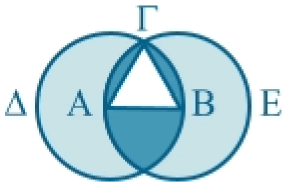
Primary Magazine

Issue 24



National Centre for Excellence in the Teaching of Mathematics

Welcome to the 24th issue of the Primary Magazine. Our famous historian is Euclid, our focus is on the World Cup and our CPD opportunity aims to develop subject knowledge in the area of subtraction. *It's in the News!* features *that* volcano!

Contents

Editor's extras
Interventions, transitions and standards – details of all are in this issue of the magazine with personal reflections and national news updates.

It's in the News!
In Issue 22 we looked at earthquakes following those in Haiti and Chile, and we revisit that geographical, scientific and mathematical theme again as we consider the volcano that brought silence to our skies! The slides provide opportunities for work with such mathematical concepts as measurement, coordinates and ratio.

The Art of Mathematics
This issue explores Egyptian art with activities that include scaling – brilliant if you are doing an Egyptian project! If you are, see also the Egyptian number system in Issue 4 of the magazine.

Focus on…
From 11 June to 11 July, football fans around the world will be hoping their team makes it through all their matches to win the World Cup 2010. Our focus in this issue is on that long-awaited event.

A little bit of history
We look at a potted history of Euclid who is purported to be the most significant of the earliest of the world's mathematicians. He was the author of the most influential mathematics books of all time, The Elements.

Maths to share – CPD for your school
We continue our series on mathematics subject knowledge by exploring subtraction. For this session you may find it helpful to make the NCETM Self-evaluation Tool available for staff to use and also download The National Strategies' guidance paper on calculation, which outlines the aim for primary children, on their journey towards becoming proficient in all aspects of calculation.

ICT in the classroom
In this issue, we look at ways to make teaching calculator skills and using them in the classroom fun – by coding and encoding messages.

From the editor

In Issue 17 of the Primary Magazine we had reports from two students, Amy and Bethany, who were involved in Inspiring Mathematics Champions, a project developed by the NCETM and supported by Yorkshire Forward, which promotes achievement in primary mathematics. Its main aim was to support trainee teachers in building teaching skills in using and applying mathematics through the development of problem solving and cross-curricular approaches. We are now pleased to let you see a report from Mike Ollerton, Inspiring Mathematics Champions: a model for continuing professional development.

In our last issue, we gave you the reflections on the Numbers Count intervention programme from Kate, and in this issue we have Ofsted's evaluation of National Strategy intervention programmes. Published in January, it was based on a small-scale survey which evaluated the impact of the Strategy's approaches to intervention on pupils working just below national expectations in a small sample of 12 primary and nine secondary schools. It found that intervention was more effective in the primary schools than in the secondary schools visited and that this stemmed from careful analysis of pupils' weaknesses, flexible planning of programmes, thorough training of key staff and effective monitoring and evaluation. It also found that good leadership and management contributed to successful impact. The publication is worth a read. We would be really interested to know about any successful intervention programmes that you are using or have developed, please let us know.

In our last issue we also mentioned transition work that is happening in Ealing and East Yorkshire: we now have two articles from Hilary in Ealing and Liz in East Yorkshire that are well worth a read. Are you doing anything in your authority that works? If so, if you are willing to share, please let us know, and we can tell everyone else!

NCETM Continuing Professional Development Standard

Finally, we are looking for applicants for the NCETM Standard for CPD in mathematics. What is this Standard you might ask? Well, read on…
Just to remind you, the aims of the Centre are to:

- raise the professional status of all those engaged in the teaching of mathematics
- improve institutional performance, including raising standards, by supporting targeted workforce professional development in order that the mathematical potential of learners be fully realised.

As part of meeting these aims, the NCETM has worked to develop a mathematics-specific CPD Standard, with a volunteer group of CPD providers. The purpose of this is to help staff teaching mathematics at all levels to access information about the CPD provision on offer, its appropriateness and quality. The NCETM Standard is now in its national pilot phase, and the hope is that all providers will have the opportunity to obtain the Standard. If you are interested in finding out more, take a look at the details on the CPD Standard microsite. We would love to hear from you if you want more details or if you wish to make a submission.

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National Centre for Excellence in the Teaching of Mathematics

It's in the News!

In this issue, we look at the volcano that closed the skies to almost everything apart from the birds!

April was the month that chaos ensued in our skies as airlines were forced to cancel flights, leaving thousands of people stranded on holiday or in business destinations around the world. It took days and even weeks for many of them to get back home, having to take extra time away from work. Many other problems arose, not least those relating to transport of fresh produce and pharmaceuticals from other countries to ours. The volcanic ash continues to intermittently affect our skies.

This issue provides opportunities to develop mathematical activities around measurement, including time, coordinates and ratio.

You may find it helpful for the discussion part of *It's in the News!* to refer to the following news articles about the volcano and its effects:

- BBC
- Daily Telegraph
- World News Network

For some background information about volcanoes visit these sites:

- Enchanted Learning
- Wikipedia
- Woodlands Junior School

This resource provides ideas that you can adapt to fit your classroom and your learners as appropriate.

As always, we would be extremely grateful if you could give us some feedback on how you have used it, whether it has worked well and how it can be improved.

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

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

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The Art of Mathematics
Ancient Egyptian Figures

When looking at Egyptian wall carvings or paintings, it is important to remember that the paintings which decorated the walls of the tombs in Egypt were intended to keep history alive. These wall paintings provide an extraordinarily vivid picture of life as it was lived in Egypt thousands of years ago.

All the figures in the tombs were drawn according to specific rules dictating how to draw the human body. The head of the character was always drawn in profile, and although the face is to the side, the eye is drawn in full so it could be shown looking straight out. The body is also drawn as though seen from the front. The legs are turned to the same side as the head, with one foot placed in front of the other – the feet are painted from the side.

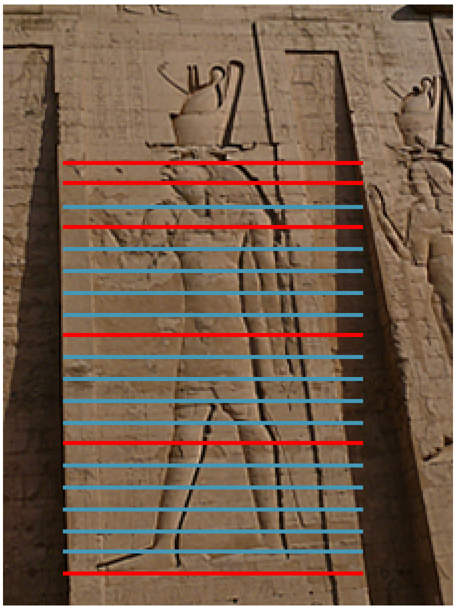
Horus

Ra

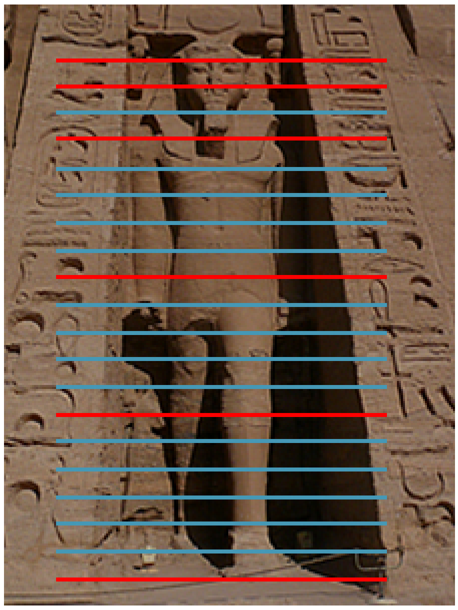
In ancient Egyptian art, each figure had to be a specific size. In the earliest examples from the Old Kingdom, Egyptian artists used a system of eight horizontal guidelines and one vertical line bisecting the figure through the ear. In the Middle Kingdom until the Late Period a square-grid of 18 units applied to a drawn human figure (standing) allowing its reproduction in various sizes, but always anatomically proportionate.

There were two squares allowed for the face (from the hairline to the base of the neck), 10 squares from the neck to the knees, and six squares from the knees to the sole of the feet. There was a nineteenth square used for the hair, but it was not counted with the rest of the body. The painting would probably have been planned on papyrus paper and then transferred onto the tomb walls by scaling up the drawing.

The concept of the square-grid to keep items in proportion is still used by architects, draughtsmen, designers and artists today.



Statues were made with the same proportions too.



A statue of King Ramses II at Abu Simbel.

Now is a chance for the children to make or draw an ancient Egyptian god or king using the same proportions as the ancient Egyptians did. You can find pictures and names of Ancient Egyptian gods at the British Museum website.

Take a grid of 19 cm high (remember 1 cm for the top of the head) and 6 cm wide. Fold it in half lengthways and divide it into five sections widthways.

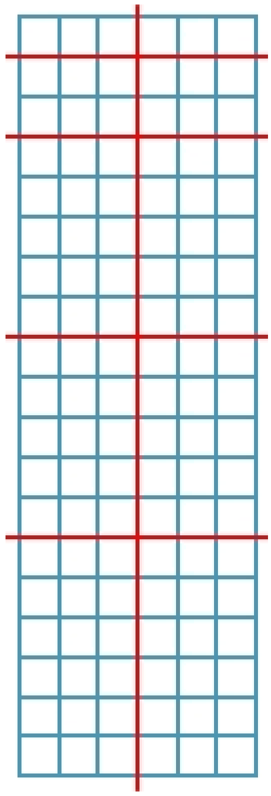
The head
Draw the head and the neck from the side view.
Add one eye from a front view. Outline it in black. Add an eyebrow that is curved and black.
Draw the lips from the side view.
Draw a black wig showing the ear.

Shoulders and chest
Draw the shoulders and chest as if you're looking at them from the front.

Hips, legs and feet
The hips, legs and feet are drawn from the side view.

Don't forget to add clothes
Men wore short skirts.
Women wore straight dresses that were held in place by two straps.

More able pupils could work out the proportion of each part of the body and draw the grid on plain or squared paper.



1 cm hairline to top of the head
2 cm forehead to neck
5 cm neck to waist
5 cm waist to knees
6 cm knees to feet

Children could then measure themselves:

- total height in centimetres
- head to neck
- neck to waist
- waist to knees
- knees to feet.

They would then be able to work out the proportion of each part of the body in comparison to the whole.

They might then draw an Egyptian figure using those proportions and compare or draw themselves using ancient Egyptian proportion. Higher order thinking questions could include, 'Why were Egyptian gods drawn to those proportions?'

Two final tasks might be:

- using scale factors to enlarge the pictures on flip chart paper A2 or A1 – perhaps pupils could use 1 cm:10 cm. A discussion of ratio may be needed here as the comparison between two or more quantities and part to part i.e. for every 1 cm on my original picture I need 10 cm on my big picture. As a final extension activity, children could discuss what has happened to the area of their picture.
- to follow the same model of proportion using clay or plasticine to make model statues of Egyptian kings.

The bibliography below will provide you with lots of inspiration:

Bibliography

- Robins, G. (1994), *Proportion and Style in Ancient Egyptian Art*, University of Texas Press, London.
- Luxor News (blog)
- Encyclopedia.jrank
- Egyptvoyager.com
- Historylink101

Focus on…the 2010 football World Cup

Can there be anyone who does not know that the Football World Cup is happening this summer? From 11 June to 11 July, football fans will be in heaven - or perhaps hell - if their favourite team is knocked out early in the tournament. The 2010 Football World Cup games will be played at a series of venues in South Africa. The tournament comes around every four years, often alternating between the Americas and Europe/Africa/Asia. A total of 64 matches will be played in ten different stadia in nine different locations (two are in Johannesburg) spread across South Africa.

There are 208 national teams and 204 of them took part in the qualification process. Each of the 32 teams which qualified for the World Cup received $1 million for preparation costs. Financial prizes are also awarded to the teams depending on the point at which they exit the tournament:

Exit point	**Payout**
Group stage	$8m
Round of 16	$9m
Quarter-finals	$18m
Semi-finals	$20m
Runner-up	$24m
Winner	$30m

Zakumi is the official mascot for the 2010 World Cup. His name comes from *ZA*, the international abbreviation for South Africa, and the word for ‘ten’ in many South African languages, *kumi*. He is a stylised leopard with dreadlocks and a wide smile. Zakumi always carries his football around with him and uses it to invite people to play. His motto is "Zakumi's game is Fair Play".

The new South African national flag first flew on 10 May 1994 – the day Nelson Mandela became president, two weeks after the country's first democratic elections of 27 April 1994 – "not as a symbol of a political party, nor of a government, but as a possession of the people – the one thing that is literally and figuratively above all else, our flag". More than 7 000 designs were entered into a competition for the new flag, but none of them received enthusiastic support. The final design was published on 20 April 1994, only one week before the flag was due to be inaugurated.

Short activities

Draw a simple T-shirt on paper or plain fabric such as calico. Either draw different large outline numerals to the shirts or ask the children to. Invite children to decorate each numeral however they wish, using fabric pens, collage materials, felt pens etc. Ask them to order these on a large washing line. Hide one or two shirts. Can the children tell you which ones are missing?

Learn to count to 10 in one of the South African languages. Use a book to help – *Count Your Way Through South Africa* by Jim Haskins & Kathleen Benson ISBN 0-8225-6048-8 for Zulu; *Count on Your Fingers African Style* by Claudia Zaslavsky ISBN 0-86316-250-9 for traditional finger counting of various African peoples.

Complete the missing numbers on the shirts sheet. The numbers can be altered to suit the needs of the children.

The competition is organised in eight groups of four teams. What other ways can you find to organise the teams? All groups must be equal or some teams would have more chance of getting through than others.

Each of the participating countries has its own flag. Download the flag sheet and sort the flags according to different criteria, such as:

- symmetrical/not symmetrical
- number of lines of symmetry
- number of colours
- horizontal/vertical lines
- straight/curved lines
- own criteria.

Which type of diagram would be best to record your results? Carroll diagram, Venn diagram or something different? Why? South Africans claim to have the world's only six-colour flag. Is this true?

Use the payout table above to calculate the total prize fund to include payments to all teams!

Longer activities

Examine a set of dominoes. A full set of double six dominoes has 28 different dominoes. Every number appears with itself and each of the other numbers including the blank. If you were to make a set of World Cup 2010 flag dominoes, how many dominoes will there be? Make the set as a class. Print out the flags and glue to thin card, or create a simple template in a word processing programme. Print on card or paper and laminate. Experiment with how many players and how many dominoes each make a good game.

What if all 208 teams had qualified? How many groups of four would there be now? Each group of four must play six games so that every team has played every other team in the group. For group ABCD, the matches would be AB, AC, AD, BC, BD, CD. Both the winner and runner up go forward to the next round from the first set of games. Thereafter, only the winner goes through to the next round, but there is also a playoff for third place between the two losers of the semi-finals. How many games would need to be played to find the winner? What other ways can you find to organise the teams? All groups must be equal or some teams would have more chance of getting through than others. Find out how many games would need to be played to find the winner of your arrangement.

Use this map to find the distances between each stadium. You can use the direction tab to find the distance from one stadium to another. Find the shortest route to visit every stadium once, starting and finishing at two different stadia.

Metin Tolan, a university professor says he has proved that Germany will win the 2010 World Cup after devising a mathematical formula that calculates the winner. He claims that Germany has won the World Cup three times, in 1954, 1974, and 1990 with an average finishing place of 3.7. What does the 3.7 mean? Use the internet to find the results of the World Cup in question and try to work out how Tolan reached the number 3.7. Can you use his idea to check his prediction?

Put the names of each team into a bag and invite each member of the class, including adults, to pick one out without looking. Children can research their own team, finding out the names of the players, when and where their team is playing and which team they will be playing against. Display the information and annotate with comments as the tournament progresses.

Other useful NCETM resources

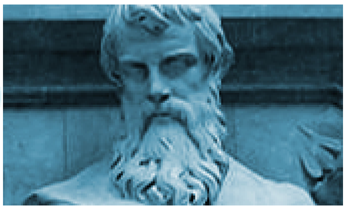
- Primary Magazine Issue 23 It's in the News!
- World Cup Fantasy Football thread in the Primary Forum
- Secondary Magazine Issue 54 Up2d8 maths looks at England's chances of winning
- Football shirt flip flop and related activities in Maths to Share in Issue 18 of the Primary Magazine

Other useful resources

- The FIFA 2010 World Cup site has a countdown clock and much more
- South Africa Information, where you can find out about the two items used by fans at every football game - the vuvuzela trumpet and the makarapa, the modified, decorated miner's helmet; you can also learn the Diski Dance!

Background information on South Africa

- The BBC website has a chronology of key events in South Africa, and a country profile; South Africa History has much useful information.



A little bit of history
Famous Mathematicians – Euclid

Euclid of Alexandria lived around 300BC. He is, by all accounts, the most prominent of the earliest mathematicians. He is best known for his essay on mathematics, The Elements. This work shows the logical development of geometry and other branches of mathematics and it has influenced all branches of science since, particularly mathematics and the exact sciences. It has been studied for over 2000 years and has been translated into many old and modern languages. It was clearly an extremely long essay because it was divided into 13 books!

More than one thousand editions of *The Elements* have been published since it was first printed in 1482. The long-lasting nature of *The Elements* must surely make Euclid the leading mathematics teacher of all time.

Little is known of Euclid's life – the date and place of Euclid's birth and the date of his death are unknown. We don't know how he died and we have little knowledge of what he did during his life. We don't know what he looked like and therefore any pictures of him are products of the artist's imagination!

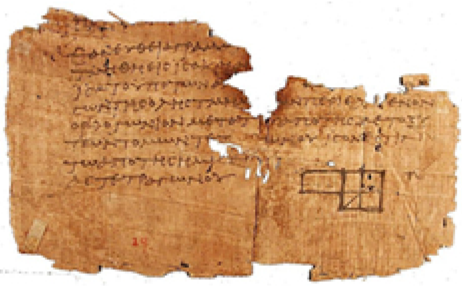
There are a couple of references to him, written centuries after he lived, by the Greek philosopher Proclus and the Greek mathematician Pappus of Alexandria. From these we know that he taught in Alexandria in Egypt and that he may have studied at Plato's Academy in Greece.

There is other information written about him that is considered to be entirely fictitious, for example, that he was the son of Naucrates and that he was born in Tyre – or, according to another source, Megara, but this could be confusion with the philosopher, Euclid of Megara.

Over the years, three possible suggestions have been proposed as to who he actually was:

- he was a historical character who wrote *The Elements* and the other works attributed to him
- he was the leader of a team of mathematicians working at Alexandria. They all contributed to writing the 'complete works of Euclid', even continuing to write books under Euclid's name after his death
- he was a fictional character - the 'complete works of Euclid' were written by a team of mathematicians at Alexandria who took the name Euclid from the historical character Euclid of Megara who had lived about 100 years earlier.

Despite this lack of actual knowledge, whoever he might have been, Euclid has had a significant influence in the world of mathematics due to his writings.



Back to the famous *The Elements*…
Apparently, the results of this work originated earlier than when Euclid wrote about them, but he was able to present them in a single, logical and coherent framework making it easy to use and reference. They remain the basis of mathematics today.

The first eight of the 13 books consider geometry, now known as Euclidean geometry to distinguish it from the other non-Euclidean geometries that were discovered in the 19th century. Among other things, he claimed that it is possible to draw a straight line between any two points, all right angles are equal and only one line can be drawn through a point parallel to a given line.

You could ask the children to explore these – are these statements always/sometimes/never true?

Books seven to nine look at number theory, and consider such things as the connection between perfect numbers and Mersenne primes, the infinitude of prime numbers, Euclid's lemma on factorisation and the Euclidean algorithm for finding the greatest common divisor of two numbers.

Why not try some investigations?
For example:

> Explore the four perfect numbers – how are they made up using the clues below:
> 6 = 1 + 2 + 3
> 28 = 1 + 2 + 4 + 7 + 14
> 496 = 1 + 2 + 4 + 8 + 16 + 31 + 62 + 124 + 248
> 8 128 = 1 + 2 + 4 + 8 + 16 + 32 + 64 + 127 + 254 + 508 + 1016 + 2 032 + 4 064
>
> What is a prime number? What do you notice about the prime numbers to 100?
>
> What does it mean to factorise? What are the prime factors of 24 140 etc?

Book 10 deals with irrational numbers and books 11 to 13 deal with three-dimensional geometry.

In addition to *The Elements*, at least five works of Euclid have survived to the present day. They follow the same logical structure, with definitions and proved hypotheses.

Dutch mathematician B L van der Waerden made this comment in his assessment of the importance of *The Elements*:
"Almost from the time of its writing and lasting almost to the present, the Elements has exerted a continuous and major influence on human affairs. It was the primary source of geometric reasoning, theorems, and methods at least until the advent of non-Euclidean geometry in the 19th century. It is sometimes said that, next to the Bible, the "Elements" may be the most translated, published, and studied of all the books produced in the Western world."

Information for this article sourced from:

- Math Open Reference
- University of St Andrews Department of Mathematics and Statistics
- Wikipedia

Maths to share – CPD for your school

Subtraction

Following on from Maths to share - addition in the last issue of the Primary Magazine, this month we explore the operation of subtraction. Teachers often report that children experience a great deal more difficulty with subtraction than they do with addition. Feedback from analysis of national, end-of-key-stage tests also supports this.

So why does it cause so many problems? Are pupils not taught the key skills of subtraction in a structured, progressive way? Are they not given sufficient time to practise and consolidate those skills? Do we not provide opportunities for them to apply these skills in different contexts? Is teachers' subject knowledge of the teaching of subtraction sufficient for the task? Ask colleagues to consider where they think the problems lie and discuss as a group.

The National Strategies' guidance paper on calculation outlines the aim for primary children, on their journey towards becoming proficient with all aspects of calculation:

"Children are introduced to the processes of calculation through practical, oral and mental activities. As children begin to understand the underlying ideas they develop ways of recording to support their thinking and calculation methods, use particular methods that apply to special cases, and learn to interpret and use the signs and symbols involved. Over time children learn how to use models and images, such as empty number lines, to support their mental and informal written methods of calculation. As children's mental methods are strengthened and refined, so too are their informal written methods. These methods become more efficient and succinct and lead to efficient written methods that can be used more generally. By the end of Year 6 children are equipped with mental, written and calculator methods that they understand and can use correctly. When faced with a calculation, children are able to decide which method is most appropriate and have strategies to check its accuracy."

The guidance paper clearly states the importance of securing mental methods for calculation prior to moving on first to expanded, and then more compact, efficient written methods. The latter seem easier to define, and indeed are laid out in the Written Methods for Subtraction of Whole Numbers section of the guidance paper. The strategies that precede these, those where pupils work mentally, are less easy to define.

Are we directly teaching these vital mental skills? Ask colleagues to consider the strategies they might use in answering the following questions. Some suggestions of how they might be solved are shown here. Before sharing them with staff, ask them to write down the methods they would use and also those they would expect the children to use:

- 9.5 – 8.6
  - 'count up' from 8.6 to 9.0, then from 9.0 to 9.5
  - calculate 95 – 86, then adjust using knowledge of place value
  - use image of a number line

- £12.75 - £7.49
  - round £7.49 to £7.50. Subtract this from £12.75, then add 1p back on
  - use mental image of a number line to know whether to add or subtract the 1p

- Find the difference between 840 and 421
  - recognition that 420 is half of 840. 421 is one more than half, so the difference is one less than half, i.e. 419

- 50 013 – 6 078
  - might be tempted to use a more formal vertical method, based on decomposition. errors likely due to the number of 'zeros'
  - counting on might be more efficient e.g. adding 922 to get to 7 000 and then 43 000 and 13

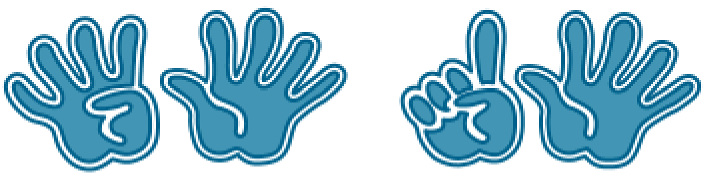
- 4 400.32 – 20.08
  - deal with whole numbers and decimals separately. i.e. 4 400 – 20 and 0.32 – 0.08.

The skill of choosing a method appropriate not only to the operation, but also to the numbers involved is one which adults often don't realise they are using. Ask colleagues to consider what is involved in the direct teaching of these mental calculation strategies. Suggestions might include:

- adopting a structured approach so that skills are developed systematically
- modelling a strategy using an image, a model, or a 'real life' scenario
- using an error or less efficient strategy as a starting point for demonstrating a better strategy
- encouraging children to compare strategies and improve them
- showing how to use a known fact in developing a strategy
- providing the children with a 'prompt' to help them recall and then use an appropriate fact.

It is important that pupils are encouraged to build up a bank of these skills to draw upon when most appropriate. Progression through their teaching does not mean that previous skills are replaced, merely added to.

It is sometimes the very early calculation skills that are the most difficult to teach. A progression through early skills for subtraction might look like this:



Counting out

e.g. 9 - 3
Hold up 9 fingers, fold down 3, count the remaining fingers

Counting back from

e.g. 9 - 3
Count back 3 numbers from 9; "8…7…6"

Counting back to	e.g. 11 - 7 Count back from 11 to 7, keeping a tally using fingers; "10…9…8…7" (4 fingers)
	⇩
Counting up (complementary addition)	8…9…10…11" *(not a 'natural' strategy for many children because of the perception of subtraction as 'taking away')*
	⇩
Using known facts	Rapid response based on facts known 'by heart'
	⇩
Using derived facts	e.g. a child who knows 20 - 5 = 15 can adjust for 20 – 6 = 14 *(more unusual in subtraction than in addition)*
	⇩
Using knowledge of place value	e.g. a child who knows 35 – 10 = 25 can use this to calculate 35 - 9

Many schools now have a 'Calculation Policy' or 'Route Through Calculation', outlining their approach to the teaching of calculation in school. Often these take account of expanded and more compact written methods, but not necessarily the progression in these early skills. If possible, take the time as a whole staff to review the school's policy and ensure that everyone is fully supportive of it.

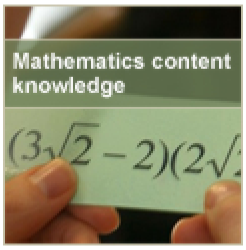
Something to Share in Issue 4 of the Primary Magazine explored the importance of using effective models and images in mathematics to support pupils' learning. Ask colleagues to list the different models and images they use in the classroom and consider the reasons for using them when teaching subtraction. They might suggest:

- helps the teacher in demonstrating or modelling a calculation strategy or provides a physical representation of a mathematical concept or operation
- enables children to do a calculation or use a strategy which they could not do without assistance
- can keep all pupils involved and engaged
- can help children to visualise what is happening.

The National Strategies have produced a whole host of Interactive Teaching Programmes aimed at supporting the teaching of key concepts using ICT: Difference, Counting on and back, Number Facts, Number Grid and Number Line are all good examples.

The Models and images charts produced by the National Strategies, cover six key areas identified as being essential prerequisites for future learning in mathematics. Four of the six charts relate directly to the teaching of subtraction and provide a useful reference for teachers.

If not already familiar, show colleagues the NCETM online Self-evaluation Tool for Mathematics Content Knowledge. It supports teachers in checking their understanding of the mathematics they are teaching and explores ideas on how to develop their practice further. Following this session, ask them to use the tool to evaluate their level of confidence in teaching subtraction-related concepts. They will need to explore the topics *Counting and Understanding Number*, *Knowing and Using Number Facts* and *Calculating*. Encourage everyone to feed back at a future meeting and share any areas for concern. It is likely that similar areas for development will emerge – and what better way to learn than together!



Further reading

Anghileri, J.: 2000, *Teaching Number Sense*. London: Continuum (pp46 – 66)

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National Centre for Excellence in the Teaching of Mathematics

ICT in the Classroom
Code breaking - with calculators

The Calculator Code

The exciting context of secret messages, codes and espionage inspires this use of ICT for Key Stage 2 pupils.

The calculator can be used to encode parts of text using calculations to spell words upside down on the screen. 0 becomes O, 1 is I, 3 is E, 4 is h, 5 is S, 6 is g, 7 is L, and 8 is B. So ‘globe’ can be made by entering 38076 and turning the calculator upside down, or by entering 19038 x 2 to achieve the same result.

This concept can be presented to children at three levels. At a basic level, children can start to break prewritten codes. This helps them to become more familiar with calculator operations and interpreting the screen, while increasing their understanding of the necessity for accurate use. Usefully, code breaking is self-checking – if the process has been carried out correctly, real words appear!

Try breaking this code with a standard school calculator and consider what calculator or mathematical skills are needed or developed to solve the puzzle:
7700 +18 hurt 1000 - 486 91 x 7 on the 15428 ÷ 2, 2 ÷ 4 $\sqrt{1156}$ had to 3788.04 ÷ 0.01. $857^2 + 3602$ said “6.9606 ÷ 9” and gave him 56.63 x 100 to 6 + (3788x100).

Much more mathematical thought is required for writing these codes than breaking them. The concept could be introduced as a problem solving activity linked to finding different possibilities and sorting. First, set the children the task of recording which letters can be made on an upside-down calculator. They can work collaboratively to discover the words that can be made with those letters and will soon discover that the word needs to be entered backwards to make it correct when the calculator is turned. Encourage them to use a systematic approach to collecting and arranging lists of words that can be encoded, include opportunities for sorting using their own criteria and explaining their reasoning for doing this in their particular way.

With the set of words, start recording and sharing different calculations that could be answered to make some of them. Groups of children might decide on one particular function to apply to every word to create their code. You could restrict the function to multiplying by a number from 1 to 10 for example, if the function code is x4 then ‘hog’, which is made from 604, would become 2416 in the coded message. This gives other groups the chance to try to break the code using their knowledge of multiples of different numbers or inversions. Can the children predict any problems with using a x10 or ÷10 function code?

Depending on the children’s experience, this is an excellent opportunity to encourage the use of the calculator memory for calculations that involve more than one step, including brackets. For multi-step quick problems to solve, try displaying the calculations in a picture clue, for example, $(41 \times 25) + 67^2$ displayed inside the outline of a snake, or (4 ÷ (101-96)) x 0.1 inside a ghost. It’s fun to observe how creative the children can be with their own calculator code picture clues!

One of the most powerful uses of the calculator in the primary classroom is for developing an understanding of the inverse calculations or missing number problems.

Calculator code breaking can give us an exciting purpose for solving problems. Why not try this example with a spy scenario…

You have intercepted a message. You've just started to destroy it when you realise that it needs to be replaced in the spy's pocket so that he does not know that you have broken the code! The decoded message reads. "Meet Bob at the Globe Theatre."
Work out the original coded message so you can recreate it and fool the spy!

If you are feeling inspired by code breaking you should find the article The Secret World of Codes and Code Breaking interesting. The NRICH Code Breaker resource is worth exploring, it includes an on-screen interactive code breaker, ideal for collaborative problem solving.

CPD and research
Reflect on when and how you teach calculator skills particularly considering the experiences children need to have encountered to interpret the screen accurately and to solve multi-step problems. Spend sometime watching how children use the calculator. Are their methods reliable and efficient? Do they use jottings to support their mathematics on the calculator? How do they use the calculator to support their explanation and reasoning when working collaboratively?

Calculator codes – Reinforce inverse operations and confident calculator use, and have a 4707.7 x 80 at the same time.