Secondary & Further Education Magazine 101

National Centre for Excellence in the Teaching of Mathematics

## Welcome to Issue 101 of the Secondary Magazine (incorporating FE)

The *Back to school* signs were displayed in the supermarkets from the beginning of August! As the beginning of term approaches this may be the time to brush off the sand and focus on issues professional and mathematical as you reset your thinking for the year ahead. Have a good year.

## Contents




# From the editor: Why do we teach mathematics?

As you read this, you may be preparing for the new term. Hopefully the summer break has given you an opportunity to take a step back from the frantic pace of the school day and take stock of your life - personal and professional?

Why do you teach mathematics? That question could be read in at least two ways: *Why do **you** teach mathematics?* Or, *Why do you teach **mathematics**?* These may be questions that you have personally considered, perhaps in the context of a job interview quite recently. What do your colleagues think? It may be that you have sat in the staffroom and swapped anecdotes which may answer these questions; it would be interesting professionally to have a collegiate response to the question:

> *Why do we teach **mathematics**?*

On the NCETM website, there is a departmental workshop, Why do we teach mathematics? This workshop provides some structured activities to help you formulate a response to this question. It starts by asking you to consider what it is you say when a pupil asks:

> *"why do I need to know about simultaneous equations?"*

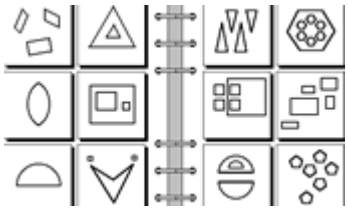
The workshop does not answer the question for you but does give some things to consider. Using the workshop could be a helpful way to consider this question with colleagues at the beginning of the new term. Working as part of a department that has a common vision and purpose adds to the coherence of the curriculum offered, and is professionally satisfying.

Some of the answers to this question are contained in the introduction to the current National Curriculum for mathematics:

> Mathematical thinking is important for all members of a modern society as a habit of mind for its use in the workplace, business and finance; and for personal decision-making. Mathematics is fundamental to national prosperity in providing tools for understanding science, engineering, technology and economics. It is essential in public decision-making and for participation in the knowledge economy.
>
> Mathematics equips pupils with uniquely powerful ways to describe, analyse and change the world. It can stimulate moments of pleasure and wonder for all pupils when they solve a problem for the first time, discover a more elegant solution, or notice hidden connections. Pupils who are functional in mathematics and financially capable are able to think independently in applied and abstract ways, and can reason, solve problems and assess risk.
>
> Mathematics is a creative discipline. The language of mathematics is international. The subject transcends cultural boundaries and its importance is universally recognised. Mathematics has developed over time as a means of solving problems and also for its own sake.
> (DfE 2013)

You might like to compare this with similar statements in the proposed new National Curriculum - see pages 9 and 88.

You may also like to try the departmental workshop Learning mathematics in my school.



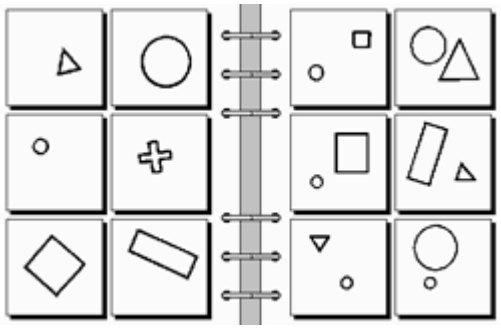


# A resource for the classroom – Bongard problems

Published in 1979, Douglas Hofstadter's book Gödel, Escher, Bach: an Eternal Golden Braid featured the problems from the Russian computer scientist Mikhail Moiseevich Bongard. The problems could be said to be like a Sudoku in that *'There's no maths involved. You solve the puzzle with reasoning and logic'* (Independent newspaper et al).

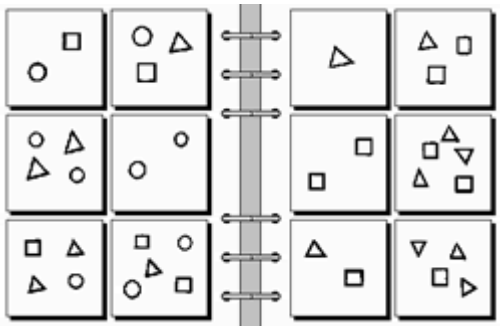
Assuming that reasoning and logic are mathematical behaviours, these problems are ideal for developing these skills along with literacy, creativity and others in the mathematics classroom.

Each problem consists of a set of twelve boxes arranged as two sets of six. The six boxes on the left hand side of the page are linked by a feature which is not shared by the six boxes on the right hand side. For example:



*Each of the six boxes on the left contains one shape whereas each of the six boxes on the right contains two shapes*

Or:



*Each of the six boxes on the left contains at least one circle whereas each of the six boxes on the right contains no circles*

It is a fundamental rule that you could not move a box from one group to the other.

There is a webpage which has links to these problems. Bongard created the first 100 problems, but there are currently 280 available. The original 100 problems are worth exploring first! There are no answers provided so you may like to think how you will cope with this – will you be a learner alongside your pupils?

So how could you use them?

- the problems are accessible to a range of pupils as there is no specific mathematical content involved in understanding the different problems – but the vocabulary that is used to describe and justify the solutions will necessitate the use of mathematical terms; pupils will need to know some precise vocabulary
- in our experience, pupils love the challenge of trying to find the connections in these puzzles. They need to have some space to work 'on' the problems rather than attempt a number in strict sequential order
- working in pairs or small groups encourages pupils to talk and reason with each other before arriving at a precise solution
- encouraging pupils to write down some of their solutions adds some depth and understanding to their use of language
- making up their own problem (there's a blank template here) and giving this to another pair of pupils, or having an on-going gallery of problems to be solved encourages creativity and ownership in pupils.

Enjoy using Bongard problems - and let us know how this develops pupil thinking in your classroom.

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Collaborative Teacher Projects

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# Focus on…Collaborative Teacher Projects

The NCETM provides funding for teachers to work collaboratively; working collaboratively is a professional development activity in which teachers can determine their own projects and research the effect. There will be a new round of funding available in Autumn 2013, details of which can be found on the Collaborative Teacher Projects page. If you are working in a Secondary school, the NCETM will be most interested in projects that focus on mathematical proficiency, which can be defined thus:

> **Mathematical Proficiency** requires a focus on core knowledge and procedural fluency so that pupils can carry out mathematical procedures flexibly, accurately, consistently, efficiently, and appropriately. Procedures and understanding are developed in tandem.

In this period before the new funding round is announced, you may find it useful to read about two previous projects.

Fabulous Fractions is a project undertaken by a group of teachers in Tower Hamlets, in London. Teachers explored the teaching of fractions as a key to deepening students' feeling for number and so boosting their facility with, and understanding of, decimals, percentages and ratio, based on approaches seen on a study visit to Hungary in 2011. The Final Report includes some quotes from teachers who participated in the project:

> *"The students became more enthusiastic and lessons on fractions became enjoyable in a way they haven't always been. It was also good to see the students having to talk and discuss more with each other around their understanding of fractions and different aspects of number"*
>
> *"Working on this unit and developing it in a collaborative way like this really helped us to reflect on practice and pedagogy, I can feel the improvement in my practice as a result, and it has had an impact beyond just this unit but more generally on how I approach planning and teaching. I am very keen to keep doing this, both in my own school but also continuing to link up across schools – it is so obviously beneficial, if you've done it once you'll want to keep doing it!"*

Exploring lesson design through algebraic misconceptions is a project that spans Key Stages 3, 4 & 5. This group, from a school in Birmingham, aimed to think critically about lesson design to ensure that misconceptions do arise within the classroom and to help students develop their conceptual understanding of algebra through a variety of alternative approaches that are planned for by the teacher. The Final Report for this project includes some of the resources that the teachers used to draw out misconceptions from their pupils, reflections from the teachers involved, accounts of joint lesson observations and comments from pupils and teachers about the project.

Teachers said:

> *"It has opened my eyes to how misconceptions can be used as a basis for lesson design and how successful this can actually be in teaching and learning."*
>
> *"I now think about misconceptions firstly when I think about my lessons. I incorporate wrong answers into my worksheets and teaching aids."*
>
> *"I now see even more value in addressing misconceptions as they arise rather than brushing over them or waiting for a more appropriate time to deal with them."*

Do think about working on a Collaborative Teacher Project in the coming year.




## 5 things to do

Try the new Geoboard tool from Beluga Learning, which also features some suggestions for its use.

Have a look at the ROGO website, which includes instructions and a daily puzzle. These puzzles develop problem solving skills alongside some basic arithmetic and are accessible to a wide range of abilities. This reminded us of the daily SET puzzle featured in Issue 47.

If you are interested in patterns you will be intrigued by this video. As the website explains:

> The particles (sand, in this case) are arranging themselves along what are called "nodal lines" – narrow curves of motionless calm that criss-cross the otherwise vibrating surface. As the frequency changes, so does the distribution of these nodal lines, which becomes increasingly intricate at higher frequencies.

The NRICH website is building a series of collections of resources to enrich the Key Stage 3 and 4 curriculum.

The collections include the process skill areas of:

- Thinking Strategically
- Visualising
- Working Systematically
- Exploring and Noticing Structure
- Mathematical Modelling
- Representing
- Posing Questions and Making Conjectures
- Reasoning, Justifying, Convincing and Proof

as well as the topic areas within Number, Algebra, Shape and Space, and Handling Data.

On 14 – 17 April 2014, East Midlands Conference Centre, Nottingham University, will be the venue for BCME8 - Building Bridges, Making Connections. This conference of the British Congress of Mathematics Education is supported by other mathematical organisations and brings together teachers from early years to higher education, researchers, teacher educators, CPD providers, advisers, consultants, policy makers, examiners and professional and academic mathematicians. BCME only happens every four years – why not book a place for 2014?

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# Tales from the classroom: position or disposition

It's a while - almost three years - since I have contributed to *Tales from the Classroom*, and this return isn't really a tale from the classroom, more an observation from the office. In previous *Tales*, my classroom "inspirational moments" were rare, in a dogged and persistent struggle to convince students that I could help make a difference to mathematics in their school. I am happy to say that by and large we have been able to convince most of our students that together we really can make a difference to them and for them. I'm now at the end of my fifth year in my school, so the Year 11 that have just left have always been "ours". And notwithstanding a seemingly unstoppable fall in our attainment on entry over the 5 years we have been able to raise our A*-C from low 30s to just touching 80%. Similarly, 3 Levels of Progress has risen from the low 40s to over 80%. It is said a picture paints a thousand words - after 4 tough years of "convincing", I've learnt that the right number can replace a thousand words!

Five years ago a massive hurdle to student progress was a desperate struggle with staff retention in the mathematics team, and this theme has continued: last September, I recruited three NQTs . Having just delivered the best results the school had ever seen in mathematics with 12% of our students having just one GCSE grade C or better, and every one of those being their maths, the pressure was really on.

Before recruiting the NQTs there had only been two other teachers out of our staff of 37 who were below U3 on the payscale – we were a school of very experienced and "responsible" teachers. Would our new maths NQTs cut it? I really hoped the culture we had developed among our students would not crumble.

Well, it has been an interesting year – and not one I would have predicted. What has surprised me most this year is the faith that our students have in our leaders (and me – though I'm still to be convinced that is "well placed"). We have worked really hard to develop a culture of mutual respect, engagement, humour and resilience. We adopt restorative practices where we can, and expect the teachers in the team to genuinely participate in them. We also try to develop an approach where any maths teacher may be your teacher at any time. Some of our students may have had four different teachers at different points during year 11, yet despite initial concerns, nearly all students and their parents were very happy on August results day. We do have "positions of responsibility" within our team – I'm on SLT and lead mathematics whilst we prepare our NQTs for that leadership role. However, we are a team, and in our discussions with parents and students always use "we" rather than "I". There is not a rule-book for this – it just happens. (Nonetheless I have my own internal mantra on a constantly repeating loop.) A student may occasionally ask "Who is in charge of maths?". It is rare, and usually the student isn't really interested in the answer beyond meeting their own need for internal schema of perceived pecking order throughout the school. Yes, we do have troublesome students – many of whom of course are themselves troubled. We work with them, sometimes their "class teacher", sometimes me. Rarely though is it hierarchical. I've never had a student say to me "You're in charge – you should have…" - that doesn't surprise me. What does surprise me is that I've never had "You're in charge – you should have…" from a teacher.

My concern about "my" NQTs was misplaced. They have thrived: they are open, ready to adapt ready to change, ready to listen to students and expect the best from students, and do their very best by the students. Already students have huge faith in those teachers. It has been one our best years.

So… the observation from the office… as in the title it is disposition rather than position that seems to work for us. We never had a particularly hierarchical structure – positions didn't really matter to us or our students. They saw us as a united team. Our students knew that the art teacher was an art teacher, yet he worked with them to ensure they could progress. Not once have the NQTs thought "it's not my job to…". I am sure as a direct result of this we have never had a student think "they are an NQT – they can't". It is an attitude of mind that has engendered the positive approach from their students.

I'm no longer an NQT, although I have to do many things where I am "new" and unfortunately "un-qualified". My position dictates that I need to get on and do them, but it is my disposition that will ultimately dictate if I do them well.

*The author is a mathematics teacher and Assistant Principal, working in an 11- 16 school in the South West*