the wearer. This is a rather more challenging activity! Make sure you choose a cross section of people, from the caretaker to headteacher and a mixture of those who will be at the meeting and those who won't. As everyone arrives, give them a copy of it. When everyone has had the opportunity to have a good look, identify the clocks or wearers together.

Spend around five minutes discussing the photo quiz clocks. You might like to focus on the following questions:

- what format were most of the clocks – analogue or digital? Is that a true representation of clocks in everyday life?
- does the mixture of clocks in everyday life dictate how you teach time? Should you teach both analogue and digital together, or one after the other?

Reflection

Ask colleagues to share their thoughts on reading Charlotte's Clock. There is a great deal in the article, much of which is as applicable to the classroom as it was to Charlotte. Make some notes of any comments on the order of teaching on a flipchart or whiteboard to make a record of this shared reflection.

Activity

It is useful to have a good idea of the progression in skills and understanding that most children will experience as they learn to tell the time. This is an opportunity to pool experience and draw up a simple progression, including the necessary supporting skills.

Vikki Horner settled on the following order to teach her daughter how to tell the time:

1. Preparation for Reading Minutes
2. Preparation for Reading Hours
3. Teaching Stage I – Hour/Minute Format
4. Teaching Stage II – Past/To Format
5. Teaching Stage III – Past/To Format

Give colleagues a copy of the Time Progression sheet. In small (ideally cross-phase) groups, ask colleagues to compare the different progressions and draw up their own group time progression.

Include supporting skills such as counting in fives and reading scales, and anything they feel is missing (eg. reading and using a calendar). Allow 20 to 30 minutes for this activity.

Take feedback from each group and begin to draw up an agreed progression. It is likely that you will need to collect each group's ideas to complete after the meeting. Where there are differences of opinion, you will need to use your professional judgement to complete the skills progression.

Discuss
Invite colleagues to take it in turns to show their favoured resource and how they use it. It may well be that a number of colleagues bring the same resource, but it is likely that they will use it in different ways. Mark on the shared progression when each resource could be useful.

Would Charlotte's Clock be a useful additional resource to have in school?

Finishing off
Complete the session with a look at John Dabell's blog, Once upon a time. Share copies as everyone will need to read carefully! Discuss.

Later...
Add brief details of the resources brought to the meeting to those below and distribute with the finalised agreed progression.

Useful resources to support teaching time

- Primary Magazine Issue 13, A little bit of history - the history of time; some snippets form the archives and Up2d8 Big Ben
- Tell the time: ITP (and supporting documents in a range of formats)
- an interactive clock from NumberGym, which allows you to show or hide analogue clock, digital clock, time in words, 12- or 24-hour clocks, minutes in numbers, minutes to or past the hour and

- more. The clock can be run in real time - watch how the different versions of the time change as the second hand reaches twelve
- As the Bell Goes Audio Reflections: teacher - Claire Rushworth - Converting Time Part 1 and Part 2
- Mathematics Concept Cartoons - there are several very useful time cartoons in this resource
- download the song Counting Time from Number Fun

Children's books to support teaching time

- *The Time It Took Tom*, also called *Tom and the Tinful of Trouble*, by Nick Sharratt ISBN 0590114271 and 0439944740
- *Cluck o'clock* by Kes Gray ISBN 0340866047
- *Clocks, Clocks and More Clocks* by Pat Hutchins ISBN 0689717695
- *It's about Time!* by Stuart J Murphy ISBN 0060557699