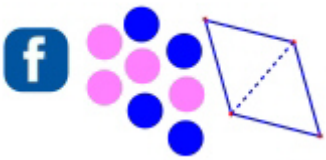
Secondary Magazine Issue 69



National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 69 of the Secondary Magazine.

Contents

Contributors to this issue include: Alison Clark-Wilson, Mary Pardoe, Richard Perring and Peter Ransom.

Secondary Magazine
Issue 69

National Centre
for Excellence in the
Teaching of Mathematics

From the editor

Now that you've survived the first few weeks of the new term we hope that you may have time to dip into the NCETM Secondary Magazine – welcome to Issue 69.

Many of you will be, and most of you may be hoping one day to be, mathematics subject leaders. Teachers in this demanding role need all the support that they can find as they carry out their responsibilities of creating a shared vision of effective teaching and learning within their departments, planning for improvement, facilitating the sharing of experiences and ideas, and maintaining well-organised systems.

In this issue we remind you of some of the comprehensive and user friendly resources on the portal that are designed specifically for subject leaders. Have you visited the National Centre's Excellence in Mathematics Leadership (EiML) microsite? We focus on the Secondary Mathematics Subject Leader in-Depth Study Modules in this issue. And you can read about some subject leadership day-to-day issues and experiences in our Subject Leadership Diary.

You can also find some useful material at other websites. For example, The National Strategies site offers guidance, and there are helpful resources at the Kangaroo Maths Subject Leadership site. The 2008 Ofsted report, Mathematics: understanding the score includes a section about leadership and management.

The introduction to the EiML microsite includes the statement that *'it goes without saying that it is teachers as individuals in their own classrooms who have the most significant influence on the mathematical learning of their pupils'*. In this issue we offer ideas for all teachers to try out in the classroom. There is a suggestion for getting students started with dynamic geometry software in An idea for using ICT in the classroom, An idea for the classroom is a ratio activity, and you will find adaptations of a 'team building' task in Focus on….

Secondary Magazine Issue 69

The Social Network

National Centre for Excellence in the Teaching of Mathematics

It's in the News!
500 million friends

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.

This *It's in the News!* is the third in a series exploring different parts of the handling data cycle.

In this issue we use the forthcoming release of *The Social Network* – a film telling the story of Mark Zuckerberg, founder of Facebook – as a context to explore ways of representing data using infographics, giving students direct access to 'interpret tables, graphs and diagrams for discrete and continuous data'.

The 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

PS: Don't forget - you can follow the National Centre on Facebook and Twitter!

Secondary Magazine Issue 69

National Centre for Excellence in the Teaching of Mathematics

Focus on…adapting 'team building' tasks

During August a discussion developed in the Secondary Forum about 'cooperative learning' tasks.

These tasks start from a variety of facts, which are printed on cards, about some object or situation. The cards are dealt out to the learners in a small group, who use the information together to solve a problem. The learners are not allowed to show their pieces of information to each other, so they have to talk to each other about what they each know.

The original version of this kind of activity was called *Zin Obelisk*. It was devised during the 1980s by Michael Woodcock – a past MP, director of several companies, consultant and writer of team-building manuals – as a team problem-solving exercise for business executives on team building courses. It has been used in this way on business management courses ever since, and can be found on many websites, for example Business Consultants Network and Baidu.com.

The kinds of question about the behaviour of people working in a group to solve the *Zin Obelisk* problem that are addressed on leadership-in-business courses are:

- what behaviour helped the group accomplish the task?
- what behaviour hindered the group in completing the task?
- how did leadership emerge in the team?
- who participated most?
- who participated least?
- what feelings did you experience as the task progressed?
- what suggestions would you make to improve team performance?

During an ATM conference the *Zin Obelisk* task was introduced to mathematics teachers soon after it had been published. Having themselves enjoyed what was then for most mathematics teachers a novel kind of activity, some conference participants took it back to their own schools and local authorities.

Zin Obelisk thus gave many students their first opportunity to try to cooperate in solving a problem as a group. The focus was on the social skills involved in sharing information, cooperating and contributing to the work of a group, rather than on developing mathematical ideas. That is why it became known as a 'cooperative learning' task.

Some teachers were, at about that same time, thinking about, discussing and trying to introduce into their classrooms, what John Mason had described in Expressing Generality in the Open University Update materials as a 'conjecturing atmosphere'.

Teachers saw in *Zin Obelisk* a task that put students in a situation in which the students, while endeavouring together to solve the Zin problem, might begin to understand that:

> *"The essence of working in a conjecturing atmosphere is…listening to and accepting what others say as a conjecture which is intended to be modified. Consequently, it is well worth noticing how you go about:*
> *- developing and using a vocabulary which fosters conjecturing, (e.g. use words such as 'I suggest that...' or 'Perhaps...' rather than 'No!' or 'That's right!')*
> *- listening to others and being listened to."*

You will find the *Zin Obelisk* task, slightly improved, at NRICH. Lincolnshire teachers adapted *Zin Obelisk* in order to reduce the number of 'red herring' statements. That version is called Workers of Zen.

The creator of *Zin Obelisk* was not a mathematics teacher. It is possible to design 'cooperative learning' tasks that have the same structure as *Zin Obelisk* but which provide rather more opportunities for mathematical learning.

It might seem to be a daunting challenge to invent a Zin-type task. But it isn't hard if you go through the following process:

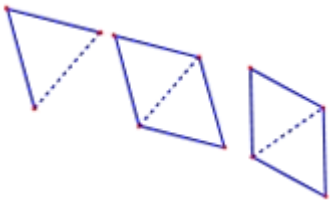
- imagine, or make a rough physical model of, an 'object', or draw a diagram
- write down facts that you 'see' about aspects of, and relations between aspects of, the 'object'. You can include one or two questions that draw attention to facts
- decide what will be the goal of the task. It might be to reproduce the diagram that you drew, or to make a model. Or it might be to deduce a fact that is not immediately obvious – as in Zin Obelisk
- put everything away and don't think about it for several days
- after a few days retrieve the list of facts, but don't look at the diagram or model. Using only the facts, and any suggestive questions, in your list, try to reproduce the diagram or model, or deduce the fact that wasn't obvious. Tick off the facts as you use them.

Olympic Podium (instructions, information sheet and cards) is a task created in this way that involves ratios and visualising three-dimensional objects. We also give the chain of reasoning that the task designer constructed when checking the list of facts. But if you are considering trying out this activity with your students you are advised to attempt the task yourself before looking at the author's chain of reasoning – you or your students may find other more 'elegant' ways of reaching a 'solution' that satisfies the conditions!

A Logo (example logos, information sheet and cards) is another 'cooperative' task that was devised by going through the process described above. It is about properties of triangles and other polygons, and the aim is to produce an arrangement of shapes about which all the statements on the cards are true.

These tasks give students opportunities to suggest tentatively, and explore together, deductions, and discuss relationships between mathematical ideas, while finding out that a conjecturing atmosphere facilitates cooperative problem solving in particular, and learning mathematics in general.

Secondary Magazine Issue 69



National Centre for Excellence in the Teaching of Mathematics

An idea for using ICT in the classroom - getting students started with dynamic geometry software – exploring quadrilaterals formed from triangles

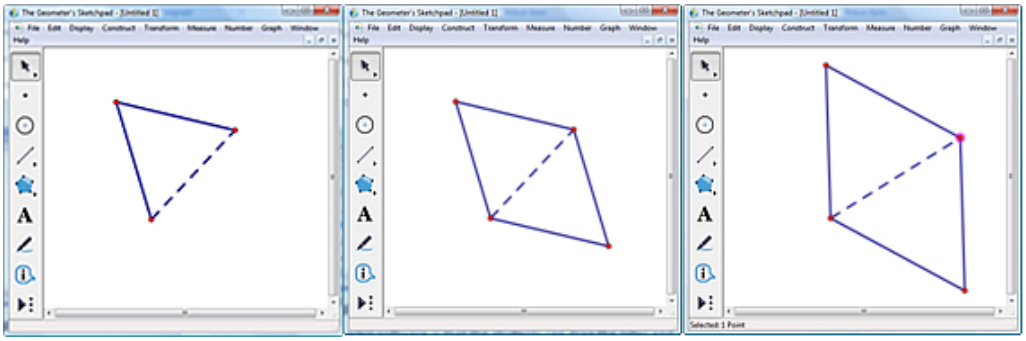
Lots of schools have access to a dynamic geometry software package such as The Geometer's Sketchpad, Cabri Geometry or Geogebra, and some teachers are using this software to support whole-class teaching on their interactive whiteboards.

Where schools have begun to provide opportunities for their students to use the software for themselves, the following lesson idea has proved to be a successful 'first lesson' which generates lots of productive mathematical thinking and does not require the students to have any software skills in order to get started.

You will need to provide the students with a pre-prepared file in which you have already constructed equilateral, isosceles and scalene 'dynamic' triangles on separate pages (or you can download these pre-prepared Geometer's Sketchpad or Cabri-Geometry files). You'll need to have checked out how to reflect bits of the shape in a selected line of symmetry – and be able to show the students how to do this...

The task is a simple one to introduce...

- if you choose one of the sides of the triangle as the line of reflection, and reflect the rest of the shape in this line, what quadrilaterals is it possible to make and why?
- how can you use the angle and side properties of the original triangle to convince somebody else of your theory?



Although you could easily do this task with paper, pencil and card triangles, an advantage of using the dynamic software is that the students can drag the sides and vertices of the triangles to test if their conjecture is 'always' true.

And you can pose some more challenging extension questions such as:

- can you say which angles and side are the same?...and how do you know?
- which quadrilaterals can't you make using this method?...and why?

Whilst working on a variety of challenges within this task, depending on the way that you have presented the task, the students could have opportunities to:

- plot the graphs of linear functions and recognise that equations of the form $y = mx + c$ correspond to straight-line graphs

- appreciate that if lines are parallel, they have the same gradient
- recognise that if lines cross on the *y*-axis, they have the same intercept value.

Asking questions such as: 'What is similar about the set of functions that produced the square and the rectangle?' and 'What do you notice about the gradients of the four equations that produced each shape?' will encourage students to extend their mathematical thinking.

Subject Leader Study Modules

If you are a subject leader, or aspiring to be one, you can take advantage of the wealth of guidance, information and inspiration that the National Centre's Excellence in Mathematics Leadership (EiML) microsite offers.

There are separate parts of the microsite for primary and secondary subject leaders. From the introduction to the material for secondary subject leaders you can move to any one of six sections:

- Section 1 surveys the role
- Section 2 focuses on four core responsibilities
- Section 3 enables you to study, in depth, six essential aspects of what an effective subject leader does
- Case Studies are illuminating snapshots of what some actual subject leaders are doing
- The subject leader's contribution to widening students' participation at A-level
- Departmental Workshops.

The six self-study modules in Section 3 address:

- providing a curriculum that gives all students excellent opportunities to fulfill their potential
- improving results by supporting everybody in your team in developing their pedagogy
- ensuring that the pedagogy enables students to learn well
- leading effective integration of ICT into teaching and learning
- understanding and implementing innovative and other changes in order to improve learning
- using data about, and from, students in order to improve practice.

Each of these self-study modules contains sub-sections from which you can select issues that particularly interest you or which are especially relevant to your situation.

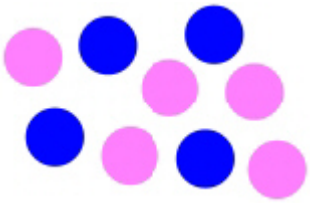
For example, in module 1 you might decide first to learn more about learning difficulties because you are presently coping with related issues. A more relaxed occasion, when you are in a reflective mood, might be the right time to think deeply about the nature of mathematics and why understanding it is essential.

You might go to Module 4 because you want to think about available ICT and how it relates to the curriculum, or to consider effective pedagogical approaches when using ICT. Module 5 supports you in considering what needs to be changed in your department, or you may choose to study the section about deciding where to spend money, or perhaps you want to know more about the role of Coaching and Action Research in bringing about change.

From Module 3 you could choose to learn more about managing behaviour, perhaps you want to think more deeply about creating a positive learning environment, or you are hoping to work more closely with other departments. From the seven sub-sections in Module 2, you might focus on the impact of assessment on learning, or perhaps you want to become clearer in your mind about the various pedagogies that mathematics teachers use.

Module 6 enables you to get to grips with terminology about using data, understand sampling, or you can consider in depth what is the use of data at all.

If you are registered with the National Centre, your Personal Learning Space is an ideal location for notes about your thoughts sparked off by studying these modules. And you can record privately your plans and any particular actions that you are considering taking.

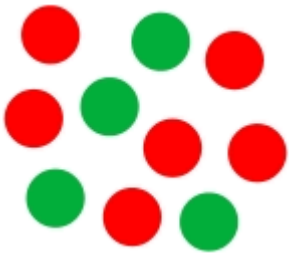


An idea for the classroom – clusters of counters

Students reduce ratios to their simplest forms in order to solve these puzzles, rather than for no apparent reason as in many textbook exercises.

Start by forming, on an interactive whiteboard or ordinary board, a clustered group of counters of two different colours.

For example, form a group of four green and six red counters:



Ask students to think what is the ratio of green to red counters. Allow them time to confer.

Having eventually established that the ratio is four to six, or, more simply, two to three, pose this problem:

> *The ratio green : red is presently 2 : 3. By adding counters to, or removing counters from, the group of red and green counters, obtain a group in which the ratio green : red is 1 : 2.*

Students should imagine that they can add counters of either colour to the group or remove counters of either colour. Explain that adding a single counter is one move, and removing a single counter is one move. The aim is to solve the problem in the least number of moves.

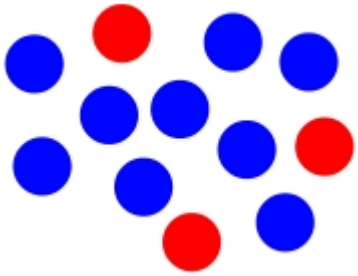
They could work on this for a short time in pairs, using thought and talk only. Invite some pairs to demonstrate their solutions.

The best solution can be obtained in one move only, by removing one green counter. Some students might think of adding two red counters. This is also a solution, but, as it requires two moves, it is not as good as the previous solution. The most literal solution is to remove three green and four red counters. This is a very poor solution as it requires seven moves.

Students could record the number of moves required for their solutions. The pair with the lowest score at the end of the whole session wins.

Here are two more example problems:

- Assemble a group of three red and nine blue counters:



- Establish that the ratio red : blue is 3 : 9, or, more simply 1 : 3.
  Challenge students to change the ratio to 2 : 3.
  (This can be done in four moves, by adding a red counter and removing three blue counters.)

- Assemble a group of three pink and twelve orange counters:

  Establish that the ratio pink : orange is 3 : 12, or, more simply 1 : 4.
  Challenge students to change the ratio to 1 : 5.
  (This can be done in three moves in two ways: by removing one pink counter and two orange counters, or by just adding three orange counters.)

These are examples of simpler problems involving fewer counters:

- Assemble a group of one green and two red counters.
  - change green : red from 1 : 2 to 1 : 3
  - change green : red from 1 : 2 to 1 : 1

- Assemble a group of two red and three blue counters.
  - change red : blue from 2 : 3 to 3 : 4
  - change red : blue from 2 : 3 to 1 : 4

- Assemble a group of two pink and four orange counters.
  - change pink : orange from 1 : 2 to 1 : 3
  - change pink : orange from 1 : 2 to 1 : 1

Challenge students to make up problems for others to solve. Require them to find as many solutions to their own problems as possible, and ask them to put the solutions in order of 'merit'.

5 things to do this fortnight

- Have you been listening to the new series of More or Less on Radio Four? These topical, eye-opening programmes about the use and abuse of numerical and statistical facts in politics, the media and contemporary life, are produced in partnership with the Open University. They may suggest ideas for classroom activities, or, downloaded and played directly to your students, they can stimulate fruitful discussion.

- Are you interested in how pictures have been used in mathematics? In a talk, Maths with Pictures, on 5 October, at the Museum of London, Professor John Barrow of the University of Cambridge will look at illustrations in ancient mathematics books, the invention of the first graphs, the representation of probabilities, sets and formulae by pictures, and the role played by computers in displaying the behaviour of extremely large and complicated problems.

- Julie Kay, former head teacher of Mark College in Somerset, is presenting her popular Dyslexia and Maths training day at Selby College on 8 October. If you teach mainly mathematics and numeracy, are a teacher or trainer of vocational subjects who also teaches mathematics and numeracy, or a learning support practitioner, you may appreciate picking up lots of really useful practical tips and strategies. You will learn about factors that affect mathematics learning, testing to diagnose difficulties, setting up programmes to help overcome difficulties, and using strategies and resources to teach particular areas of mathematics.

- The fifth Institute of Mathematics and its Applications (IMA) Maths Works takes place at the Royal Statistical Society, London, on 15 October. It will focus on helping you incorporate workplace-related learning opportunities into your classroom practice. In addition, it is also hoped that there will be opportunities for you to see at first hand examples of using mathematics in the workplace.

- Have you booked your place on the NCETM National CPD Conference, Professional Learning Networks: learning better through learning together? On 1 December you could join teachers from across the country to explore the benefits of networking and collaboration to enhance your mathematics teaching and learning. You will hear from practitioners who have created networks of all sizes across their department, school or college, local cluster group, HEIs and industry. The day will include interactive group sessions to explore the power of working and learning together, workshops to present examples of collaboration, and keynote presentations from inspiring individuals who use networks. The conference, in Sheffield, is free and is open to teachers, lecturers and advisers from all sectors. To book your place, please email events@ncetm.org.uk. Details of the programme will be published on the portal next month.

Secondary Magazine Issue 69

National Centre for Excellence in the Teaching of Mathematics

Subject Leadership Diary

GCSE results day was earlier this year and, despite the notice on the school website about not releasing results until 10:00 am, there were plenty of excited voices and smiles this year as the staff filled the admin office discussing results – hindering rather than helping the process of getting individual results into envelopes.

The head teacher was beaming because the results were well up on last year. A six per cent increase in those students getting five or more A* to C in English and mathematics put us at 71%. I was delighted – the mathematics results were up 4% on last year and matched the English results exactly at 77.3%. Now there's a nice starter for the new term: if English and mathematics get the same percentage result at A* to C, what must the minimum percentage be to guarantee the students get 77% at both English and mathematics A* to C? (Answer at end.)

Then we had to wait two days for the individual breakdown before I could see whether any appeals were needed. We have great faith in the rigour of the mark scheme and will appeal if a student is within one mark of a crucial boundary. Last year we appealed on behalf of three students and two made it up to a grade C. If they are within two marks we inform parents that it might be worth appealing. More than two marks out and we don't recommend an appeal unless we feel that there is a really good reason why the paper should be seen.

One year, this was important when a 'high flyer' was awarded a U for a module and we could not see how that was possible. When we got a look at his paper it was clear that this student needed urgent help, and a crisis was avoided. This year we will appeal on just one case – someone who was two marks out, but since the student's handwriting was never very big or very legible we will see what can be done.

I examine each teacher's residuals to see how they have performed: nothing to worry about there. The higher attaining classes showing positive residuals, middle attainers round about zero, and lower attainers negative residuals. It is always surprising how high (or how low) a residual some students have, but there again, to some students mathematics comes quite naturally and to some it doesn't. This reminds me to read *The Mathematical Brain* by Brian Butterworth again – it is also worth reading this article.

My next job before enjoying the last few nightmares before term starts (yes, there's always a few nights when my subconscious mind gets going and has me trying to teach mathematics to a class of hooligans while I am sitting at a student desk – and they are just my SLT!) is to get a faculty agenda together for the first student-free day back.

I also sort out a timetable for officially observing the faculty before I complete their performance management reports, due by the end of September. My deputy head of mathematics and I do one observation together to check we agree on our judgements then we will do the other observations independently. This year, I also want to do some informal paired observations with faculty members so we can work together to improve our skills.

Then there's a bit of stress-baking to do: I make a mean (not to be interpreted as 'average') apple cake, and there have been a few windfalls recently. I use the Blenheim Orange variety at this time of year – excellent eaters and good in cake, though they will be even better in a month or so. I'll serve this on Monday when the faculty are reviewing how their students did – they each provide me with a sheet showing those

students who did better than their target grades and those who did worse, with some explanation about why they think this happened. It's always good to reflect on successes and failures so that we can all benefit from 'what went well' and make sure we improve on the 'even better if' side of things.

69 – the number that makes students snigger. Well, it is special since $69^2 = 4\,761$ and $69^3 = 328\,509$, which uses all the ten digits once and once only. Also $99\,066^2 = 9\,814\,072\,356$ uses all ten digits and both 69 and 99 066 have lovely symmetry! Oh, the beauty of numbers!

Here's hoping that mathematics teachers everywhere have a successful and enjoyable time working at the frontiers of their knowledge this year!

BTW, the answer is 88.5%.