Primary Magazine

Issue 40

National Centre for Excellence in the Teaching of Mathematics

Welcome to the 40th issue of the Primary Magazine. Our history article links mathematics into the topic, Houses and Homes, we look at the art of Theo van Doesburg and focus on banks. Our CPD opportunity considers the teaching and learning of percentages and our ICT article explores the use of sensors and data loggers; *It's in the News!* features the discovery of a Viking burial ship.

Contents

Editor's extras

We are very pleased to announce the release of the NCETM's latest resource, The NCETM 'essentials' collection: Guiding you to the right solution.

The NCETM online resources number many thousands of pages. It can sometimes be a little daunting to find exactly what you want and useful sources of information or discussion can often be missed.

So the NCETM's guidance pages point the way to solutions to the frequently asked questions that National Centre staff often hear. Each page of guidance contains links to relevant resources from across the NCETM online offering.

They also include links to discussion forums, and offer the opportunity to examine and record your own practice and thoughts as you read the guidance.

Have you ever asked yourself any of these questions?

- how can I teach mental and written calculation strategies effectively in primary mathematics? If so, take a look at Calculations
- how can I use ICT and digital technologies in mathematics lessons? Digital technologies could be just for you!
- how can I plan in the early years foundation stage (EYFS) for teaching mathematics using everyday situations? Take a look at EYFS maths in everyday situations
- where can I find mathematics classroom resources and support for Primary NQTs? You might find some ideas in Primary NQTs
- how can I work with teachers and leaders from other primary schools to develop their mathematics learning and teaching? Primary schools working with other schools will be helpful
- how can I devise rich mathematical tasks for the primary classroom? Discover lots of ideas in Rich mathematical tasks – primary
- how can I best support colleagues in improving the teaching and learning of mathematics in my primary school? Supporting staff in primary schools has lots of useful suggestions
- how can I work with teachers and leaders from other schools to develop their mathematics learning and teaching? Working with teachers and leaders in other schools has, among other things, a link to the Schools Working Together microsite
- are you worried about how to help the low attaining pupils in your primary school class? Then take a look at Teaching low attainers.

If you have further suggestions for guidance resources you would like to see, please do get in touch.

Did you know that 4 000 years ago, children in school were learning mathematics just as they do now? Have you ever wondered what mathematics children from the past learned and how they learned it? There is a free online multimedia resource pack created by the University of Cambridge's Millennium Mathematics Project, which shows how we can find out about an ancient civilisation through the objects they left behind. It has been developed for the transition from Key Stage 2 to Key Stage 3. There are some suggestions for its use - for example, forming part of a Transition Day, or a topic which could be started in the primary school then completed in the secondary school. The pack is based around short video clips in which Dr Eleanor Robson (Department of History and Philosophy of Science, University of Cambridge)

explores mathematical history and archaeology and introduces key concepts in Babylonian mathematics. Each pack includes related investigative activities and worksheets for students, and teacher support notes. You might also be interested in having a look in Issue 5 of the Primary Magazine, where A little bit of history features the Babylonian number system.

And finally…you might like to explore the Running the numbers project from Chris Jordan's photographic arts website. Clicking on the paintings reveals some interesting sights! You may need to be selective about the ones you show the children. Each comes with an interesting statistic. What ideas for mathematics can you get from them - apart from the obvious ones of estimation and 'big' numbers? Let us know how this inspires you.

Magazine authors: *Caroline Clissold, Emma Low, Cherri Moseley, Donna Wright*

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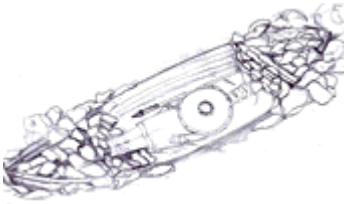

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It's in the News!

On 19 October 2011 we heard in the news that a Viking ship, buried for more than 1 000 years along with the body of a chieftain and his sword, shield and spear, had been excavated on the peninsula of Ardnamurchan, in the south west of Scotland. We thought this would make an interesting theme for this issue's *It's in the News!*

In these slides there are links to geography and history. If you do a topic on the Vikings, you might find these slides helpful. If not, why not share this with your class anyway? The slides give opportunities for work on a variety of mathematical concepts such as number, shape and measurement including time.

Before you use the slides you might find the following websites useful for information on this discovery and the Vikings in general:

- Ardnamurchan.com gives details of this area of the UK
- BBC History - you might also find it helpful to use A little bit of history from Issue 39 of the Primary Magazine
- The Guardian - this includes a video of part of the excavation.

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, 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.

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The Art of Mathematics
Theo van Doesburg (1883 - 1931)

Theo van Doesburg

Theo van Doesburg was born on 30 August 1883 as Christian Emil Marie Küpper. His artistic family lived in Utrecht, where his father Wilhelm was a photographer. Very little is known of his early life.

After beginning to train to become an actor and singer, Christian decided to become a painter. He signed his first paintings Theo Doesburg because he regarded his stepfather, Theodorus Doesburg as his natural father. He later added 'van', meaning 'son of', to his name. As Theo van Doesburg, he held his first exhibition in 1908. He was a competent figurative painter, his work similar in style to that of early Van Gogh.

From around 1912, van Doesburg also wrote for magazines. He continued to write and review for magazines during his two years in the army, from 1914 to 1916. It was through this work that he became aware of the work of Piet Mondrian. In 1915, van Doesburg participated in the foundation of the artists' associations *De Anderen* and *De Sphinx*. Through this he met many like-minded artists. In August 1916, architect J J P Oud commissioned him to design a stained-glass window. His work was such a success that numerous other stained glass commissions followed.

In 1916 van Doesburg met Mondrian and for a while they became close friends. Along with Anthony Kok, Bart van der Leck, Vilmos Huszar and J J P Oud, they founded the far-reaching movement and magazine De Stijl in 1917. Van Doesburg edited and published the magazine from its foundation until its demise following his early death in 1931. Dutch for 'The Style' and also known as Neoplasticism, this artistic movement of painters, architects and designers worked to build a new society in the aftermath of World War I, advocating an international style of art and design based on a strict geometry of horizontals and verticals. They tended to use flat primary colours arranged geometrically. According to some, the later rift between van Doesburg and Mondrian was caused by van Doesburg's daring introduction of the diagonal into his work. Both artists evolved out of the Dutch figurative tradition into complete abstraction at exactly the same time, but while Mondrian stuck with this style, van Doesburg's work is far more varied. He was a painter, poet, art critic, designer, typographer, architect, performance artist and more.

He lectured and published, talked and theorised, attended conferences and congresses and exhibitions, many of which he organised himself. He travelled extensively in Europe in the 1920s as an ambassador of De Stijl, making connections and collaborating with his contemporaries. Walter Gropius, principal of the Bauhaus found van Doesburg aggressive and dogmatic and would not offer him a post at the Bauhaus. So van Doesburg set himself up near to the Bauhaus buildings and started to attract students interested in new ideas. He began his own De Stijl architecture course, poaching students from the Bauhaus. He preached geometry and the use of primary colour and the submersion of the individual in the collective, things that later became an integral part of the Bauhaus philosophy.

Architype Van Doesburg typeface

Van Doesburg was involved in all the '-isms' of the time - Neoplasticism, Constructivism, Suprematism, and Dadaism. After his split with Mondrian, van Doesburg named his art Elementarism. This was characterised by diagonal lines and rivalled Mondrian's Neoplasticism. He also invented an alphabet, now a typeface: Architype Van Doesburg is highly geometric, constructed from perpendicular evenly-weighted strokes. Each character is based upon a square divided into 25 smaller squares.

He met Nelly van Moorsel, a pianist, at an exhibition of the *Section d'Or* group of abstract painters that he organised in The Hague in 1920. He was 15 years older than her and already married but that did not stop her. She abandoned her orthodox Roman Catholic family and went with him to Paris, considering herself married to him, although in fact van Doesburg was not divorced from his previous wife until January 1923. They finally married in 1928. They were inseparable - whenever van Doesburg appeared in a photograph she is beside him, often the only woman in the group. Her mischievous grin was a wonderful counterpoint to his solemn gaze.

The van Doesburgs lived in Meudon, an outer suburb of Paris. He began painting again - he had done no painting at all in Germany - and design commissions came his way: the Flower Room in the modernist Villa Noailles in the south of France being the first. This was an opportunity to put his ideas into practice. Shortly afterwards he collaborated with Jean Arp and his wife Sophie Taeuber-Arp to redesign the interior of one wing of the Aubette building in Strasbourg as an entertainment centre. This work is van Doesburg's masterpiece of interior design. For the first and only time, his powerful and dynamic diagonal blocks of primary colour march across the walls and ceilings of large, public rooms. Sadly, the designs did not meet with public approval and were covered over in 1938. Only recently have the rooms been restored, finally being opened to the public in their entirety in 2009.

Van Doesburg had a thrilling spatial imagination and created axonometric projections of ideal houses. In these drawings, perspective is ambiguous; walls are no longer supporting structures but floating, intersecting planes of primary colour; rooms are not static boxes but conceptual spaces hovering in the air. The volumes of the buildings seem to explode from an inner core, as though erupting into the third dimension and straining for that elusive fourth.

In 1925, van Doesburg marked his transition from painter to architect by building his own studio-house. With money she had been left in her father's will, Nelly bought a plot of land in Meudon. There, at 29 rue Charles Infroit, the couple built a studio-house to van Doesburg's own design. Construction was slow, partly because of difficulties with the building material, which was 'solomite', an insulating fabric of compressed straw. He died on 7 March 1931, the house within a few months of completion. He suffered a heart attack following a bout of asthma and died aged just 47.

Activities

Illustration in the style of The van Doesburg's *Composition Arithmétique*

Arithmetic Composition (Composition Arithmétique), 1930

Van Doesburg used a simple mathematical calculation to produce his *Arithmetic Composition*. The sides of each of the black squares painted on a white background and the distance between them are half the size of the preceding square.

Study for Arithmetic Composition is the original plan for Arithmetic Composition. Van Doesburg used diagonal lines on graph paper to plan both the size and arrangement of the squares.

Show the children the two images, *Arithmetic Composition* and *Study for Arithmetic Composition*. Ask them what they notice. How does the size of the squares change? What about the spaces between them and the reverse 'L' shape containing each square?

Once the children are clear about the composition of the painting, invite them to design their own arithmetic composition in the style of Theo van Doesburg. Each child could choose their own shape and the relationship between the sizes as well as the final colours. Planning it out first on graph paper helps to ensure that the composition follows the arithmetic rule (or rules) decided upon.

Display the final results with a short explanation of the inspiration behind the art work. You might like to give the display the overarching title 'Arithmetic Compositions'.

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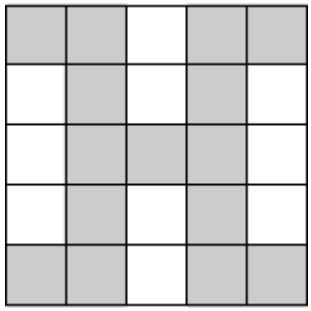
Architype Van Doesburg



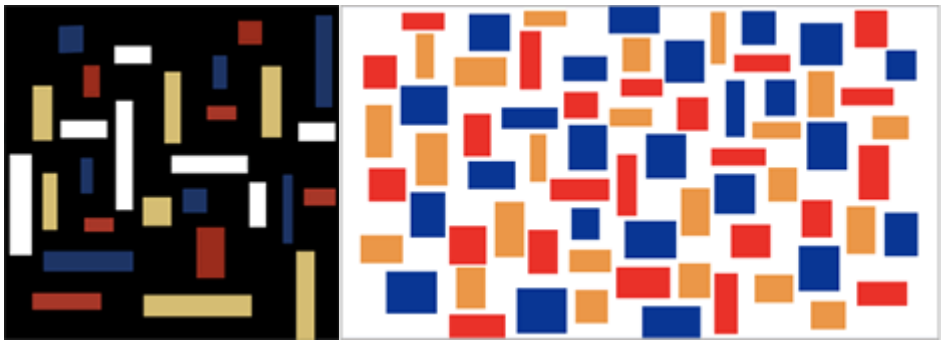
Letter X in *Architype Van Doesburg*

Architype Van Doesburg is an alphabet constructed from perpendicular (right-angled), evenly-weighted strokes. Each character was designed within a square divided into 25 smaller squares, using a strict grid method.

Give the children the information about the how the capital letters in the alphabet were constructed and challenge them to create their own version. Some children will find it useful to design their letters on graph paper. Compare the children's designs with van Doesburg's, checking that they only use perpendicular lines. Are some of their designs clearer letters than the originals? You could agree some improvements and display it as the class alphabet.

Alternatively, show the children the Architype Van Doesburg and ask them to design a lower case version. Decide whether this should still be based on a 5 by 5 square grid or perhaps a smaller one.

Theo van Doesburg produced a series of paintings entitled Composition, numbered in order of creation. The following examples show how the density of rectangles increased over time until there are no gaps.



Illustrations in the style of Theo van Doesburg
Left: *Composition VII* (the three graces) and right: *Composition XI*

Illustration in the style of Theo van Doesburg's *Composition XX*

This style is particularly accessible to younger children. Explore the pictures and the differences between them together. Provide children with a range of rectangles in assorted colours and sizes and invite them to create their own 'Composition'. They will need to decide whether or not to leave spaces between rectangles and which colours to use. Some 'Compositions' outline the rectangles with a fairly thick black line. Children could replicate this using a thick felt pen and a ruler, though they will need to take care to avoid smudging the lines.

Children could also cut out their own rectangles from their chosen coloured paper. Others may choose to use a different shape.

More information on Theo van Doesburg from:

- Encyclopedia Britannica
- iconofgraphics.com
- Museum of Modern Art (MoMA)
- Tate Online
- Wikipedia.

For images:

- Wikimedia Commons.

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Focus on…Banks

Financial capability is about helping children and adults to acquire knowledge and skills which enable them to make confident and secure financial decisions throughout life. Understanding money and how banks work will provide children with the early foundations of financial capability that will help them to make appropriate decisions about what to do with the money they receive.

With Christmas just around the corner, what better time to turn our minds to spending and saving money and taking time to focus on… banks!

The history of banking


London Royal Exchange

The first bankers were merchants of the ancient world who made loans to the farmers and traders that carried goods between cities. In ancient Greece, and during the Roman Empire, lenders based in temples would make loans but also accepted deposits and changed money. The London Royal Exchange was established in 1565. At that time moneychangers were already called bankers, though the term 'bank' usually referred to their offices, and did not carry the meaning it does today.

The revolution of 1688, which brought William and Mary to the throne, gave England a measure of political stability unknown for nearly a century. Commerce flourished but the public finances were weak and the system of money and credit was in disarray. The goldsmith bankers had been damaged by the lax financial management of the Stuart kings. There were calls for a national or public bank to mobilise the nation's resources. Many schemes were proposed. The successful one, from William Paterson, envisaged a loan of £1 200 000 to the government, in return for which the subscribers would be incorporated as the Governor and Company of the Bank of England. Although the new bank would have risked its entire capital by lending it to the government, the subscription proved popular and the money was raised in a few weeks. The Royal Charter was sealed on 27 July 1694, and the bank started its role as the government's banker and debt-manager, which it continues today.

Jenni Back and Liz Pumfrey look at the History of Money on the NRICH website, following the story from early bartering to current technology, standing orders and debit cards.

Our money and the banks

In a world where many items are bought with credit or debit cards or through online trading, it is difficult for children to develop a sense of money. It is important that they learn about money, and how to become financially capable, at an early age, so that it becomes second nature as they venture into a world full of bills and spending.

"Why do we need money?" ***"Where does money come from?"***

Discuss with children that we need money because it is a way of paying for things we need or like. Money is a type of currency where we give coins and notes in exchange for goods and services. Explain that their parents may get paid for the jobs that they do, for example, working in shops, factories, offices and they use that money, known as 'wages', to buy clothes, food and other items as well as paying for heating and telephone bills at home. Not all money has to be spent, it can be stored and kept to buy things at a later date. Children may discuss saving money in piggy banks or money boxes, whilst others may have bank accounts that are maintained by their parents or accounts that they have more engagement with.

Consider the Data Handling cycle and ask children to investigate where their money comes from. Do they receive pocket money? Do they do jobs at home to earn money? Does it mainly come as a gift for a birthday or other celebration? Or do their parents buy the things they need? Further investigations might include 'What do we do with our money?' where children can explore what most of their money is spent on and how many children save their money in a bank or building society. The beginnings of the bank and how money works can be explored with children using this Bank of England education video.

Focus on…money in Issue 8 of the Early Years Magazine looks at exploring money with very young children through the story of Jack and the Beanstalk, looking at different types of money, how to keep their money safe and what they could spend their money on. In addition, Up2d8 Maths in Issue 20 of the Primary Magazine is a wonderful classroom resource containing many discussion points and activities based around children's pocket money. Nationwide Education also provides some excellent resources, including short stories for young children examining the dilemma of wanting to buy a pet and all the financial decisions that need to be made along the way.

"What is currency?" ***"Do banks all over the world use the same currency?"***

From 1200 B.C. to 50 B.C. different currencies were invented around the world. The Chinese used a type of shell called Cowrie shells and metal tools as money, while the Athenians used nails, and the Saxons - sword blades. Even polished volcanic rock was used as money in parts of America. Unlike the exchange of goods or bartering, using objects as currency gave traders a way of paying for things. This meant they no longer had to find someone who wanted what they had and had what they wanted. However, there were still problems. Objects weren't easy to divide into smaller amounts, so you couldn't make up differences in amounts (or give people change), and with so many different currencies being used, people couldn't always agree on what things were worth (source: Pounds and Pence 2a: The First Steps Towards Currency). You might be interested in looking at A little bit of history in Issue 9 of the Primary Magazine, which focuses on the history of money.


Notes and coins

Today, the wide range of coins and notes – from the 1p coin to the £50 note – means that we can make up any number of different amounts. Our modern banknotes developed from the use of paper receipts given by a special bank, the Bank of England. Set up in 1694 to help King William III raise money to fight a war against the French, people used this bank as a safe place to store their gold. The bank would write a note stating the amount of gold handed to it for safekeeping. People trusted the bank's promise to pay back the amount in gold and they began using the notes to pay for things. Everyone knew that they could take the note to the bank and get the gold if they wanted it. This trust in the Bank of England's notes continues today. The reason that banknotes are worth the amount written on them and can be used to pay for things of that value is because everyone trusts them. Look at a banknote. It says 'promise to pay'. It is the Bank of England's job to make sure that we can always trust their banknotes and that they keep their value (source: Pounds and Pence 3a: 21st Century Currency).

You could organise role play situations where children can experience choosing their own currency and buying items they want or need. What problems do they have? Provide opportunities for young children to explore the currency they use. Can they sort the coins in different ways and talk about the value of the coins and notes. Ask children to make up specific amounts using a variety of coins e.g. How can we make 20p? Use a 20p coin; two 10p coins; 20 1p coins; a 10p coin, a 5p coin, two 2p coins and a 1p coin etc. Older children may use a similar exercise to investigate systematic approaches to problem solving.

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Marion Bond discusses the problems and difficulties of teaching money to young children in Money Problems? and explores how to use a range of other classroom resources to support learning and to avoid money confusion. Role play may also help children of all ages understand what happens when debit and credit cards are used to pay for goods or to withdraw money from a bank in order to dispel the myth that there is a 'never ending' source of money obtained from a 'hole in the wall'!

Look at different forms of currency from around the world and the difficulties in using our currency in other countries. Discuss how each form of currency is not directly equivalent: £1 is not equivalent in value to €1 or $1. This will lead to looking at how the bank calculates exchange rates, and older children can begin to convert form one currency to another using their knowledge and understanding of ratio. Most bank websites will have tables showing current exchange rates, giving children the opportunity to read and interpret information and gather the information required to convert the currencies. Current exchange rates can be found on the Royal Bank of Scotland and NatWest websites (accessed October 2011).

"What happens to your money in the bank?"

"How do banks make money?"

"What happens if you borrow money from the bank?"

Banks work because, on the whole, we trust that they will keep our money safe, make it grow and give it back to us when we ask for it. Explain to children that as soon as we give the bank our money, it gives it to someone else. This is because a bank is like any other business, but the product they work with is money. Banks use money to make more money. They also create money by giving people loans. When people put money into the bank, the bank puts this money to work by lending it out to larger businesses who then use it to buy or make other things. Buying and making things makes money and some of this money gets put back into the bank. The bank can then lend this money to yet another person and so banks make money go round.

This Bank of England video explores what happens to your money when you put it into your bank account. It explains interest gained on money in the account, as well as what happens if you decide to borrow money from the bank. Explain to children that by putting money into a bank account, it is not only kept safe but it also increases in value because banks will pay you if you agree to save your money with them. The amount they give you is called 'interest'. Older children can start to look at this in terms of percentages, as interest is paid as a percentage amount of your total savings. Provide opportunities for children to calculate interest growth on various amounts of savings. It is just as important to explain to children the effects of interest on money borrowed from the bank or on a credit card. Take the opportunity to discuss with much older children the misconceptions of the effects of continuous percentage increases, e.g. a 5% increase each money for three months is not the same as a 15% increase at the end of the third month (see Maths to share: CPD for your school in this issue).

Banker for the Day provides a range of scenarios for older children to explore with regard to calculating interest and making decisions about money using their knowledge of how interest is calculated. Which bank should they save their money in and which bank would be the best place to take out a loan?

Organise a trip to a local bank so that children can experience banking first hand and consider more seriously the benefits of saving their money. You may also consider setting up a bank in school. Many of the high street banks are keen to support schools and to encourage saving from an early age. HSBC is one of the main banks who will work with schools to set up a SchoolBank, a mini HSBC branch that children run in their own school for other children. This is organised with support and guidance from local HSBC employees. Children can apply to be a cashier, sales adviser, marketing manager or even the

branch manager! They then help their customers open MyMoney accounts, pay in or take our money and answer enquiries. This is a wonderful insight into the world of work and the SchoolBank employees can even earn a Certificate of Achievement.

Which banks are children aware of? Ask them to find out the distances from school or their home to the nearest local banks. Gather information from home, if possible, about where parents and other adults keep their money. Which is the most popular bank used and why is this? Is there any correlation with the most popular bank and the distance from home? Or is the selection of bank based on other criteria, such as recommendations from other family members; free gifts offered when opening an account: money back on opening an account; best interest rates? How do you select the best bank to store your money?

As well as focusing on the bank as a means of developing financial capability, this is also a wonderful opportunity to share with children a potential career pathway and purpose for learning and developing mathematical skills. Contact a local bank and organise for employees to come and talk to the children about the roles they have and how mathematics enables them to do their job. The Bank of England careers website also focuses on the wide range of careers available.

Other resources

- Bank of England: Pounds and Pence
  This resource is intended for teachers of pupils aged nine to 11. It provides a range of stimulating resources that will encourage pupils to think about money and prices
- Lincolnshire County Council/CfBT Education Trust: Primary Financial Capability
  Documents outlining the progression in skills of financial responsibility, financial competence and financial understanding, activities and other resources to support teaching financial capability
- Nationwide Education
  This website is designed to help stimulate and raise awareness among children and young people, particularly in the areas of Financial Capability, Sustainable Living and Safety
- Personal Finance Education Group (PfEG)
  A website that provides free support, resources and expert consultancy to make learning about money easy (including information about My Money Week)
- Teaching Financial Capability
  A tool for teaching financial capability at school.

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A little bit of history
Houses and Homes

In this article, we will look at ways in which to link mathematics to your history topic of Houses and Homes. This is a topic traditionally covered in KS1, but some of the ideas might inspire you to spend some time looking at this theme in KS2.

However, due to the large amount of ideas and resources, this feature can only be read directly on the portal, otherwise the interactive nature of the way they are presented will be lost.

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Maths to share – CPD for your school

Percentages

People deal with percentages most of the time in their daily life and we might assume that this is an area of mathematics of which we all have a good understanding. "No!" I hear you say - so where do the problems lie and how can we support colleagues with teaching percentages in the classroom?

It would be helpful if you have copies of Teaching Percentages as a Multiplicative Relationship for staff to refer to in the meeting.

Background reading

Many of the difficulties that children (and adults) have when calculating or working with percentages involve seeing figures as whole numbers, as opposed to parts of a whole, and the multiplicative nature of percentages.

Paul White at the Australian Catholic University and Michael Mitchelmore at Macquarie University, Australia, researched Teaching Percentages as a Multiplicative Relationship and looked at the abstract nature of teaching percentages and associated teaching strategies. Their research is published on the Mathematics Education Research Group Association (MERGA) website (accessed October 2011).

When Two and Two is Not Equal to Four: Errors in Processing Multiple Percentage Changes by Haipeng (Allan) Chen and Akshay R. Rao at the University of Minnesota also focuses on computational errors when working with percentages. It looks at how the perception of percentages as whole numbers leads to errors in calculation.

Critical numeracy and abstraction: percentages by Paul White, Mike Mitchelmore, Sue Wilson and Rhonda Faragher, describes an approach to teaching percentages that puts contexts and application before abstract concepts and procedures.

Setting the scene

Ask staff to refer to Teaching Percentages as a Multiplicative Relationship by Paul White and Michael Mitchelmore. In this article, White and Mitchelmore talk about 'Teaching for Abstraction'– here, teachers support children through four stages of development:

- *familiarising* themselves with the structure of a variety of relevant contexts – teachers encourage children to explore familiar contexts involving percentages in meaningful situations.
- *recognising* the similarities between these different contexts – activities are planned for children to compare and contrast the use of percentages in specific contexts.
- *reifying* the similarities, above, to form a general concept – teachers support children in making and explaining generalisations based on the similarities found in the 'Recognising' phase. These generalisations can then be used to carry out abstract (i.e. decontextualised) percentage calculations and provide opportunities for…
- *applying* the concept in new situations. Here, children can begin to create their own problems involving the application and calculation of percentages.

To support staff in understanding these four stages, explore further their understanding and application of percentages.

What do we understand about percentages?

To promote discussion about percentages, ask staff to consider their definition of a percentage and times when they would use percentages or the language of percentages. Using the National Strategies Negotiating Meaning Chart (adapted from Hillingdon LA), ask colleagues to work in pairs or small groups and to consider:

- what is their definition of a percentage?
- when do you experience this element of mathematics in every day life?
- what other areas of mathematics are related to percentages?
- what language is used when talking about percentages?
- are there pictures, diagrams or symbols that are commonly used when teaching or talking about percentages?

This activity could be useful in seeing the progression of concepts and ideas if staff members are split to work in year groups or key stages. These questions can also be used in the classroom to set the context of teaching and to gather new ideas as children learn more about percentages.

Mathsisfun defines percentage as 'Parts of 100', while the freedictionary.com defines it as 'A fraction or ratio with 100 understood as the denominator; for example, 0.98 equals a percentage of 98'.

Percentages are well represented in 'the real world'. We see them used in the stock market, shop sales and discounted prices, discussions about wage increases, when dealing with VAT and other taxes, tips and commissions, bank and credit card interest etc. Staff and older children may be interested to see this video produced by the METAL (Mathematics for Economics: enhancing Teaching and Learning) project at Nottingham Trent University. The film examines car prices and their depreciation in order to check out understanding of percentages.

Other areas of mathematics related to percentages include fractions, decimals, ratio and proportion. Younger children will build prerequisite skills through developing a good understanding of the concepts of multiplication and division and proportionality. While learning about percentages, children will use language such as per cent, fraction, proportion, part, hundredths, tenths, thousandth, chance, likelihood, probability.

It will be interesting to look at the range of images and models that teachers think about to illustrate percentages. Some of these may include 100 grids with shaded areas, paper strips of 100 squares, fraction walls to show equivalence (such as the ITP Fraction). Staff will also show the % symbol as a means of representing percentages and may also list fractions out of 100.

Misconceptions and errors

Ask staff to discuss the difficulties that children have when learning about percentages or fractions. What are the most common errors and misconceptions?

These may include:

Difficulty in converting percentages to fractions and decimals – a belief that 5% is 1/5 or 0.5

Understanding the language related to percentages is crucial here. Emphasising that the translation of 'per cent' is 'out of a one hundred' may help children to write the percentage as a fraction out of 100 and then find simpler, equivalent fractions.

Models and images will also visually support this concept. A hundred grid with shaded squares could show the difference between 5% shaded and 1/5 shaded.

Understanding the multiplicative nature of percentages and getting confused with complex calculations such as:

In the sale, a pair of jeans costing £40 is reduced by 40%. The following week, they are further reduced by another 10%. How much will the jeans cost after the second discount?

Many children (and adults!) may respond by answering £20 as they have worked out 50% off (40% and then a further 10% off) rather than calculating that the jeans will cost £24 after the first discount, and it is this amount that we then use in the second discount to calculate the answer of £21.60.

Investigate the differences in these situations by asking staff:

> *Would you rather have 50% off a pair of jeans which cost £40 or an initial 40% off followed by another 10% discount?'* or,
>
> *You can have a pay rise of 15% or 5% each month for 3 months. Which pay rise scenario would you choose and why?*

Ask them to illustrate their argument with a picture or diagram that can explain which is the better option.

Having whole number dominance and not seeing fractions and percentages as parts of a whole e.g. 5/7 + 5/6 = 10/13

…'whole number dominance', the notion that the mental representation of numbers may have developed in a way that favors whole numbers relative to decimals, fractions, percentages and other complex numerical forms.
(Behr, Post and Wachsmuth 1986 IN Chen and Rao, When Two and Two is Not Equal to Four: Errors

in Processing Multiple Percentage Changes, University of Minnesota, 2007).

Again, having visual aids to support these calculation is crucial in seeing the mathematics behind this calculation rather than looking at it an abstract way and dealing simply with the 'numbers'.

Calculating or reading a percentage but not understanding what it is expressing

Students can quickly learn how to accurately calculate a percentage but they might struggle to explain what percentage is actually stating. That is, the distinction between a "rote-calculation" and a "mathematical inference" can be elusive.
(The METAL project, Nottingham Trent University).

Children need to see, and work with, percentages in real life or in context in order to understand what they represent. Ask staff to work in pairs and to list occasions when their pupils would see or use percentages in real life situations. This activity could also be extended to include the consideration of fractions. While it is vital for children to understand percentages as being fractions out of 100 and 100% representing the 'whole', emphasise to staff the importance of children understanding situations where they will hear about increases of 200% etc. and what this represents.

Next steps

Remind colleagues that it is essential that:

- the teaching of percentages is put into a context for children. Seeing a context and what the percentage means in that context, will support children with their calculations.
- they provide a range of models and images for children to use when developing their understanding of fractions, decimals and percentages. This will support early misconceptions of 'whole number dominance' and when converting between the representations.

Other references

- Now, having considered aspects of percentages and the misconceptions that children and adults have, you may ask your colleagues to put 110% into their teaching of percentages and explore some of the other humorous anecdotal misuses of percentages by sharing John Dabell's blog, Giving 110%
- Maths to share – CPD for your school in Issue 17 of the Primary Magazine focuses on fractions, decimals and percentages
- Putting percentages in context, BBC News Magazine (accessed October 2011).

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National Centre for Excellence in the Teaching of Mathematics

ICT in the Classroom – sensors and data loggers

In this issue, we consider the use of sensors and detectors in mathematics through problem-solving scenarios. The contexts for the problems could be changed to suit children's interests, events in school or a curriculum theme, but in each the pupils will need to make decisions based on using and interpreting the data they collect.

Data logging involves using a device which records data from sensors, and either displays or feeds the collected data to a computer to be stored and represented. The data can be used to produce graphs and charts. Data loggers can capture and display data as it happens, collect data continuously or at regular intervals over longer periods of time. Everyday uses for data logging include weather stations and traffic flow systems. Some devices can respond to data, for example a movement or sound sensor could trigger an alarm or turn on a light when the data matches criteria.

Data loggers enable children to investigate their environment using their mathematical skills of understanding measures and data handling. Before these activities, it is valuable to observe children exploring the sensors in pairs or small groups to see and hear the "What if... ?" and "How can I... ?" questions they pose for themselves, and what mathematical language these resources promote.

The curtains

Curtains need to be chosen for a new sensory room, TV room or quiet room in the school or other local setting.

Ask the children to use light sensors to investigate which fabric the curtains should be made from to make it as dark as possible. They might think about colour and doubling or combining fabrics, or consider other factors such as price. The children will need to devise their own way of comparing the outcomes from different fabrics using the data from the device.

Ice cream

The PTA will be providing ice creams for the summer picnic. The ice cream will need to be scooped out in the kitchen, then brought round to people on trays outside.

Ask the children to use temperature sensors to investigate the best containers for preventing the ice cream melting too quickly e.g. cardboard cup, ceramic bowl or wafer cone. One advantage of using a sensor that takes regular measurements, is that the experiment is not affected by a thermometer being moved and handled. Try setting up a video camera to record the ice cream melting, then the whole class can observe and review the experiment together alongside the table or graph created from the data collected. Using the temperature sensors on frozen food provides an opportunity to explore negative numbers, and an introduction to calculating with them.

Shh...

We will be recording advertisements in Literacy later this term.

Ask the children to use a sound sensor to investigate which is the quietest room in the school for recording the radio programme or podcast. Try taking readings at different times of the day or on different days of the week. Once children are familiar with the types of table and graph produced by the data logger on the computer, they can be given graphs without location information for them to reason about where the sensor might have been located.

A Department for Education initiative to enhance professional development across mathematics teaching

Search and rescue

Someone has stolen an animal from the zoo. We know that it is sleeping in one of these bags. How can we recover the animal quickly without opening all the bags?

Recreate the scenario with a selection of bags. In one bag, place a toy animal made from a hot potato or heat pack. Ask the children to think about which sensor might allow us to detect an animal inside a bag without looking inside. One suggestion made by a Year 4 child thinking about this problem, was to put a sound sensor next to each bag to detect snoring! It is useful for children to investigate and discuss different methods although, with the warm toy, this scenario is obviously set up for use with temperature sensors. To know whether the temperature sensor can be used in this case, children need to think about these questions:

- can we use a temperature sensor to find something we cannot see?
- how sensitive is the temperature sensor?
- what materials and containers can it sense the heat through?

Rather than data handling, this activity provides opportunities to discuss and calculate differences in temperature.

Reflection

A recent NCETM report, Mathematics and Digital Technologies: A Report, NCETM 2010, recommends that primary mathematics teachers should be able to use digital technologies to:

- log simple data using appropriate data-logging equipment
- take learners outside to investigate contexts in which mathematical learning can take place, as well as collect evidence that can be used back in the classroom to help solve a particular problem.

Consider how the activities here might develop the way children learn mathematics in your setting. Who is able to access data logging devices in your setting and what are the resources used for? Exploring the sensors, some children in Year 1 were keen to investigate:

- "I'll stick it in my mouth to see how hot I am."
- "I'll put my music on and see how loud it would go and how low!"
- "I'll put it on some paper to see how bright it is."

Consider what mathematical concepts, skills and vocabulary could be developed by following these lines of enquiry.

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