Secondary Magazine Issue 35

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 35 of the Secondary Magazine. Are you making the most of the long summer evenings? How will you use your time now Year 11 have nearly disappeared? We hope this edition will give you some things to interest and engage you at this lovely time of year.

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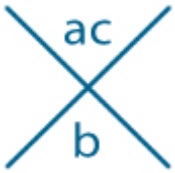
From the editor

I saw something new last week. As I walked around a high school in the USA, students up and down the corridor were consistently using the same process to factorise expressions. Students were being asked to factorise (and solve) the expression $n^2 + n - 12 = 0$. The first thing they did was to draw an X and put in some numbers. If the expression was expressed as $an^2 + bn + c = o$, then:



so the X for our expression could be:

The next step was to find a pair of numbers whose sum was b and whose product was ac which for our example would be:

Students then re-wrote their initial expression by splitting the 'n' term according to their new numbers, $n^2 + 4n - 3n - 12 = 0$, which enabled them to use a 'box' method to factorise, similar to our grid method for multiplication, reversed:

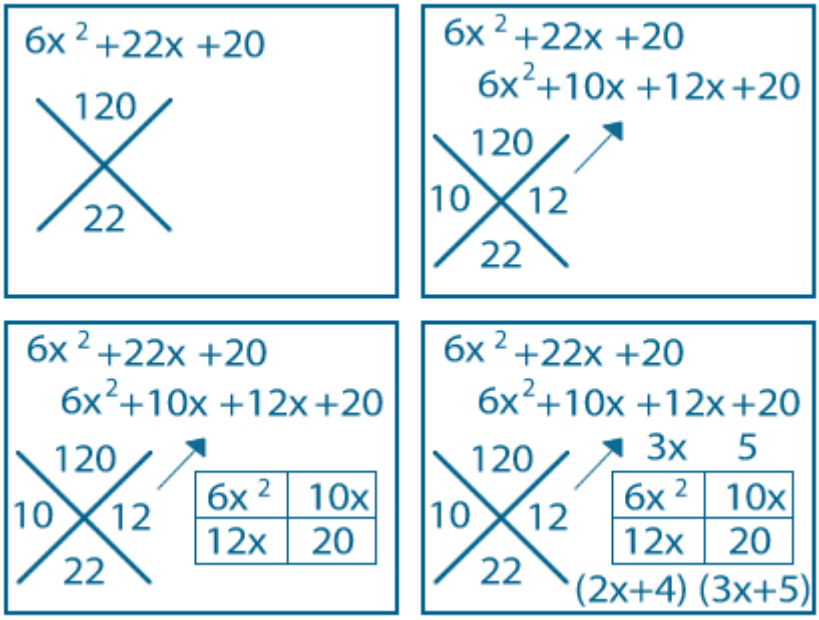
	n^2	$4n$
	$-3n$	-12

	n	$+4$
n	n^2	$4n$
-3	$-3n$	-12

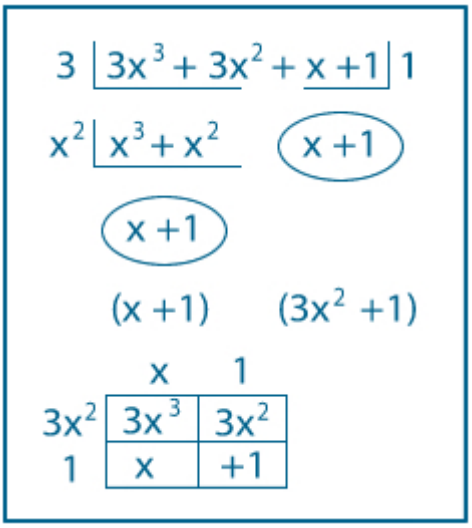
So $n^2 + 4n - 3n - 12 = 0$ and $(n + 4)(n - 3) = 0$

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

Let's follow this through for a more complex example:



This 'box' was also used to factorise higher order polynomials:



I thought this was quite a neat trick. It helped low ability pupils to perform complex algebraic manipulations. I'm sure I will use it in my classroom.

As I flew back to the UK on Saturday night, I continued to think about this experience more (I had plenty of time with a crowded overnight flight!). Every teacher in the school followed a common approach to factorising; the school had given each pupil a flow chart to structure their approach. They had taken every possible step to enable pupils to learn and perform an algorithm.

There are plenty of times in our schools when identifying common approaches would be beneficial to our students. How does your department teach percentages? Do you all always identify 1% and then build up from there? Do you use parallel number lines so that pupils have an image of the equivalences between fractions, decimals and percentages? What about dividing fractions – how do you explain the 'turn upside down and multiply' algorithm? What about algebra? What sort of image do your pupils have for variables? Has your department agreed to eliminate 'fruit salad' algebra (a = apple, b = banana, etc.)? How do your pupils solve equations? I could go on…

Perhaps it would be helpful to categorise the things in that list? Some of them are images that can help pupils construct an understanding, some of them are ways of doing things (or not). Perhaps we should decide which list the common approach would benefit most. And then I start to ask myself: do pupils all need the same image of algebra say, or would it be helpful for them to have a range of images to use in different situations and allow access for different sorts of learner? If pupils had a range of images and experiences of variables and how they might behave, then they might have different ways of solving equations and not need to resort to the same algorithm…

Funny how one thing leads to another. What do you think?

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.

On 4 June, Great Britain held its elections for the European Parliament – the other countries in Europe held their elections over the subsequent weekend in accordance with their own polling conventions. Each country in Europe has been able to choose its own method of seat allocation with the proviso that the MEPs must be elected using a form of proportional representation. How has Great Britain chosen to do this? Pupils are invited to consider how the votes of people in the UK are allocated to the European Parliament seats. They can then work out the allocation of seats for their region. So if you were standing as an MEP, what is the smallest proportion of the vote that would guarantee you a seat? Is it 100/n % where n is the number of seats allocated in your region, or is it more complicated than that?

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.

Click here to download the Up2d8 maths resource - in PowerPoint format.

The Interview

Name: Steve Lomax

About you: Gloucestershire Mathematics Manager

The most recent use of mathematics in your job was... to challenge some 'interesting' comparator statements made from data analysis based solely on percentages without any working knowledge of the actual numbers involved.

Some mathematics that amazed you is...

- meeting the concept of Pi as a pupil
- cutting a Mobius strip divided into thirds
- more recently, solving the NRICH Crossing the Bridge puzzle in 17 minutes.

Why mathematics? It is something I have always enjoyed and been fascinated by from an early age – simple as that I'm afraid!

Your favourite/most significant mathematics-related anecdote is… One key moment in my teaching career was when I picked up a high performing A2 class in Y13 (mostly KS3 L8, GCSE A* etc.). I had been teaching for about 11 years and my style had become very much in the line of using collaborative activities involving as many misconceptions and cognitive conflicts as possible to challenge understanding. Initially, some of the 'more able' students in the class clearly didn't like the approach as it was potentially the first time they had experienced 'being stuck' in a maths lessons and they had limited strategies as learners to deal with the situation. Through further investigation I found out that the students had mainly experienced KS3 and KS4 maths lessons following the 'Triple X' teaching method (eXposition, eXample, eXercise). This experience emphasised how important it is to explicitly address metacognition and the emotional and social side of learning mathematics, rather than simply passing on knowledge to the next group of students.

A maths joke that makes you laugh is… What did zero say to eight? Nice belt!

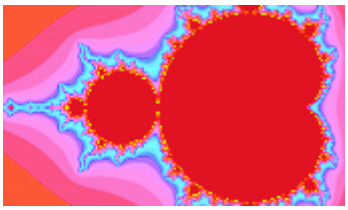
Something else that makes you laugh is… Tommy Cooper

Your favourite television programme is… Spooks

Your favourite ice-cream flavour is… raspberry ripple

Who inspired you? Some brilliant teachers at school – especially my physics teacher, Mr Parkinson, who made me believe I could study mathematics to a higher level – and my granddad, who taught me to play the piano simply for the love of it rather than passing graded examinations.

If you weren't doing this job you would… travel as much as possible with my family.



Focus on... $\sqrt{-1}$

Complex numbers were first used in the 16th century when the Italian mathematician Girolamo Cardano published Ars Magna. In this he was the first mathematician to give an algebraic solution to the general cubic equation $x^3 + ax^2 + bx + c = 0$ by substituting x for x-⅓ a and thus reducing the original to the depressed cubic $x^3 + px + q = 0$. Cardano used a technique which he was shown by Niccolo Fontana to solve any depressed cubic, finding the root at:

$$x = \sqrt[3]{\frac{-q}{2} + \sqrt{\frac{q^2}{4} + \frac{p^3}{27}}} + \sqrt[3]{\frac{-q}{2} - \sqrt{\frac{q^2}{4} + \frac{p^3}{27}}}$$

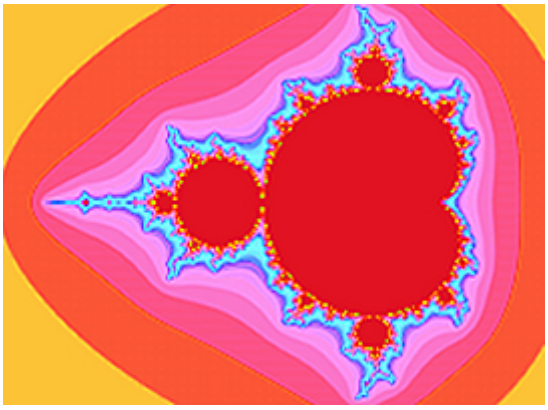
This work was built on by Rafael Bombelli in 1572 when solving a depressed cubic such as $x^3 - 15X - 4 = 0$ which, using Cardano's method, requires calculation of $\sqrt{-121}$. Bombelli knew that this equation had real roots and after what he called a 'wild thought', gave a purpose and a consistency to $\sqrt{-1}$, a concept that, until that point, mathematicians had been happy to ignore! You can read more about the beginning of complex numbers on the University of North Dakota website.

"One thing puzzles me Betty," mused John. "Where does 'i' go on the number line?"
A quizzical look came over Betty's face. They tried putting it in all sorts of places on the number line but it just didn't fit. No matter where they placed 'i' it was different to the number that was already there.
(from John and Betty's Journey into Complex Numbers by Matt Bower).

Descartes was the first to use the term imaginary number in 1637, but they were not widely accepted by the mathematics community until the work of Euler and Gauss in the 1700s.

The Mandelbrot Set is the set obtained from the iterative equation $z_{n+1} = z_n^2 + c$ where c is in the complex plane. A complex number is in the Mandelbrot Set if, when $z_0 = 0$, z_n never becomes greater than a given number (dependant on c).

The Mandelbrot Set below (from Wolfram Mathworld) shows the values of c in the complex pane coloured according to the number of steps required to reach $r_{max} + 2$:



In The Da Vinci Code, the character Robert Langdon jokes that Sophie Neveu "believes in the imaginary number *i* because it helps her break code".

De Moivre, whose formula links trigonometry and complex numbers, is said to have predicted the date of his own death. He noted that he was sleeping for 15 minutes longer each day and hypothesised that he would die on 27 November 1754, the day in which he calculated he would sleep for 24 hours. He was right!

An idea for the classroom

Watching an aspiring AST last week, the advantages of the technological age were apparent in the classroom. The teacher had carefully prepared her lesson using her laptop, which could be projected onto the Interactive White Board in the classroom. Pupils could watch a dynamic image of the enlargement of a shape and begin to develop an intuitive feel for enlargement before putting pen to paper.

Inspired by this experience, and wanting to make sure that I was using the available technology appropriately, I started to browse YouTube and happened upon an old favourite which I had not used since my video player chewed its last tape: *Donald in Mathmagic Land*. Once your ears are tuned in to Donald's particular form of quacking, you are transported to a land where the trees have square roots and the streams flow number sequences. The original film has been split into three parts (download part 1; part 2; part 3).

Donald puts his own spin on a variety of topics including the Pythagoreans, the Golden Section, playing musical instruments, snooker etc.

I know pupils will not be so readily engaged by this film as they might have been when it was made in 1959, but there are some lovely snippets to use:

- history of mathematics talking, especially the Pythagoreans (*Recognising the rich historical and cultural roots of mathematics*)
- linking mathematics and music using frequencies (you may also want to explore one of the case studies in the NCETM secondary module) (*Understanding that mathematics is used as a tool in a wide range of contexts*)
- games, including snooker, chess and baseball (*Work on problems that arise in other subjects and in contexts beyond the school*)
- images of shapes (*Mathematics is a creative discipline*)
  (*quotes from the QCA Key Stage 3 programme of study*).

I hope you enjoy re-viewing Donald Duck as much as I did!

5 things to do this fortnight

- On **11 June** at the Science Learning Centre, Keele University KS3, there's a conference Subjects Working Together, Embracing the Big Picture which should be an exciting and informative day for you and your colleagues to:

    - explore the challenges presented by the new KS3 Curriculum in the context of STEM
    - share good practice and network with colleagues
    - begin to explore ways of introducing new ideas into the curriculum
    - have the opportunity to look at a range of resources available for STEM teachers.

  The conference will consider strategies for teaching and learning across STEM subjects and vehicles for collaboration. Through exploring active examples of exciting and effective collaboration in a range of workshops and examining a range of human, organisational and practical resources, we hope that you will return to school invigorated and enthused, equipped with ideas for cross-curricular projects and approaches.

- There are two BEAM conferences coming up. The first of these takes place at the Holland House Hotel, Bristol, on 12 June, the second at King's College, London on 19 June. These conferences are aimed at teachers of primary mathematics but the ideas and challenges discussed will resonate with all who teach mathematics. Keynote speakers in the morning are Anne Watson and Sue Gifford, and workshops for the afternoon include Mike Askew sharing lessons from international research.

- The inaugural conference Dyscalculia and Maths Learning Difficulties is being held on **19 June** at the Holiday Inn, Bloomsbury. This conference brings together four of the top experts in dyscalculia and maths learning difficulties to give a broad overview of the current state of knowledge of theory and practice in this vital, but under-researched field.

- The deadline for applications for the NRICH Teacher Inspiration Programme is **29 June**. Make sure you get your application in for these free professional development day courses, which start in October.

- Count the maths jokes in this video, then maybe you and your department could try to write and perform something! Department meetings might never be the same again!

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Diary of a subject leader

Real issues in the life of a fictional Subject Leader

Within the last month, my trusted second in department announced her success in securing a promotion to a neighbouring school. I was very pleased for her. Her qualities and experience had been recognised and she was certainly ready to run her own department. However, part of me was devastated. I had lost a valuable colleague who would be difficult to replace.

Time was short and deadlines were approaching. Due to her relatively late appointment in the year, the school needed to act fast in advertising the vacant post. So what credentials did I expect and want the successful applicant to have? Up to now, I had taken my second in department's qualities and flair for granted. An identical replacement may not exist and upon reflection, I would prefer them to bring equally good but different qualities to the department.

While writing the mandatory job description, I contemplated the similarities and differences between a key stage coordinator and a second in department. Was there a difference and if so, what exactly was it?

My image of a key stage coordinator is a manager of systems, someone who organises the admin tasks, the assessments, exam entries and who acts as the initial buffer between me and any issues that may arise. A second in department however must deputise and be capable of running things in my absence. They must be ambitious, forward thinking and possess leadership qualities. So are they the same job? Is one a manager and one a leader? Am I really looking for someone who possesses both sets of qualities? Are my expectations unrealistic?

I read my own job description for guidance. The first bullet point described my responsibility in evaluating, sustaining and developing teaching and learning standards. This was surely applicable not only to post holders but to all teachers. The second bullet point outlined the need for a vision in deciding the strategic direction and development of the subject itself. As I strongly believe in a shared vision, I would expect all staff to contribute to a greater or lesser degree. The third bullet point highlighted the need to remain up to date with educational developments, both within and beyond maths. This linked in with the fourth, concerned with the effective leadership and management of staff. Suddenly the job was not just about good teaching but more concerned with the maximising of opportunities and available resources, including the staff. This went beyond oiling the wheels and basic admin duties. It included the effective management of people.

Yet I must be realistic. I am unlikely to find someone who has all these qualities on day one. Nevertheless, I will be looking for someone whom I believe has the potential to run a department and who demonstrates commitment, organisation and flair. I know people with these qualities exist, but will they apply?