Secondary Magazine
Issue 81

National Centre for Excellence in the Teaching of Mathematics

Contents

Contributors to this issue include: Mary Pardoe, Richard Perring, Peter Ransom and Jim Thorpe.

Image Credits
Page header - Square dancers photograph by Ivo Kruusamägi some rights reserved

From the editor

Welcome to Issue 81.

In Deep Progress in Mathematics: The Improving Attainment in Mathematics Project, by Anne Watson, Els De Geest and Stephanie Prestage, we read...

"In spite of this wealth of research, it is customary for students in the lowest achieving groups to be given repetitive, procedural, fragmented, disjointed, simplified mathematics."

…and later…

"Self-esteem can be developed through:

- *Believing that students desire to learn.*
- *Responding to, using and generating students' own questions.*
- *Fostering awareness of learning.*
- *Offering challenge and support instead of simplifying the work.*
- *Enabling students to step out of their comfort zones and take risks, such as creating their own hypotheses (for some of these students, no part of a mathematics lesson is a comfort zone).*
- *Developing 'togetherness' in classrooms when working on mathematics."*

It is possible that square dancing, on which we focus in this issue, is a context in which it is relatively easy to develop the self-esteem of students in these ways. Surely getting students (and possibly the teacher) square dancing together will at least facilitate the last of these aspirations?

Certainly the resources in Improving Learning in Mathematics, which features in ILIM – ave atque vale?, provide excellent support for our efforts to develop learners' self-esteem.

> *"Our first aim in designing this resource is to make mathematics teaching more effective by challenging learners to become more active participants. We want them to engage in discussing and explaining their ideas, challenging and teaching one another, creating and solving each other's questions and working collaboratively to share their results. They not only improve in their mathematics; they also become more confident and effective learners."*

From *Improving Learning in Mathematics*

Although, unusually, in this issue of the Secondary Magazine we do not have an interview, The mathematics I do, in Issue 20 of the FE Magazine, is a fascinating article by Doug Williams. It is very likely to entice you to the wealth of fascinating ideas that you and your students can explore at his Mathematics Centre Website. In the next Issue (82) of this magazine we will look at some particular aspects of Doug's resources.

Our Subject Leadership Diary in this issue draws attention to the exploration of an unusual spiral escalator as a context that may interest and challenge students. And if you have some unusual ideas for ways of focussing in your lessons on the imminent census of England and Wales, Secondary Watch invites you to share them.

Secondary Magazine
Issue 81

National Centre
for Excellence in the
Teaching of Mathematics

It’s in the News!
Big foot

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 as a framework which you can personalise to fit your classroom and your learners.

A pair of size 21 trainers has been found at a petrol station in Derbyshire! Police are hunting high and low (though maybe not too low!) for the owner of the enormous Nike basketball boots.

Denise Bostock, who works in the lost property office for the police said, “You just can’t imagine the size of the person who could fit into them.” It’s this statement that this resource explores, using the context of the shoes to make predictions – firstly, in a number sequence, and then using survey data.

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 Functional Skills and Key Processes.

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

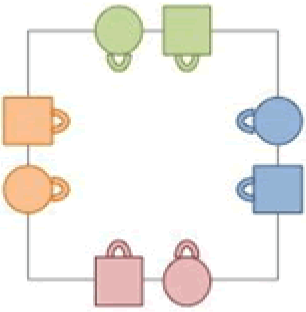
Secondary Magazine
Issue 81

National Centre
for Excellence in the
Teaching of Mathematics

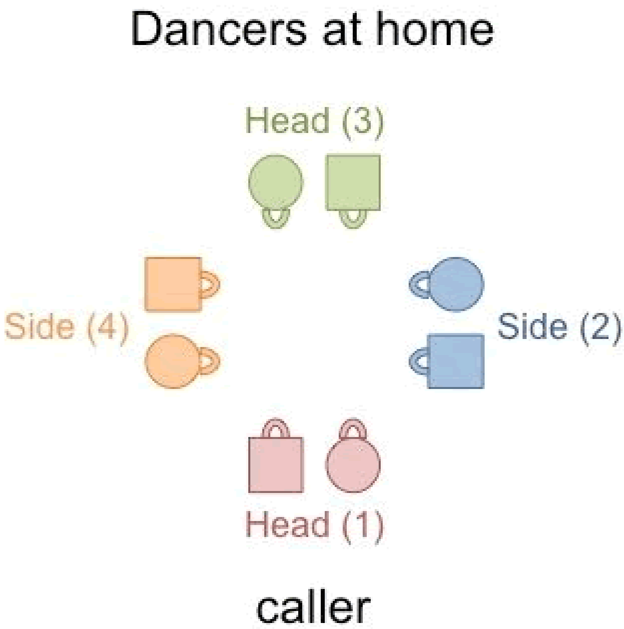
Focus on…square dancing

The square dance probably evolved from the Quadrille, and was popular in England during the 17th century.

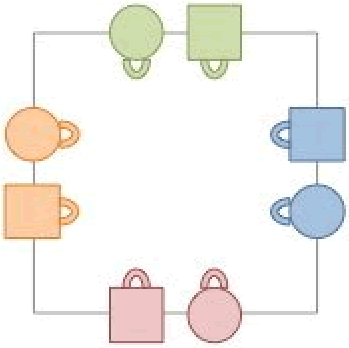
A square dancing formation, with the dancers arranged in a specific way, is a *setup*. The *home* setup is a square arrangement of four couples, as shown in this diagram – in which girls are represented by circles and boys by squares, with loops showing the direction in which each person is facing.



The couple facing away from the caller in the home setup is couple 1. The couples are numbered in a counter-clockwise direction. Couples 1 and 3 are head couples, and couples 2 and 4 are side couples.



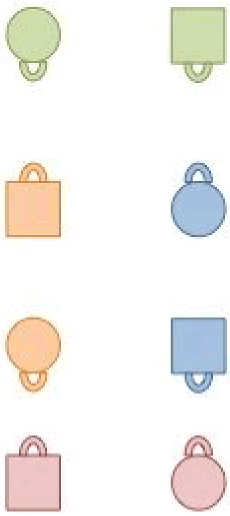
In this photograph, the girl and boy in both side couples are not placed in relation to everyone else as in the *home* setup.

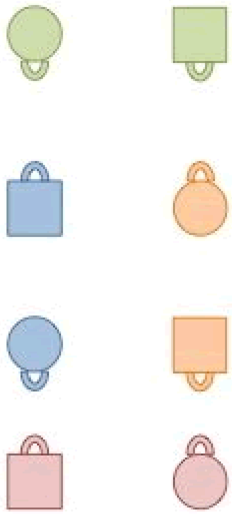


Square dancers by [Ivo Kruusamägi]

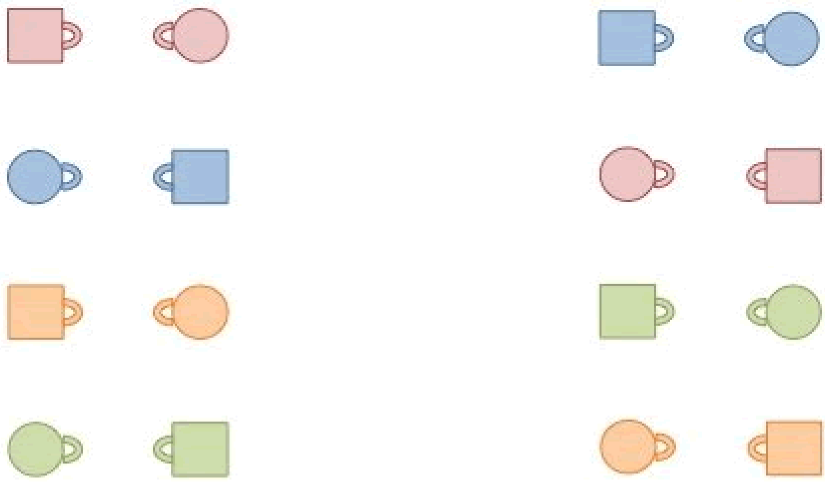
Square dancing can be explored mathematically because the dancers move systematically and symmetrically from one setup to another. Within square dancing, symmetry, system, pattern, order, and relationships between them, exist to be discovered and understood.

During a square dance many different setups may occur. For example, these are two possible *8-chain* setups…





… and these are two *facing-lines* setups …

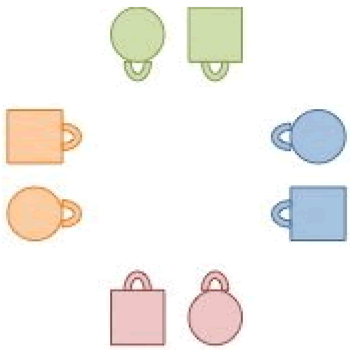


Students could explore possible arrangements of dancers in two parallel rows subject to various conditions, such as no dancer being opposite their partner, with or without taking orientation of the dancers into consideration.

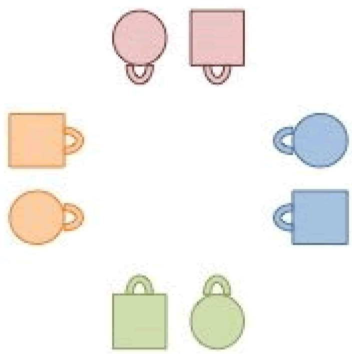
Dancers are not expected to memorise their movements from one position to another in any but the simplest square dances. Usually a *caller* shouts cues (calls), using conventional terms and names that are defined by CALLERLAB, the International Association of Square Dance Callers.

Various lists of calls with illustrations exist on the internet. There are also excellent collections of video clips that explain, very clearly, groups of calls for square dancers at any level of expertise. For example, this short video for beginners from Online Video Square Dance Lessons shows dancers in the home setup, and simple movements such as *Do Sa Do* and a *half promenade*.

Even in the very simple moves demonstrated in the video just mentioned there are mathematical relationships to explore. A *half promenade* first transforms the home setup …

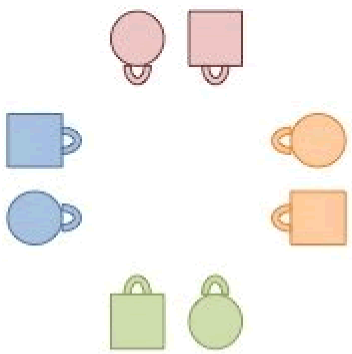


… to this setup …



If you challenge students to explain what has happened to the arrangement of the dancers, they might 'see' that the dancers in the red and green couples have been reflected in horizontal and vertical lines through the centre of the setup, while the blue and orange couples have remained where they were.

The arrangement is then changed to this …



… and students may 'see' that this time the orange and blue dancers have been reflected in the same two perpendicular lines.

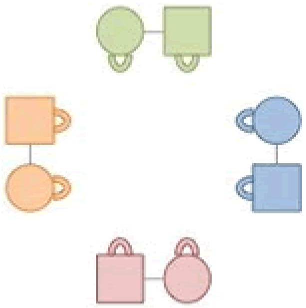
What simple single movement then returns the dancers to the *home* setup?

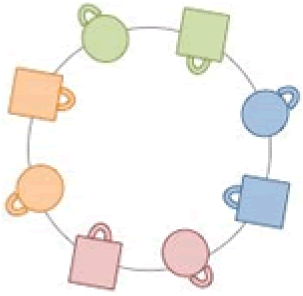
By square dancing through this simple call, students could ***experience***, and perhaps be surprised by, the equivalence of the combination of the two reflections to the rotation.

While preparing to enjoy doing some square dancing, students might 'play with' the lovely animations at Animated Square Dancing. There are also lots of nice animations at Noriko Takahashi's website, which she started to create in 1997 in an effort to recruit young people to square dancing.

TAMinations are extremely useful square dance animations by Brad Christie. You, or your students, can study dancers' exact paths by playing these animations at any one of three speeds, by pausing them, or by progressing or retracing the paths step-by-step. In fact, this collection is all you really need to understand very many calls. You could go to Starting Formations, click on *Mainstream* then choose a formation to scrutinise.

For example, selecting Alamo Ring takes you to the *Ocean Wave Family* animations, among which is *Allemande Left* to an *Alamo Ring from static square*. It shows elegant arcs in the dancers' paths as they move from this …   … to this …

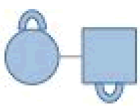


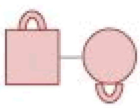


Challenge students to draw the paths of all eight dancers on one diagram, showing all the arcs. What symmetry does their diagram have?

What are the other possible ring arrangements of eight dancers?

Selecting Zoom takes you to *Right-Hand Box*, which is one of the featured *Zoom* square dance actions. Can students visualise, and then sketch or draw, the two curved paths and the two straight paths of the dancers as they move from this …   … to this …   ?





Square dancers by Matěj Baťha

Rich Reel, in his extensive Square Dance Calling Notes, illuminates the meanings of several terms that occur when people communicate with each other about square dancing. Students could explore any of the ideas that are associated with these terms, which Rich Reel summarises in the following way:

Formation	*Where dancers are standing on the floor relative to each other, and which direction each of the dancers is facing relative to the others*
Arrangement	*Where the boys and girls are within the formation*
Sequence	*The order of the dancers going around the formation in a counter-clockwise direction*
Relationship	*This is how the boy sequence is related to the girl sequence, or how a reference dancer is positioned relative to his or her partner*
Orientation	*If we were to take the entire formation and all dancers in it, and rotate everything 90˚ clockwise or counter clockwise about an imaginary flag-pole rising up out of the floor from the very center of the formation, we would be changing only the orientation of the formation. There are 4 orientation states corresponding to 0˚, 90˚, 180˚, and 270˚, and they are expressed in terms of a how a reference boy is positioned relative to his home*
Occupation	*Whether or not two otherwise similar formations differ in Occupation depends on whether a particular person (reference boy) is a Head or a Side*
Symmetry	*Three important kinds are:* ***Formation Symmetry****,* ***Arrangement Symmetry****, and* ***Sequence Symmetry****. If the dancers don't make any mistakes and dance what is typically called at most open dances, all of these symmetries exist at the same time. In fact, these symmetries exist at all times. It is possible, and in fact interesting at times, to have 'Asymmetric Choreography' that deliberately upsets one or more of these symmetries causing certain kinds of imbalance in the square*

Sources of information and inspiration

The links already given will lead you to a great deal of information that may be useful if you are planning to introduce your students to square dancing so that they can enjoy doing it properly, and exploring the mathematics of the patterns and relationships that they encounter.

Another source of inspiration and guidance is the article, From Square Dance to Mathematics by Zoe Bremer, in *Mathematics Teaching 220*.

Do not plan your lessons before exploring Dancing with Mathematics, which consists of many interrelated web pages from Motivate.

You may also find Mike Askew's short film, Maths with dance, useful.

Image Credits
Page header and final photograph above - Polish dancers photograph by Deathskull some rights reserved
Square dancers photograph by Ivo Kruusamägi some rights reserved
Square dancers photograph by Matěj Baťha some rights reserved.

ILIM – ave atque vale?

Quite recently, in response to my recommendation to someone to apply for the Standards Unit (SU) box, *Improving Learning in Mathematics (ILIM)*, I was informed that there were no more hard copies available, only the downloadable version from the Excellence Gateway. 'Ave atque vale' ('Hail and farewell') is a line from a poem by Catullus, his grief-stricken response to the untimely death of his brother.

Did the apparent loss of the box in physical form herald the end of an era? Where had all those thousands of copies ended up? I discovered two of them in my local primary school: one unopened and the other used more for inspiration about methods than for its pupil resources, calculus not being taught in Year 6 – the person so inspired was not a teacher at the primary school but a volunteer who came in to work with small groups of Y6 pupils. A secondary school I visited a while ago displayed a pair of the boxes – but high on a shelf, available only to those brave enough to stand on a chair. Were they not valued? Well, the PGCE student I visited there had been discouraged from employing the methods found in it. Perhaps, like the loaves and the fishes of biblical repute, unused copies could be collected up by the basketful?

So, where do you start with such a wide-ranging Aladdin's cave as the SU box?

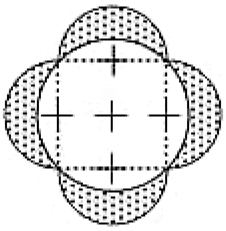
The videos of classroom practice, perhaps? These demonstrate the use of the sample student resources that, together with teacher encouragement of students to work as groups (not merely in a group), promote learning aided by discussion and experimentation. Let it be emphasised that it is the way of working that is paramount: mere learning resources are not in themselves enough. This truth belies the sometimes-expressed need for yet more teaching material.

From its ubiquity, the availability of the SU box might be presumed, but John Hibbs writes elsewhere of his astonishment at being approached at an ATM event by FE teachers asking whether resources for post-16 teaching existed. Perhaps, rather than availability it's a problem of accessibility: the SU box remaining unopened because of its imposing size – a 32.5cm x 27cm x 20cm maroon and blue cardboard case containing a box of digital material and four folders, all but one subdivided with allusive titles: *'mostly number'*, *'mostly algebra'*, a Professional Development Guide – *'Learning from mistakes and misconceptions'*, *'Managing discussion'*, *'Developing questioning'*, … . Much else is in there, as you can see from the staffroom copy – it is a comprehensive agenda for improving learning in mathematics. Yet, one teacher still said of this microcosm of effective practice, "I don't have time for discussion, but the students quite like some of the card sorting."

'Microcosm' is perhaps too ambitious a description: ILIM hints at much but, for instance, doesn't address the value of taking risks, for example, as a teacher, asking questions to which you don't have an answer. ILIM is very earnest and, the value of *surprise*, a theme of Issue 63 of the Secondary Magazine, is not featured therein. To quote Johnston-Wilder, S and Mason, J (eds) (2005):

> "Expectation is a product of imagining, and without an expectation there is unlikely to be any surprise, yet geometry is a domain full of surprising relationships."

In Johnston-Wilder and Mason's text is an activity that invites readers to calculate the four shaded areas, referred to as 'lunes'. (When calculating areas don't use a numerical approximation to π.)



With this set simply as an exercise, students might show no interest in the calculated area, just one number – with or without units – among an infinity of them. BUT, if built up to, like a good joke, by calculating areas of circles and parts of them, there may be gasps of surprise at the area of the lunes: maybe the students will doubt their own calculation. Surely mathematics is only worth the educational candle if its power to intrigue is ever-present?

It was, I recall, though I'm unsure, an NCETM Regional Co-ordinator who took photocopied sheets into an FE mathematics department and in a few minutes gathered a crowd of mathematics lecturers who enthused over the teaching opportunities provided by the photocopies. "Where can I get copies?" a lecturer finally asked. "Over there," replied the Co-ordinator, pointing to the SU box propping open the door. Whether the shrink-wrapping dividing the sections had been removed is not recorded.

I hope my sadness at what I presume to be underuse of the SU box is not misconstrued as 'teacher bashing': that there genuinely is a problem of access is not to be denied. My friend Kev, colleague and enthusiastic mathematics educator in many roles, had a large slice of his desk weighed down by the 32.5cm x 27cm x 20cm cuboid for many months, until a breathing space in marking released him to open the SU box. But I don't think that unopened SU boxes is really down to shortage of time: the minutiae of teaching is surely about how to use time to incorporate what is valued, and what is valued is what we believe has a pay-off.

How much pay-off do we need before we make the effort to engage with what promises to deliver better learning? Unless we see it in action, the promise of even a high pay-off may be too remote. Sure, there are videos in ILIM of teachers working with students, but even at just one remove from experienced reality the impact may be slight.

I hope that it is untimely to lament the passing of Improving Learning in Mathematics: that what remains is the work's relevance. One teacher, who whole-heartedly espoused the ILIM approach, reported that while she was as yet uncertain of its impact on GCSE results, the lessons were far more pleasant. The students enjoyed them more and she herself could breathe more easily as she didn't have to be uptight and in charge all the time in order to motivate progress. True, she had to prepare more materials, but the classroom peace more than made up for that. If you know what repeat GCSE classes in FE are like – students reluctantly and out of necessity striving for an improved grade – you will perhaps know how she feels. Perhaps there is still time for Catullus' sentiment to be reversed: vale atque ave.

Indeed, so it has come to pass – The National STEM Centre has a supply of the Standards Unit boxes 'freely available for teachers'. If you would like one, they are available to collect.

References

Johnston-Wilder, S and Mason, J (eds) (2005) *Developing Thinking in Geometry*. London, Paul Chapman Publishing. ISBN 1-4129-1169-9
[OU Module text for ME627, Developing Thinking in Geometry]

5 things to do this fortnight

- Have you visited the new NCETM microsite Using ICT and Digital Technologies for Teaching Mathematics? From this starting point, you can explore resources and professional development materials that will enable you to embed digital technologies in your students' learning of mathematics. Most students use digital technologies, which are now embedded in the culture and fabric of society, in all aspects of their non-school lives. In her Interview in Issue 80 of this magazine Professor Rosamund Sutherland explained that she is currently leading a JMC working party [scroll down to second afternoon discussion] on *The place of digital technology in school and college mathematics*.

- Would you like to take advantage of some new opportunities to engage with STEM support organisations, and strengthen links with a major business partner in your area? You could do this by attending one of the regional National STEM Centre events, Driving success through STEM, which will take place in the West Midlands, the East of England and the North East during March and May.

- The London Mathematical Society's Women in Mathematics Day 2011 will be held on 6 May. At this annual event, those at early stages of a career in mathematics, such as final-year undergraduates and postgraduate students, meet and talk with women who are active and successful in mathematics. This year the mathematicians who will give talks are Dr Claire Gilson, who is Senior Lecturer in mathematics at the University of Glasgow, Dr Joan Lasenby, a Royal Society Research Fellow working in the Signal Processing Group at the Department of Engineering of the University of Cambridge, and Dr Rowena Paget, Lecturer in Pure Mathematics at the University of Kent. Participants are invited to join a dinner at a local restaurant after the event.

Woman teaching geometry, 1309-1316

- Are you interested in contributing an essay to Biographies of Women Mathematicians? This is an on-going project, at Agnes Scott College, Atlanta, illustrating the numerous achievements of women in the field of mathematics. You can send your contribution by email to Lawrence Riddle, who is Professor, and Chair of the Department of Mathematics, at Agnes Scott College.

- Among the women mathematicians featured on the Agnes Scott College website is Sophie Germain, who would have been 235 on 1 April. In April 1807, Carl Friedrich Gauss wrote of her:

  When a woman, who because of her sex and our prejudices encounters infinitely more obstacles that an man in familiarising herself with complicated problems, succeeds nevertheless in surmounting these obstacles and penetrating the most obscure parts of them, without doubt she must have the noblest courage, quite extraordinary talents and superior genius.

  You and your students might enjoy this six-minute video about Sophie's life and work.

Sophie Germain

Image Credits
Page header and image above drawings of Sophie Germain, courtesy of School of Mathematics and Statistics, University of St Andrews Scotland, in the public domain
Woman teaching geometry courtesy of Wikimedia Commons, in the public domain

Subject Leadership Diary

It's the middle of mad March mathematics! We've just had Pi Day, though many of us think that 14 March is written 14.3, rather than 3.14 as it is in the States. In my school, we prefer to make mention of Approximate Pi Day, which is 22 July (22/7). So, what can you do on (Approximate) Pi Day, or any other time? This year, we worked with spirals – initiated by our taking part a couple of weeks ago in an after school in-service session, run by Texas Instruments, at the Acton Bus Depot where we looked at some of the mathematics available there. As well as a wealth of data that can be collected by examining and measuring the old buses and trains (for example, is the leg-room between seats increasing or decreasing?) there is a fascinating piece of a spiral escalator on view. We discovered that this amazing escalator operated for only one day – in 1906 at Holland Park station – and it consisted of a double helix that turned through 1½ turns in rising 35 feet in height, travelling at 100 feet per minute. It was situated in a shaft 23 feet in diameter. You might find that looking at an empty toilet roll holder helps you to visualise the situation! You can see a photograph of part of the escalator at kineticarchitecture.net, and part of the patent at the Elevator Museum. So, a bit of functional mathematics here for you! How long was the 1½ turns of the spiral? How long would it have taken you to travel from the top of the escalator to the bottom? Get students discussing questions such as these in groups – and see how they get on. Nothing like working at the frontiers of your knowledge from time to time!

Of course, 1 March was World Maths Day and we encouraged our students to spend some time in school or at home on the Sumdog website. If they play these free mathematics games in school they can compete against each other if they wish. Or if they don't visit the website during school time, you might want to raise awareness of it amongst your students – we all know that they play computer games, so why not turn that to everyone's advantage by having them practise some arithmetic at the same time?

PGCE student teachers are now in school again for their second stretch of school-based learning. It is always great to have them back since they invigorate the entire faculty with their enthusiasm and questions – which in turn get us questioning some of what we do and how we do it. It is good to look forward to these students becoming teachers who will guide the mathematics education of our country's pupils – especially when so much seems in the balance regarding university fees, initial teacher education and teachers' pensions. Tomorrow we have our Year 8 Parents' Evening and our present student teacher will be there, sitting with the teacher of the class she is currently teaching. She will see how an experienced teacher endeavours in just five minutes to communicate everything that needs to be said or answered about a pupil. These sessions are always hard to manage at the end of a busy day – one might have to see up to 60 sets of parents (if you have two Y8 classes): at five minutes per pupil, that's five hours of solid chat. Thank goodness for the students and parents who hand out cups of tea! However, not every set of parents is likely to turn up. In our school we arrange phone calls if parents cannot get an appointment slot due to the teacher being fully booked, though these calls often last more than five minutes.

A while ago, we were successful in obtaining a telescope through the Telescopes for Schools programme that took place at the end of 2008. Currently the GCSE Astronomy students are using it. In the mathematics faculty we are always looking for new ways of applying mathematics, and there's a host of astronomical data that students can display in graphs and charts, and interpret. The NASA Kepler project is about the search for habitable planets – and that certainly grabs the imagination! You can start to look for planets around other stars – you are shown how to find new planets by looking at the way the brightness of a star changes over time. (Unfortunately it doesn't work with all internet software at the moment.) If you log in, you can get access to light curves and see if you can find a planet! How exciting is that! Students and teachers with stars in their eyes!