Secondary Magazine Issue 89

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 89 of the Secondary Magazine!

Summer is here? The question mark is needed because of the extremely variable weather we have been having recently, from drought warnings to floods! Whatever the weather, it is the summer term, external examinations are over and you just might have time to reflect and plan while dodging the raindrops. The two predominant themes in this issue are the recent Ofsted report Mathematics: made to measure and the forthcoming games – neither of which can be ignored. Happy reading!

Contents

From the editor – Mathematics: made to measure

Have you had a look at the recent report Mathematics: made to measure? Armed with a highlighter pen, I sat down to read the report. Within minutes I had highlighted significant chunks of the first few pages – what could I possibly leave out? Firstly, the report seems to echo my perceptions of what is happening in secondary schools and secondly it gives realistic suggestions for improvement.

> *The responsibility of mathematics education is to enable all pupils to develop conceptual understanding of the mathematics they learn, its structures and relationships and fluent recall of mathematical knowledge and skills to equip them to solve familiar problems as well as tackling creatively the more complex and unfamiliar ones that lie ahead*

The opening paragraph of the executive summary (above) sets a clear purpose for our work in school – one with which I cannot argue and yet, when I look at the departing Year 11 pupils, I wonder whether my colleagues and I have accepted and met that challenge?

Schools are incredibly busy places. Teachers are active from the moment they enter the building to the moment they leave at night – and beyond, but is our activity as teachers of mathematics directed to those points? I can definitely point to lessons where pupils have opportunities to develop their fluent recall of mathematical knowledge and skills; I can also identify the times when pupils solve familiar problems but it's the other parts that are more difficult – teaching is hard 'it does my head in' as some of my pupils might say. Integrating the ideas of developing conceptual understanding of mathematics, tackling creatively more complex problems and developing capacity to be able to apply knowledge and skills to problems that lie ahead into everyday teaching is a truly professional challenge.

The report is VERY readable and includes a lot of exemplification through 'prime practice' inserts so do read it for yourself. However the paragraph that I am thinking about at the moment is this:

> *187. Few schools provided guidance for teachers on preferred teaching approaches….. Teachers in many of the schools spoke of the informal discussions they had about approaches to teaching some topics, but such strategies were typically ad hoc. There was little evidence of schools developing systematic guidance for teachers on a range of topics. Sometimes, subject leaders believed that consistent approaches were being used and were surprised and disappointed to find during inspections that they were not. Scrutiny of pupils' work had become a common monitoring activity but it rarely considered consistency and appropriateness of approaches, or curriculum coverage and depth. Thus opportunities were missed to pick up weaknesses and inequalities early, and to provide support and challenge for teachers before fragile or patchy learning turned into underachievement.*

I am asking myself: What would the inspections teams have said about my school? Do we give sufficient time to sharing our teaching approaches? What do I really do as a result of a work scrutiny? Answering these questions will give me plenty of food for thought in the coming weeks. What will you be thinking about?

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A resource for the classroom – concentric circles

As the countdown to the games continues, the resources for the classroom in this issue use the idea of concentric circles. Circles feature throughout the mathematics curriculum and are common shapes in the mathematics classroom. Wikipedia defines a circle as:

> *a simple shape of Euclidean geometry consisting of those points in a plane that are equidistant from a given point, the centre*

This resource comes in two parts: the first is a set of instructions to draw a set of three interlocking rings using a pair of compasses and a ruler; the second uses equations of circles to identify pairs of concentric circles on a graph.

A note of warning as there are some restrictions on using the five rings of the Olympic logo which have prevented its use on cakes and in shop windows.

Part One – Drawing three pairs of concentric circles

Whenever I work on geometric constructions, there are pupils in my class who are simply not dextrous enough in using a pair of compasses to achieve an accurate result in whatever construction problem they are tackling; this exercise is for them – to improve their dexterity. You may like to think about having a (very) small screwdriver available to adjust those pairs of compasses that slip all the time and a supply of 'proper' pencils that fit into the pairs of compasses rather than the propelling pencils that pupils like to use.

This set of instructions will support pupils in drawing three pairs of concentric circles on a square paper grid – you will need to think about how to colour them effectively.

Variation one: you could present pupils with the 'picture' which uses the scaffold of a square grid – the skills pupils will use in working out how to draw the rings will support the development of problem solving skills. They could then make up a set of instructions for other pupils as a way of organising and communicating their findings.

Variation two: this logo could also be drawn using a dynamic geometry program (such as GeoGebra). While a simple drawing exercise does not exploit the power of the program, this exercise could be a useful familiarisation exercise to prepare pupils to use the program dynamically in the future.

Variation three: pupils could be asked to add more pairs of concentric circles to their drawing.

Part Two – The equations of three pairs of concentric circles

This resource sheet comprises two sets of cards. Both sets have twelve equations of circles. Pupils need to identify the six equations that they need to draw three pairs of equally spaced concentric circles.

The cards in Part A are factorised equations like this:

$$(x-5.5)^2+y^2=2^2$$

A useful interim step might be to sort the cards into the pairs of concentric circles.

As a more complex exercise, the equations on the cards in Part B have not been factorised; these could also be sorted into pairs (of concentric circles) but this may cause some surprises.

A way of checking pupils' solutions to either of these sets of cards would be to use a graph plotting program.

Focus on…differentiation

The NCETM Departmental Workshop Teaching Mixed Ability Mathematics has some interesting ideas about differentiation in mathematics lessons, and contains this quote:

> *A brief history of streaming is provided by Jackson (1964) (described by Barker-Lunn (1970) as believing in non-streaming) who sketched the Victorian standards system in which teachers were paid according to the number of children who passed to the next standard. This resulted in the brightest and weakest children being ignored and the teacher concentrating on the average pupils, namely those most easily brought up to the level required to pass to the next standard.*

You can read the rest of this quote in the Workshop's Resource Sheet 2.

The Mathemapedia entry Differentiation starts by saying:

> *Whatever type of group you are teaching - almost every individual has a different mathematical mind that looks at mathematics in different ways, understands at different levels at different times. The teacher is always looking for ways to manage this more effectively for more learners*.

The booklet Differentiation on Cumbria Grid for Learning that talks about differentiation in Science is worthy of consideration. Substituting the word mathematics for science makes this paper relevant for our ongoing work in the classroom. The paper talks about three types of differentiation:

a) DIFFERENTIATION BY OUTCOME, in which all pupils undertake a common task and differentiation is sought on the basis of the quality of response or outcome

b) DIFFERENTIATION BY TASK, in which pupils are set specific tasks matched to their ability. The tasks may be differentiated on the basis of inherent difficulty, the amount of structure, or the amount of guidance given, or a combination of all three.

c) DIFFERENTIATION BY TEACHER INPUT, in which during the assessment of tasks an allowance may have to be made for the level of teacher intervention.

The American website Teaching Today features an article, Differentiating Instruction in the Mathematics Classroom, that focuses on differentiation in mathematics. It begins:

> *What can you do to help all students reach their full potential? One option is to differentiate your instruction; in other words, teach using a variety of techniques and strategies that address the varying needs of all students.*

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5 things to do

Join the countdown to not only this summer's Olympic Games but also to future games in Sochi 2014, Rio de Janeiro 2016 and Pyeongchang 2018.

The June edition of the web-based NRICH magazine features some useful resources with an Olympic theme. I particularly like the Nutrition and Cycling problem which features a set of information cards to enable pupils to answer the questions about nutrition on a cycle ride. There is also an Olympic Records activity in which pupils have to match the graphs of Olympic records to the events.

Draft programmes of study for the new primary mathematics curriculum are available from the DfE website. You have an opportunity to respond to the proposals: ACME is working with the NCETM to facilitate this and you can contribute to the NCETM forum. Other information is available from the NCETM news item, which includes the links to a questionnaire which can be used to submit your response. It might be easy to think 'this has nothing to do with me – I work in a secondary school'; changing the requirements of the primary curriculum will affect the provision for pupils in secondary school so this is a chance to make your voice heard.

To coincide with Alan Turing's 100th birthday year, the Museum of Science and Industry are leading a citizen science experiment to find out more about the Fibonacci sequence and sunflowers. Turing's Sunflowers is a MOSI initiative in association with Manchester Science Festival and supported by The University of Manchester and Manchester City Council. The aim is to grow 3 000 sunflowers which will enable the scientists to collect enough data to test theories proposed by Turing and others.

The Royal Academy of Engineering Connecting Teachers programme has placed eight teacher co-ordinators around the UK. Their work is to work with other STEM teachers to widen participation at Key Stage 3, engaging girls as well as boys. Do find out who your co-ordinator is and see how you can get involved.

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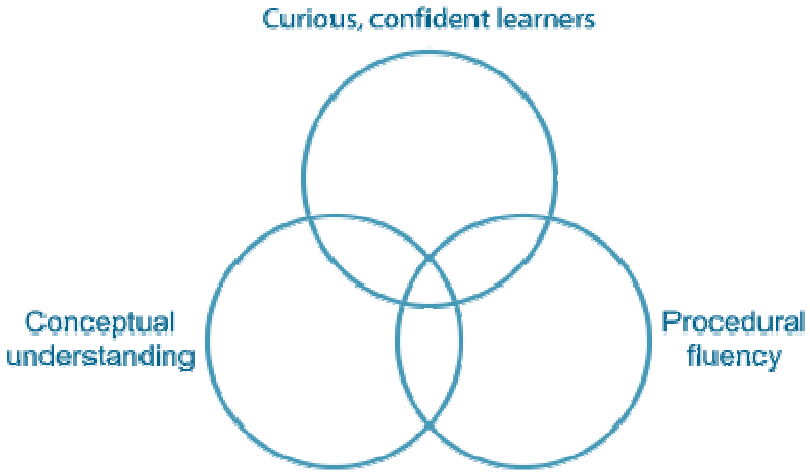
Tales from the classroom

I've been reading the Ofsted report Mathematics: made to measure and have found myself nodding along with a lot of it. While reading I started to identify three themes which formed a Venn diagram in my mind (possibly addled with exam preparation):



My thought is that mathematicians sit in the centre.

Whether this is valid or not (I'd be interested to hear other people's thoughts), I've found it to be a useful structure to think about my teaching, the activities and strategies that I use.

There are few lessons that I can think of that work on all of these (I'm not even sure if that would be desirable) but, as I think about my favourite activities, they seem to address two rather than just one. The Standards Unit resources, for example, feel like they are very good at developing both *Curious, confident learners* and *Conceptual understanding* but are maybe less aimed at developing *Procedural fluency* while a worksheet of examples is very good for developing *Procedural fluency*. It got me thinking about what questions might address just one area of the diagram so, in my Year 7 lesson, I tried to explore each part separately.

Procedural fluency
I drew a rectangle on the board, labelled one side 3cm and the other 4cm and asked them what its area was. They looked happy, lots of whiteboards said 12cm^2 and everyone seemed very much in their comfort zone.

Curious, confident learners
I drew another rectangle on the board and told them that the area was 15cm^2. Then I asked what the dimensions might be. This class are used to this sort of way of working, the language I've used 'curious and confident' is a big thing at my school and they didn't let me down. They weren't daunted by the lack of structure and many of the pairs came up with reasonable generalisations.

Conceptual understanding
Finally, I drew a 3cm by 5cm rectangle on the board and asked 'Why is the area of this rectangle 15cm^2?'
Year 7: 'Because three times five is 15'

Me: 'Why is that helpful?'
Year 7: 'Because the width is three and the height is five so the area is 15cm^2'

Going back to the report, I searched out the line that said that *pupils' 'explanations' often consisted of restating the method rather than justifying their answers*. I'd expected a better answer to the why question but it seems that the conceptual understanding of area isn't there yet. I'm confident that I am giving the opportunity for students to explore the concept but maybe I'm just using this as a tool to get to a procedural fluency that is longer lasting rather than deeper.

It seems to me that a genuine conceptual understanding across the board is a (big and daunting) target for me to work on next year.