Secondary Magazine Issue 62

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 62 of the Secondary Magazine.

Contents

Contributors to this issue include: Hazel Kendrick, Sue Madgwick, Mary Pardoe, Peter Ransom and Dylan Wiliam.

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From the editor

The NCETM portal contains many resources that can support us in working with colleagues to achieve professional growth. For example, there are currently 42 secondary departmental workshops to structure and guide our explorations together of particular themes and ideas.

But interacting professionally with one another may not be as straightforward as it seems.

In 1988, David Sturgess drew on his great experience as a facilitator of professional development when he wrote, for the ATM, *Working Together – Facilitating professional growth in teacher groups*. In this book David discussed many factors that may increase or decrease the effectiveness of our efforts to communicate with each other about our teaching.

For example, on the very first page he reminds us of an essential aspect of communication:

"In any conversation that I have with another person there can be four communications taking place at the same time.

What I say.
What I think I mean by what I say.
What you think I say.
What you think I mean by what I say."

David goes on to ask questions, exemplified by reports of incidences and activities, about what may be going on when we are trying to work together on issues. We are led to reflect on what it is helpful to bear in mind, and for which we can try to allow or compensate.

Do we, for example, always bear in mind the following consequences of being human?

- The aim of an effective professional development group activity is not to reach a conclusion that can be recorded, but to help people to become aware of what they themselves want to achieve.
- Teaching is a very complex task – we cannot expect to solve all the problems – but to become clearer about what they are.
- Each teacher has to work from his or her own past experience, and so needs opportunities to reflect on it, and on what can be learnt from it.
- It is not helpful to professional growth if a task, focusing for example, on curriculum content or transfer between key stages, is regarded as an end in itself. Success depends on the extent to which participants increase their understanding of what they are each capable of achieving as a teacher.

Working together to improve our teaching is a complex human activity, which is partly what makes it so interesting. Perhaps, as the school year moves towards an end and teaching loads lighten, we will find more time to reflect together on ideas and experiences.

You will find many starting points on the portal. You might find some in this issue of the magazine.

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It's in the News!
Oil Spill

The fortnightly *It's in the News!* 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 20 April 2010, there was an explosion at a drilling rig in the Gulf of Mexico. Oil has been flowing into the sea for more than 50 days. This is now the worst oil spill in history – surpassing the 11 million gallons that flowed from the Exxon Valdez in 1989.

This resource uses the context of the recent oil spill in the United States to pose questions for students to work on. Firstly, students are asked to consider the size of a barrel of oil and then they are asked to think about the amount of oil that is leaking out each day and the area this amount of oil would cover on the surface of the sea.

The activity asks students to get an understanding of the size of a barrel of oil and gives some equivalent facts to aid their understanding. Students are then asked to consider how much oil is still leaking from the drilling rig and what area this might cover on the sea.

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

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The Interview

Name: Dylan Wiliam

About you: I taught mathematics, physics, and for one year, English, in schools in London in the late 1970s and early 1980s, and then joined Chelsea College (which later merged with King's College London) to work on a project called "Graded Assessment in Mathematics".
I am, for the next few months at least, Deputy Director of the Institute of Education, University of London. Before that, I was Senior Research Director at the Educational Testing Service, Princeton, NJ, Assistant Principal of King's College London, and before that, a mathematics teacher in Shepherd's Bush and Paddington. In September, I will retire from full-time work, and concentrate on writing, and working more closely with teachers and schools than is possible as a full-time academic, or university administrator.

The most recent use of mathematics in my job was: estimating the relationship of standard deviations of teacher quality to standard deviations of student progress (the answer is somewhere between 0.1 and 0.2). It is, I think, one of the most important numbers I have ever come across.

Some mathematics that amazed you is: the fact that some infinite sequences can be summed in a different order to produce a different sum, so that addition is not necessarily commutative!

Why mathematics?
When I was 14, I thought I wanted to be a chemist, but I found that I was enjoying mathematics more and more. Then I discovered that in the sixth form, you could do double mathematics, physics, and nothing else. I was hooked!

A significant mathematics-related incident in my life was: I remember Douglas Quadling once telling me that he had managed to design an "angle-poise" lamp-stand that requires only a single spring (the classic design has two or three). I remember spending weeks puzzling over this, trying out ideas, and eventually coming up with a way of doing it. Another incident that I can remember clearly was related to a question that came up in a class I was teaching: which numbers can be expressed as the sum of two squares? I spent several months of Sunday afternoons working on this, and when I finally cracked it, for the first time in my life, I discovered where the phrase "walking on air" came from.

A mathematics joke that makes you laugh is: There are two people in a room. Five of them leave. How many people need to arrive before the room is empty?

The best book you have ever read is…impossible to pin down. My favourite fiction books tend to have a strong sense of place, such as Peter Høeg's *Miss Smilla's Feeling for Snow*, David Guterson's *Snow Falling on Cedars*, Graham Swift's *Waterland* or E. Annie Proulx's *The Shipping News*. Having said that, if I had to choose just one, it would be Jorge Luis Borges' *Fictions*. It is probably the only book that I have read that I will read again.

Who inspired you?
Alan Chisnall, my mathematics teacher at Altrincham Grammar School, and then Margaret Brown and Paul Black, at King's College London. They have been the most significant intellectual influences on my life.

If you weren't doing this job you would: be a not very good musician, a passable joiner, or go back to being a mathematics teacher (I still miss it).

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Focus on…Martin Gardner

Martin Gardner
21 October 1914 - 22 May 2010

"Martin turned thousands of children into mathematicians, and thousands of mathematicians into children."
Professor Ronald Graham, University of California

In addition to creating, for 25 years between 1956 and 1981, the Mathematical Games column in *Scientific American*, Martin Gardner wrote more than 65 books and many other articles about mathematics, magic, philosophy, literature and science.

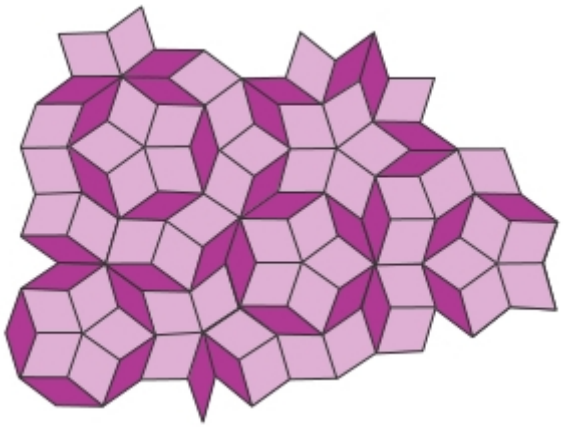
By playing in his mind with ideas that amazed him, and then communicating his delight to the world, Martin has fascinated, enlightened and inspired millions of people.

In the December 1995 issue of Scientific American, Martin told readers that he missed doing the column *'because I met a lot of famous mathematicians through it'*.

He helped to establish in the public mind many notable people and ideas.

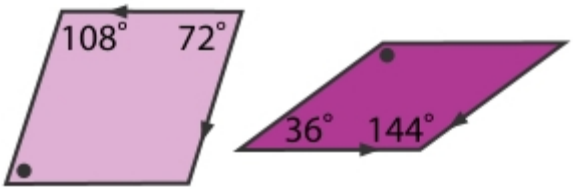
- For example, Martin's enthusiastic reporting of a finding by Roger Penrose, who is now Professor Sir Roger Penrose of the Mathematical Institute at the University of Oxford, that tiles can coat a plane without ever repeating the same pattern (available on YouTube in two parts, one and two) helped to introduce the world to Roger's ideas.

  Your students may enjoy creating a Penrose non-periodic tiling such as this:



  using these rhombus tiles, and following these rules:

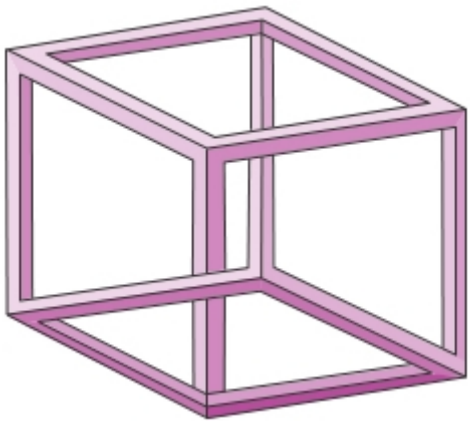
  Two adjacent edges must have arrows pointing in the same direction, or no arrows at all. Two adjacent vertices must both be marked (with a circle), or both be unmarked.



- An article that Martin wrote in 1957, and which he later included in his Mathematical Puzzles and Diversions (1959), first popularised pentominoes, and led eventually to the founding of Kadon Enterprises. Students will find some interesting challenges and activities at the pentomino website and at the University of Plymouth's Centre for Innovation in Mathematics Teaching (CIMT).

- In the October 1970 issue of *Scientific American*, Martin introduced readers to the Game of Life, invented by John Horton Conway, a British mathematician, currently professor of mathematics at Princeton University. As a result of the player setting up initial conditions, a collection of cells live, die or multiply, forming unexpected patterns as the game progresses. You can play the game on the bitstorm website.

- During 1961, Martin helped to publicise creations of the Dutch artist M.C.Escher.



In his 1995 interview in *Scientific American*, Martin said that, if he had known that Escher would become so famous, he would have bought more of his pictures!

Martin was fascinated by Escher's amazing tessellations and tilings, such as Penrose 'ghosts'. Learn more about Escher's life and work, and see many more of his ingenious tessellations and other creations by watching this short film.
In Issue 52 of the NCETM Secondary Magazine, Focus On centred on M.C.Escher.

Since his death four weeks ago, many people all over the world have been paying tribute to Martin Gardner's inspirational work:

- In this 45-minute video, Martin, and many of his friends and colleagues, and other mathematicians, demonstrate and talk about his ideas.

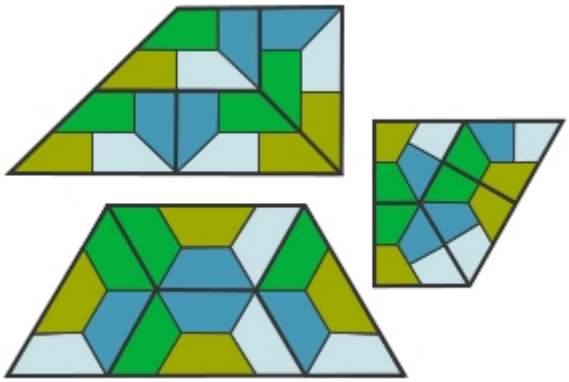
- Dr James Grime, Enigma Project Officer working for Cambridge University and the Millennium Mathematics Project, has created his own video tribute A flexagon for Martin Gardner; James, as Singingbanana, shows you how to make a flexagon.

In 1971, during my first year as a mathematics teacher, I bought a copy of Martin Gardner's Further Mathematical Diversions. As I was a very inexperienced teacher, this book was a treasured source of ideas for lessons. For example, his chapter about Rep-tiles: replicating figures on the plane, suggested explorations of shapes and angles.

Martin shows these three trapeziums as examples of rep-tiles of order 4:

Can students discover why they are called 'rep-tiles', and why they are 'of order 4'?
And what are the angles and the side-length relationships in each trapezium that enable us to fit copies together like this…?

...and then like this...?



...and so on, for ever?

Martin Gardner looked for connections between the mathematical phenomena and puzzles that intrigued him, and the magical conjuring tricks that he loved. So it is no surprise that his Rep-tiles chapter includes this image:

He writes: *'A trick playing card that is sometimes sold by street-corner pitchmen exploits this rectangle to make the ace of diamonds seem to diminish in size three times. Under cover of a hand movement the card is secretly folded in half and turned over to show a card exactly half the size of the preceding one. If each of the three smaller aces is a rectangle similar to the original, it is easy to show that only a 1-by-√2 rectangle can be used for the card.'*

- Not all Martin's books were collections of his puzzles and Scientific American articles. One of his best-selling books is The Annotated Alice, in which he analyses the mathematics behind many of Lewis Carroll's imaginative creations.

When Martin wrote, in *The Mathematical Magic Show*:
'There is still a difference between something and nothing, but it is purely geometrical and there is nothing behind the geometry', we might be forgiven for thinking that it was the Mad Hatter talking!

- The Gathering for Gardner Foundation (G4G) *'works to honor the achievements of Martin Gardner by promoting the lucid exposition of new and accessible ideas in recreational mathematics, magic, puzzles, and philosophy.'*
  The G4G biannual conferences aim to encourage the cross-discipline fertilisation of ideas between amateurs, young people, professional scholars, world-class expositors and innovative performers. The Ninth Gathering 4 Gardner (G4G9) was held in Atlanta in March, 2010. Puzzles and ideas explored at the G4G gatherings can be found on the Kadon website.

Other tributes

The Martin Gardner Interview at This Side of the Pond is a fascinating illustrated interview about his whole life. It is in five parts.

You can read another illustrated interview with Martin Gardner on the *Mathematical Association of America (MAA)* website.

Three puzzles from Martin Gardner were posted in tribute to him on 22 May on the *Scientific American* website.

There have been very many more tributes, including in these newspapers and magazines:

- The Daily Telegraph
- The Guardian
- Harry's Place
- The Independent
- Scientific American
- Time
- The Times

Following his death, Scientific American republished Martin Gardner's final article. This very interesting piece is from the August 1998 issue. In it he writes modestly:
I myself am little more than a journalist who loves mathematics and can write about it glibly. I took no math courses in college. My columns grew increasingly sophisticated as I learned more, but the key to the column's popularity was the fascinating material I was able to coax from some of the world's best mathematicians.

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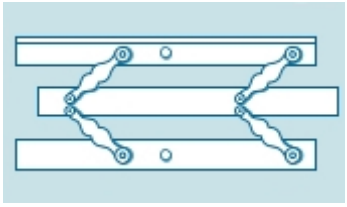


National Centre for Excellence in the Teaching of Mathematics

An idea for the classroom – making parallel rulers

Drawing instruments fascinate me. I like the cases in which they sit, and the beauty of the instruments, old or new. I use them in the classroom to motivate my students, who can experience some history of mathematics by exploring the development of the technology of the time. Making these instruments gives students a sense of achievement when they see how well they perform.

I start with an instrument that has connections with mathematics and navigation - the parallel ruler.

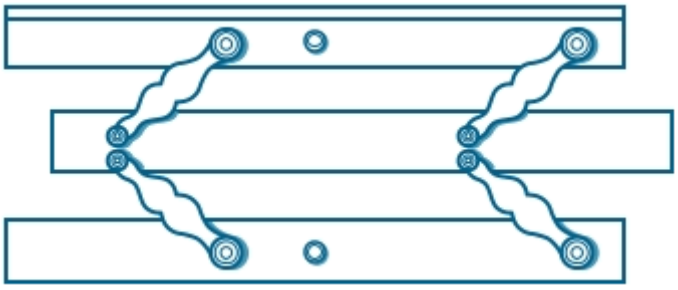
The photograph shows a large double parallel rule, a small parallel rule and one handmade from an A4 sheet of card, all placed on a sea chart showing a compass rose.

The most common parallel rulers look like two normal, usually unmarked, rulers joined with two bars of equal lengths. The smallest one I have is 6 inches long and 1 3/8 inches wide when closed. It is made of a black wood (ebony?) and joined by two brass bars. There are no markings, but there is a small brass peg in the middle of each rule, presumably to assist moving the rule. I think this one probably came from a case of several mathematical instruments. The edges of the rulers have parallel chamfers so that you can run a pen or pencil along an edge that either touches the paper or is above it.

History

By the year 1600, parallel rulers were common. The older bar types used to be made in ivory or ebony with brass, silver or electrum cross-links.

The double-barred parallel rule, illustrated below, was an improvement on the plain parallel, as the ruling edge moves a greater distance from the fixed rule, and also moves in a direct line. The difference between this and the plain parallel is the addition of an extra rule and pair of bars, which are joined at reverse inclination to the first pair. As this was more difficult to make it is seldom as true as the plain parallel.



In the classroom
I've used parallel rulers in a few ways in the classroom.

The first way was with a Year 10 class of middle-achievers when we were studying bearings.

I decided that rather than spend too much time drawing bearings from those given in a text book, I would set a lesson where the class were working in groups of 3 or 4 with real maps. I borrowed maps of the Solent area, the area around Southampton, as that area is known by my students, and asked them to plot a sailing course round the Isle of Wight.

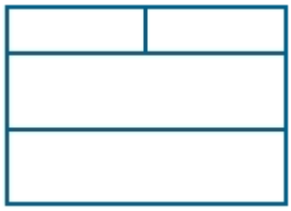
I first showed them how to use the parallel ruler to get straight lines parallel to the given north line at the side of the map – so that they could measure the bearings on which they would have to sail to get round the Isle of Wight.

The work involved measuring angles and using a scale of 1:50 000. One student, a sea-cadet, said that it was the most relevant work he had ever done in mathematics.

Making a set of parallel rulers
Sir Isaac Newton just folded a piece of paper to make a straight edge: you can challenge your students to make a set of parallel ruler from card and split pins.

Steps for success!

1. take an A4 piece of card and put it landscape format in front of you
2. draw a line 5cm from the top edge of the card
3. draw a line half way down this thin strip, perpendicular to the drawn line
4. draw a line 8cm from the bottom edge of the card. Your card should look like this:



5. cut out the four pieces and fold them all in half to make thin rectangles
6. on one side of each piece draw the long line of symmetry
7. put the two larger pieces together with the folded edges at the top and bottom
8. on one of the larger pieces, mark two points on the line of symmetry, 2cm and 17cm from the left hand edge
9. on the smaller pieces mark points on the lines of symmetry 1.5cm from each end
10. use a sharp point to make small holes on the marks you have made
11. use the fasteners to join the small pieces to the large piece already marked and holed
12. put a pencil point in the other holes on the short pieces, and locate where you need to make holes on the other large bit
13. make the holes and use the fasteners to complete the instrument

14. round off the ends of the short pieces if you wish.

I've also used parallel rulers with students in Years 7 and 8 – when we have studied parallel lines and locus.

There's something about the movement that adds dynamism to the concept of angle. The students can see the corresponding angles remaining the same, and also the alternate angles.

With locus work you can consider the locus of a point on the hinge *(what can you say about its distance from the pivot?)*, or on the moveable rule. The locus can be traced out using dynamic geometry software.

Be creative!

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Maths comes alive with 'Maths in a Box'

Every mathematics teacher will at some point have been asked by their students 'what is the point of maths?' and 'why should I carry on studying it?' Maths in a Box provides fresh ideas about ways of tackling these questions: it is a collection of electronic and paper resources, including posters, DVDs, booklets containing careers profiles – and even a book exploring some of the mathematics behind magic tricks.

The box contains more than 50 resources that aim to encourage the uptake and further study of maths and are suitable for students in key stage 3 right up to key stage 5. The materials have been tried and tested in schools all over England and Wales as part of the government-funded 'More Maths Grads' project.

Highlights of the box include a DVD featuring over 40 worksheets showing mathematics in real world contexts, and a booklet explaining the relevance of topics such as geometry and algebra.

Each maintained secondary school in England should have received a free copy of Maths in a Box at the beginning of the summer term. A similar box has also been distributed to secondary schools in Wales, with the same resources in Welsh.

In addition, the box offers teachers the opportunity to win £1 000 for their school in a prize draw. All teachers need to do is submit their feedback before 25 June 2010 via the mathscareers website.

National Project Manager, Makhan Singh, says, *"Maths in a Box is a vital resource for all maths teachers in secondary schools and FE colleges and also for university outreach departments. It shows that maths is used in a whole number of ways that school students may never have thought of. For example, it shows how geometry is linked to fighting cancer and how logarithms are used in our analysis of earthquakes. And at the same time, it shows how maths can be fun, as students will be able to perform – and understand – the magic tricks for themselves. Maths comes alive with Maths in a Box!"*

Many of the resources are also free to download from the website, and if you have any further questions about the Maths in a Box resource, please contact Hazel Kendrick.

5 things to do this fortnight

- Alan M. Turing was born in London on 23 June 1912, and died too young in 1954. During World War II he worked as a codebreaker at Bletchley Park, and was responsible for the development of modern computer science.
  You could visit Andrew Hodges' extensive website about Turing's life and work, or read Alan Turing: The Enigma by Andrew Hodges. Why not arrange a visit to Bletchley Park, where your students could explore the Enigma Machine and the Bombe. You can choose between talks about codes and ciphers, the mathematics of Enigma, and, for gifted GCSE and A level students, breaking Lorenz. You can book through the Bletchley Park website.

- The 2nd National Conference Dyscalculia & Maths Learning Difficulties 2010 takes place on Wednesday, 30 June 2010 at the Waldorf Hilton Hotel, London, where you can join experts in dyscalculia, mathematics learning difficulties and effective mathematics teaching to get a broad overview of the current state of knowledge in this field.

- Friday 2 July 2010 is NRICH Teacher Inspiration Day. The NRICH team, at the University of Cambridge, is offering this free professional development course for key stage 3, 4 and 5 mathematics teachers.

- If you live in the South West, you might like to attend the University of Plymouth Maths Teachers conference, which takes place on 9 July 2010.

- Another imminent summer conference is the annual Mathematics in Education and Industry (MEI) mathematics conference 2010. This year's conference, promising to improve your teaching while you do some interesting mathematics, will take place from 1-3 July at the University of Reading in Berkshire.

Diary of a subject leader

Issues in the life of an anonymous Subject Leader

Star Wars Day – May the Fourth be with you! – followed the bank holiday break, during what was traditionally SATs week.

We did the SATs last year, and this year used the optional Y9 tests as indicators of students' progress. The data suggests end of KS4 individual learning targets, which students use to help focus their learning for the rest of Y9 – we produce an AfL sheet that allows them to reflect on their learning and what went well. We no longer invigilate (yippee!), but I go in at the start of the tests to check that the students are settled and that everyone has the correct papers. We are a big school, so getting round to the main examination area and then to the smaller areas, where readers, amanuenses and extra time are allowed, takes some time – but keeps me fit!

I finish the week by discussing with a student and his parent whether or not the student should continue doing GCSE Statistics, the student having submitted a piece of coursework that could have been better. We decide that he will continue.

The start of the next week is busy. On Monday afternoon, I attend presentations given by prospective deputy headteachers; one in particular shows great vision and charisma, so it is no surprise the following day when that person gets the job. In the evening, I attend a full Governing Body meeting which is very well chaired, as always, allowing everyone to have a say while keeping to the point – and that makes such a difference to the meeting.

A couple of days later, I am involved in a conference call, discussing a conference at the National STEM Centre in York. Our talk revolves around the selection of main speakers, and how we can bring course participants on by involving them in showcasing some of their work. We decide to offer speakers the option of leading either a 30-, 60- or 90-minute session, so that everyone we ask will feel that there is something they can present. Of course my tongue is tied, and pen prevented, from letting you know whom we invited.

Monday 17 May is the 67th anniversary of the Dambusters raid on the Ruhr Valley dams. So I dress up as a flight sergeant from 1943 to work with my students that day on the geometry of the raid and how simple mathematics played such a big part in its success. This year I have been fortunate to find a knitting pattern for a WAAF pullover and so we include some mathematics connected with knitting. Our NQT joins in to observe a lesson and dons the WAAF uniform. Heads are turned as we both march across the school site to pick up our mail. It generates a lot of interest – students start to talk about their connections with the RAF through grandparents, or their own membership of the Air Cadets.

Depending on the class taught that day, we explore bearings (plotting the route over Germany using copies of maps that are as authentic as possible), geometric constructions (perpendicular bisector and perpendicular from a point to direct the flight path and release the bouncing bomb at the correct point) and distance time calculations (for example, to calculate how long it took the planes to clear the dam after the drop). The work continues for a few lessons afterwards because it is so rich in functional applied mathematics.

Two days later it is mentoring day; every student, plus parent, in Y7 to Y10 inclusive, has made an appointment to see a mentor for 15 minutes. Being attached to the Y9 team I have my fair share of mentoring to do. But I have enough spare time to meet with other parents who want to see me about

something particular while they are in school, and a few other staff need some assistance – this all adds to a very interesting day.

I am out on a course the following day – not Goodwood or Aintree unfortunately – but Leading from the Middle, run by the National College. This is excellent CPD, and an opportunity to meet with colleagues in the county from different subject areas and learn how they are meeting the constant change.

My week ends with news of an excellent weather forecast, so while my wife is out at her weekly Scrabble, I scrabble on the net for a hotel room the following day, which is Saturday: we have decided to get a weekend away exploring the joys of the National Trust in Berkshire!

Life teaching mathematics is so rich and varied these days.