Secondary Magazine Issue 55

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 55 of the Secondary Magazine. As the countdown to Easter continues, we hope this issue will give you some mental exercise as you prepare for the imminent chocolate onslaught!

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From the editor – Eureka moments

I've just been listening to Just a Minute – the Radio 4 programme where participants have to talk for a minute without hesitation, repetition or deviation. The programme, which is introduced by Chopin's Minute Waltz (which sounds like a five-minute dirge when I play it), always makes me smile. This week's episode featured the fantastic Graham Norton for whom the subject on the card was 'Eureka moments'.

After several interruptions, the name of Archimedes was mentioned. Archimedes lived from 287–212BC in Syracuse, a Greek colony on the east coast of Sicily. Legend has it that the King asked Archimedes to help solve the problem of whether his crown was pure gold or a mixture of gold and silver. Archimedes, upon getting into his bath, realised that equal weights of gold and silver are no longer equal when weighed in water so he jumped out of the bath and ran naked through the streets shouting 'Eureka!' (I have found it).

Wikipedia states that:

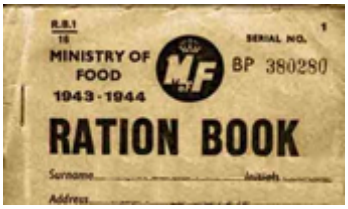
> *"Archimedes is generally considered to be the greatest mathematician of antiquity and one of the greatest of all time. He used the method of exhaustion to calculate the area under the arc of a parabola with the summation of an infinite series, and gave a remarkably accurate approximation of pi. He also defined the spiral bearing his name, formulas for the volumes of surfaces of revolution and an ingenious system for expressing very large numbers."*

Archimedes was killed by a Roman soldier. When the Romans attacked Sicily, Archimedes was working on a geometric problem in the sand and did not notice the soldier who killed him, against orders, because Archimedes did not give him due deference.

This set me thinking about my 'Eureka moments'. I can remember my first year of teaching – I had a top set in Year 9 and had to start teaching them trig. As I did some research into the best ways of introducing the topic, I think I had a 'Eureka moment'. I had always been able to 'do' trig – sine, cosine, trig identities were part of my mathematical language – but all of a sudden I suddenly understood why it all worked, and at the same time realised that I hadn't understood it previously.

Richard Skemp would have described my newly acquired understanding as 'relational understanding' and my previous mastery of the techniques as instrumental understanding.

I'm not sure what Graham Norton would make of these understandings, but why not share some of your Eureka moments with us here?



Up2d8 Maths

The fortnightly Up2d8 Maths resources explore a range of mathematical themes in a topical context. The resource is not intended to be a set of instructions but rather a framework which you can personalise to fit your classroom and your learners.

Has the food we eat ever been more analysed than in the present day? Do you consider organic or air miles? Do you shop locally? Are you a part of the slow food movement? Is your favourite take-away a curry, a pizza or fish and chips? The food options open to us at the moment seem almost endless but it hasn't always been this way. This year sees the 70th anniversary of the introduction of food rationing. An anniversary being marked by various television and radio shows as well as an exhibition at the Imperial War Museum.

This resource uses the context of rationing to explore how our shopping habits and the food we eat has changed over time and, in doing so, will allow students the opportunity to use proportional reasoning to compare and represent data graphically.

The activity gives students the opportunity to compare data and trends over time and to represent this graphically. In doing this, they will also explore proportional changes. Students are introduced to food rationing and are first asked to consider how this compares to their own diet. Students are also introduced to the National Food Survey and are asked to construct their own chart of the changes to the national diet through time.

This resource is not year group specific and so will need to be read through and possibly adapted before use. The way in which you choose to use the resource will enable your learners to access some of the Key Processes from the Key Stage 3 Programme of Study.

Download this Up2d8 Maths resource - in PowerPoint format

Download this Up2d8 Maths resource - in PDF format

The Interview

Name: Jenni Back

About you: I trained as a secondary mathematics teacher with Bob Burn and Hilary Shuard at Homerton College, Cambridge, a very long time ago. I then taught mathematics in secondary schools up and down England before taking a career break to have children. After that, I helped out in mathematics classrooms in primary schools, first of all as a parent helper and then as part of the research for my PhD. I started off looking at explanations in maths lessons and ended up getting interested in the social and mathematical aspects of talk in maths classrooms. Since then, I worked for NRICH as their primary co-ordinator for several years, then I helped train primary teachers to teach maths at Middlesex University. More recently, I worked as a researcher for the NCETM on the Researching Effective CPD in Mathematics Education (RECME) project, and am now working with teachers in primary and secondary schools to support them in developing professionally as teachers of mathematics.

The most recent use of mathematics in your job was…I work with teachers a lot but also teach mathematics to children, so last week I was teaching children how to tell the time using 12-hour, 24-hour and analogue clocks. I was amazed at the complexities involved in reading the scales in all the different representations, let alone expressions like '5 to 4' or '25 past 6'.

Some mathematics that amazed you is…Looking at the possible extension of ideas about regular polygons to polygons with sides that are not whole numbers. Try creating a polygon with two and a half sides using the usual rules about the external angles – great fun, a huge surprise to me and accessible to fairly young mathematicians.

Why mathematics? Because you can work it out and don't have to take too much on trust or remember loads of facts and information.

Your favourite/most significant mathematics-related anecdote is…When I was collecting data for my PhD I was observing a lesson about the factors and multiples of large numbers with a class of eight- and nine-year olds. There had been some discussion about whether a number which had a factor of eight would also have a factor of four and one child had made the statement that if a number had a factor of eight then it must have a factor of four and he said 'because four is a factor of eight'. A little later in the lesson a number was identified with a factor of 6 and one of the other children went on to suggest that it must have a factor of 3 'because 3 is a factor of 6'. I was struck both by the echoing of the pattern of words and by the generalising of the rule. It was good to see some evidence of mathematical thinking.
Another example was where one child, whose response to being asked in class what maths was like, said: "It's like Marmite, you either love it or hate it!" I just wish we could increase the numbers of people who love it.

A maths joke that makes you laugh is…Why did 10 run away from 7? Because 7 8 9.

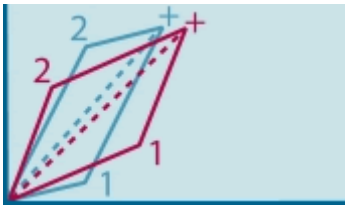
Something else that makes you laugh is…Gavin and Stacey, especially the first series.

Your favourite television programme is…QI.

Your favourite ice-cream flavour is…Pistachio.

Who inspired you? Hilary Shuard and Mike Askew.

If you weren't doing this job you would…be walking in the hills or mountains.



Focus on…averages

- According to the Oxford English Dictionary, the earliest usage of the word 'average' appears to be in the context of a legal term for a tenant's day labour obligation to a sheriff. From around 1500, the word was used to mean 'damage sustained at sea'. Wikipedia says: "The law of general average is a legal principle of maritime law according to which all parties in a sea venture proportionally share any losses resulting from a voluntary sacrifice of part of the ship or cargo to save the whole in an emergency."

- What does 'the mean' mean? In this As the Bell Goes audio reflection Nat Parnell, a teacher in Devon, asks his classes to think of a definition for themselves.

- Simpson's Paradox states that *It is not necessarily true that averaging the averages of different populations gives the average of the combined population*.

  The Stanford Encyclopaedia of Philosophy gives the following description, loosely based on a discrimination suit that was brought against the University of California, Berkeley: *"Suppose that a University is trying to discriminate in favour of women when hiring staff. It advertises positions in the Department of History and in the Department of Geography, and only those departments. Five men apply for the positions in History and one is hired, and eight women apply and two are hired. The success rate for men is twenty percent, and the success rate for women is twenty-five percent. The History Department has favoured women over men. In the Geography Department eight men apply and six are hired, and five women apply and four are hired. The success rate for men is seventy-five percent and for women it is eighty percent. The Geography Department has favoured women over men. Yet across the University as a whole, 13 men and 13 women applied for jobs, and 7 men and 6 women were hired. The success rate for male applicants is greater than the success rate for female applicants.*

	Men		***Women***
History	*1/5*	*<*	*2/8*
Geography	*6/8*	*<*	*4/5*
University	*7/13*	*>*	*6/13*

  How can it be that each Department favours women applicants, and yet overall men fare better than women? There is a 'bias in the sampling', but it is not easy to see exactly where this bias arises. There were 13 male and 13 female applicants: equal sample sizes for both groups. Geography and History had 13 applicants each: equal sample sizes again. Nor does the trouble lie in the fact that the samples are small: multiply all the numbers by 1000 and the puzzle remains. Then the reversal of inequalities becomes fairly robust: you can add or subtract quite a few from each of those thousands without disturbing the Simpson's Reversal."

  You might find that this vector diagram helps with the visualisation of the problem, and there's a description of some of the issues raised by the paradox in this article from the Wall Street Journal.

- 'The average…' is a phrase often used by the media. For example, did you know that:

    - in 1991 the average house in England had 5.33 rooms and 2.36 people lived there
    - the average family sofa sees 293 spats, 1 369 cuddles and 1 600 spillages during its eight-year life, according to a UK survey
    - the average family spends £459 per week
    - the average family income is £32 779 before tax
    - the average cost of raising a child is nearly £200 000
    - the average child gets £6.84 a week in pocket money
    - the average woman spends £189 a year on toiletries, hair products and creams
    - the average driver thinks that they are better than the average driver.

- Do you find your class don't remember the label to attach to each type of average? Do you remember this rhyme from a few issues ago?

    Hey diddle diddle the **Median**'s the ***middle***,
    You add then divide for the **Mean**,
    The **Mode** is the one you see the most,
    And the **Range** is the difference between.

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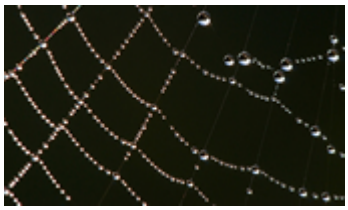

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An idea for the classroom – substitution

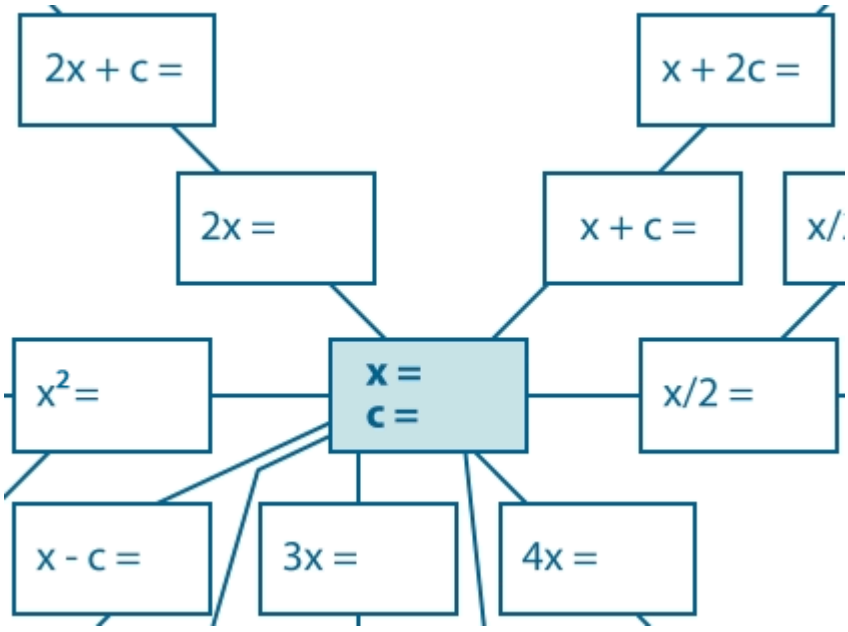
As the Year 11 countdown continues, I have gone through the mock examination and identified some curricular targets for my Year 11 group. Year 11 do not seem very confident with certain aspects of algebra – and when this is combined with some negative numbers the difficulties are certainly compounded.

A favourite starter is to display the numbers from 1 to 20 (usually accompanied by 'are we having a test?') then to give pupils three values like a = 1, b = 2, c = 5. Pupils then have to make up an algebraic expression for each of the numbers. In this case it may look like this:

$1 = a$
$2 = b$
$3 = a + b$
$4 = b^2$
$5 = c$
$6 = c + a$
$7 = c + b$
$8 = bc - b$
$9 = (a + b)^2$
$10 = bc$
…

As pupils get used to the format of this starter (which can be repeated frequently with different values for a, b, c etc.) one of the values can be defined as a negative number to give pupils more experience of this area of difficulty.

I felt we needed an intermediate step between this starter and a full-on exam question, so I asked pupils to tackle a spider diagram like this:



A Department for Children, Schools and Families initiative to enhance professional development across mathematics teaching

The first time, I chose some 'nice' values of x and c. Having made sure that pupils felt comfortable with the idea I chose some less comfortable values which included a negative value for c. Then we were ready for some exam questions – no problem!

Have you got some good ideas to build up pupil confidence with substitution activities? Why not tell us about them here?

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5 things to do this fortnight

- As part of the ongoing work to support the Learning and Skills Sector, the LSIS STEM Programme is once again running free network events in science, mathematics and engineering during the spring term. These networks are designed to enhance teaching practice, increase individual subject expertise and support colleagues across the post-16 sector and are open to delegates with an interest in STEM from all LSC-funded, post-16 learning providers. Mathematics events started in Leeds on 11 March and are taking place across the country.

- From the 11 to 13 April, Durham University is hosting an exciting and innovative Conference for Teachers of Mathematics. The main aims of this conference are to:
    - support professional development by providing enhanced knowledge and practical resources to take back into the classroom
    - enthuse and encourage teachers by providing sessions led by experts in their respective fields
    - inform teachers of the latest developments and innovations in teaching
    - empower teachers to give their students the best possible guidance and support when considering higher education.

  This conference is open to all mathematics teachers looking to further their knowledge and will be of most benefit to those teaching at A-level, but those teaching at GCSE level are also more than welcome to apply.

- The Institute of Mathematics is holding a major one-day conference Mathematics and its applications for the present day on 22 April 2010 at Saddlers' Hall, London.
  The aim of the conference is to bring together people with an interest in mathematics and its applications to consider current issues in the subject. The conference will cover research topics in mathematics; public understanding of mathematics and industrial applications of mathematics. These topics will be of interest to both mathematicians and those working with mathematicians as the presentations will address the impact of the work rather than emphasise its technical nature.

- As this year's GCSE exams draw ever closer, your thoughts might be turning to how things will be different with the introduction of functional skills next year. QCDA has just produced a pilot pack for those schools involved in the final year of the pilot. Essential reading if this is you, but interesting reading if you know it's coming your way soon!

- There's lots happening to distract you over the next couple of weeks. Easter, the Boat Race, and the Grand National, but surely these all pale alongside the Hare Pie Scramble and Bottle Kicking taking place in Hallaton, Leicestershire, on Easter Monday.

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Diary of a subject leader

Real issues in the life of a fictional Subject Leader

I've just marked another mock paper for Year 11. This time I only made them do the calculator paper. Well, I was under the impression that all too frequently our students reach for the calculator rather than working it out themselves. Industry and the world of business seem to frequently complain that students cannot perform basic routine calculations without reaching for the calc. – how wrong could I be?

Why is it that on a 'dividing in a given ratio' question I saw a column of seven £2.40s neatly lined up and a fairly organised and accurate classic column addition executed! (I never see this on the non calc paper!) Ah, you say, they may not have a calculator. Well, I gave them all one at the start of the exam. They can be a little light-fingered, but surely not on their own doorstep as it were...

When I spoke to the author of the seven £2.40s I discovered she just didn't really get the idea of repeated addition being multiplication. When I pushed a bit further and just said, "Why did you not just use the calculator to add up the £2.40?" she suggested that the calculator may not always tell the truth. I started on some questioning about truth only being a particular perspective on reality and that it was perfectly possible that the calculator's reality was its truth and her truth was hers. But, in truth, I was well out of my depth!

We checked that if the question had been 23 x 34 she could type that in and get the answer -"Derr! Yeh, that's what they is for..." I asked if she ever used a calculator in class? "Nope, I has a phone." Then I said, "But I don't let you use your phone in the lesson..." "Well that's why I do it in my head..." She was beginning to do my head in!

This particular girl was far from alone in terms of hesitance or even reticence about using the calculator. There was something in her 'lack of familiarity' with having a calculator to hand. Looking at all the papers, there was also something about a lack of formal methods throughout the papers. If that perception is true, should I worry?

I've 'taught' the group for eighteen months, although it may be fairer to say I've 'learnt' the group for 18 months. Only in the last few weeks have we been able to get to a point where I can reasonably deliver an explanation or method without so much interruption that the whole exercise is not rendered pointless. So in reality, I have used a fair bit of problem solving and learning through activity. And, although I normally get students working in pairs or fours, rarely can I devote more than sixty seconds on a particular group before needing to move on to the next, to keep students on task and in the room. I have not been allowed the opportunity to teach formal methods. That has annoyed me and I believe it will impact on our results. Nonetheless, in terms of solving a mathematical problem that involves calculation, students are not incapable. I now question, is that not what I want?

Functioning mathematically requires students to be able to apply mathematics and mathematical strategies to resolve issues or solve problems that they confront. However, because we need to assess that in an exam, I fear that we want them to be functional – but we will need to tell them how to 'function' correctly. Functioning that works may not be sufficient, they may need to function 'our way'. It reminds me of a conversation with another mathematics teacher about whether problem solving can be 'taught' in a similar way to – say trig. If we teach 'problem solving' as a topic of content rather than it being a process of our learning across topics, can we say that students are able to problem-solve? Or, can they just solve problems of the type we have taught them...?

When I shared all this with my team, they just gave me that look. When my smile showed it was OK not to be too serious, one just said, “They can’t use their calculator to add? How **** dysfunctional is that?”