Secondary & Further Education Magazine 103

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 103 of the Secondary Magazine (incorporating FE)

As the leaves are starting to turn and those glorious colours herald autumn, the days shorten, leaving plenty of time for mathematical and professional enrichment. This issue contains a variety of articles that provide resources for the classroom and possible catalysts for professional development. We hope you enjoy reading it.

Contents

From the editor: Mathematics and Science

You have probably had a look at the National Curriculum that was published recently, and the NCETM support for the new programmes of study that are due for implementation in August 2014 at Key Stage 3. The NCETM has published Mathematics in the new National Curriculum: latest facts and guidance to keep you totally up to date.

You have probably also looked at the GCSE subject content and assessment objectives document for mathematics that was published for consultation between June and August of this year (2013). But have you looked at the equivalent document for Science?

You may find this document interesting, as each section of the Science document makes explicit links to the mathematics that is used within the topic. Here are some examples:

Within Biology (on page 8) there is a section on Health, disease and the development of medicines. At the bottom of the section is this paragraph:

Use of mathematics

- translate information between graphical and numerical forms
- plot and draw different types of appropriate graphs selecting appropriate scales for the axes
- calculate cross-sectional areas of bacterial cultures and clear agar jelly using πr^2

Within Chemistry (on page 17) the section on Structure, bonding and the properties of matter concludes with the following:

Use of mathematics

- estimate size and scale of atoms and nanoparticles
- translate information between diagrammatic and numerical forms
- represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures eg allotropes of carbon
- interpret, order and calculate with numbers written in standard form when dealing with nanoparticles
- use ratios when considering relative sizes and surface area to volume comparisons.

What will you do now?

You could:

- use this document to include relevant references in your mathematics scheme of work which would enable mathematics teachers to refer to the scientific contexts when working on specific topics
- talk to the Head of Science in your school. Do you have a common understanding of the contexts that are suggested? Do you have a common understanding of the mathematics used?

- there may be some scope for joint working in science and mathematics, for example, a mathematics teacher could participate in a science lesson to teach the necessary mathematics, or science students could bring their work to the mathematics classroom (by negotiation, of course).

Why not tell us how you are using this document?

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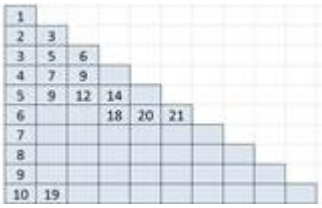

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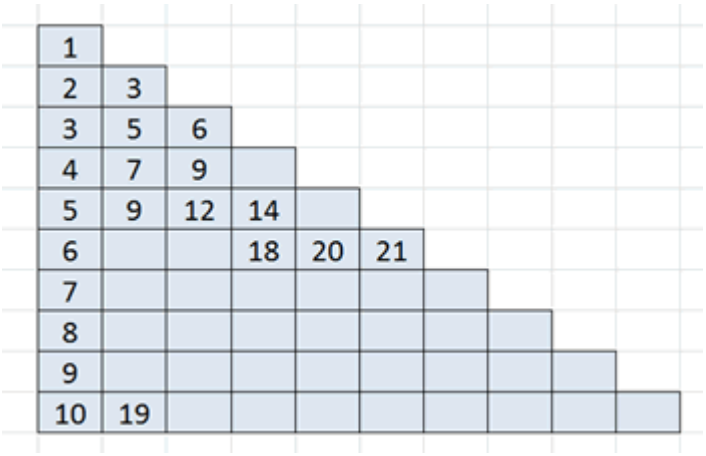
A resource for the classroom – a number pattern

You may like to promote mathematical behaviour in your classroom by considering this number pattern (you may want to use this spreadsheet).



1									
2	3								
3	5	6							
4	7	9							
5	9	12	14						
6			18	20	21				
7									
8									
9									
10	19								

Here are some possible questions you could ask:

How are the rows of the pattern constructed?

Add up each row. Can you predict the total of the next row?

How are the columns of the pattern constructed?

Add up the total of each column. What do you notice?

Does this happen if you add up, say, the first five rows? Or the first seven rows? etc

Look at the tenth row:

- how many terms are there?
- what is the difference between the first two terms?

Imagine you were going to write the 49th row:

- how many terms will there be?
- what will be the first two terms?
- what will be the total of the row?

Can you find any other patterns within the grid?

Why not tell us how you have used this number pattern within your classroom…

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Focus on…Every Child Counts

In this article, Andy Tynemouth from Edge Hill University and National Adviser for Every Child Counts discusses the problems of supporting learners who struggle to make sense of mathematics

Ever met a Y7 who isn't yet fluent in counting? Or who hasn't managed to master the concept of division? What about one whose self-esteem is below basement level? I'd be prepared to bet that most, if not all, teachers who have tackled mathematics in Y7 have met all of the above. As one well-respected secondary colleague said to me, 'Andy, I'm a good teacher. I can teach algebra and calculus but give me a kid who can't count and I'm lost!' The needs of these learners seem intractable, every attempt at addressing their needs seems doomed to failure: not least because failure at mathematics is all they've come to expect.

So…what do you do?

One approach could be to give them specialised tuition. Working for Edge Hill University for the last 6 years I have been lucky enough to be closely involved in the development, maintenance and roll out of the highly successful Every Child Counts (ECC) suite of programmes. As some may know, ECC was envisaged as a 1:1, specialised tuition programme funded by the previous government. It was originally targeted at Y2. The thinking behind this is that if you can tackle serious under-attainment early enough it can be nipped in the bud, and there is certainly strong evidence to support this. However, many thousands of children fall behind ***after*** Y2[1]. Imagine this: if mathematics lessons start to sound like double Dutch in Y3 then you still have eight years ahead of you to face bafflement, frustration and self-deprecation. This is likely to be enough to permanently damage even the most resilient of learners. It's more like a punitive sentence than the privilege of education.

This has led us to develop our programmes beyond their initial remit, i.e. beyond Y2 and KS1. Developing our programmes for older children, and later for students in Years 7 and 8, has been a fascinating journey. Believe me, the needs of a six-year old who cannot yet count fluently are very different from those of a 12-year old suffering the same problem (and there are many more of these than you may think).

But, before I go on, a word of caution. No doubt there will be almost as many ideas of what constitutes specialised tuition in mathematics as there are readers so I intend to clarify what I mean.

ECC programmes are built on constructivist principles. In other words we build on what the children have already got in place. We do not plug gaps nor, without a thorough understanding of where they came from in the first place, simply rectify misconceptions. In our intensive, teacher led programme Numbers Count (NC), NC teachers always start with an extensive phase of diagnostic assessment[2]. This can last as long as seven lessons: a significant proportion of a 40 lesson programme. During these sessions the NC teacher does not attempt to teach, rather they simply give the learners lots of opportunities to perform and discuss mathematics in a non-judgemental environment. This is harder than it sounds. For most teachers the instinct to intervene when a 'mistake' is made, or when a learner encounters struggle, is overwhelming. Most NC teachers report that mastering diagnostic assessment is the single most challenging aspect of their NC PD. However, we believe (and our substantial data on the attainment gains accrued on NC bears out) that developing an intimate knowledge of a learner's mathematical resources – their knowledge, skills, understanding and dispositions – is fundamental to helping those among the very lowest attaining learners to succeed. The teachers plumb the depths of these resources and then draw up a bespoke programme for each individual child.

The word bespoke is key here. There is much evidence that no two learners take the same path through the learning of mathematics[3]. This means that to really be able to put learners on a more productive path

a teacher needs both to gain a full picture of the learner's available mathematical resources and then to plan to help the learner to build on their existing foundations. The role of connections is fundamental in this. Those seeking to learn mathematics must be able to make a series of qualitatively different connections between:

- prior and current learning
- different representations of mathematics (symbols, language, imagery and concrete experience[4])
- divergent contexts

In these articles I will be exploring a very successful approach to the first: making connections between prior and current learning. We will see how Numbers Count teachers have used the 'learning map' to support this process.

The quandary with older children and learners is their increasing levels of self-awareness. Instinctively, we see this as a disadvantage assuming 'if they know they aren't good at mathematics then it'll be harder to move them on'. There is something to this argument. The amount of 'stuff' a twelve year old knows that they don't know is substantially greater than the amount of 'stuff' a six year old knows they don't know. However, this is not the end of the story. The art of teaching, as in many other areas, often consists in finding ways to turn an apparent deficit into an opportunity: for teachers, a learning opportunity. What is different about the older learners (that is from Y4 to Y8) is their capacity to be mobilised alongside the teacher as an active partner in their own learning rather than as their own denigrator. As we will see in a future article, there are mechanisms that teachers can use to do exactly that.

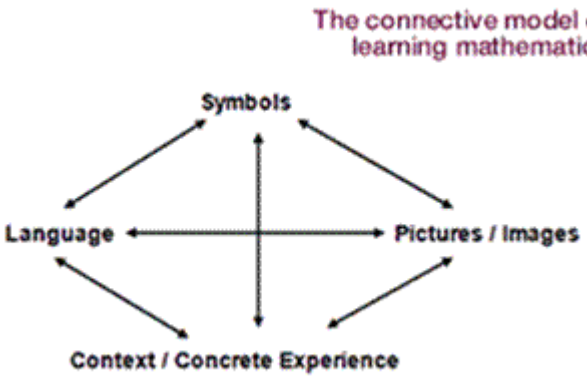
Footnotes

1 This year an estimated 79 000 children entered secondary school below age- related expectations in mathematics. For the same cohort more like 50 000 were below age-related expectations at the end of KS1. (DfE, National Tables:SFR34/2013, 2013)

2 In his sensitive and optimistic book 'Entering the Child's Mind' (1996) Herbert Ginsburg writes of the state of mind that teachers must adopt in order to learn how a child thinks. The teacher '*…should begin with the proposition that the child's thought is the product of a genuine attempt to make sense of the world and to create meaning.*' Those who struggle the most with mathematics are not wilfully refusing to learn. There are good reasons why they are in a pickle and we, as their teachers, need to understand these reasons ***before*** intervening if we are to genuinely help.

3 Denvir and Brown (1986) demonstrated that a child's grasp of number can probably take as many routes as there are children. Ann Dowker's (2004) very thorough literature review shows not only that the journeys children take to mathematical understanding are non-linear but that, using the correct methodologies, even the most hard pressed can be helped.

4 ECC programmes have evolved around a 'connectionist' approach to teaching and learning. This is best expressed through Haylock and Cockburn's (2013) connections model (diagram below) which is widely used in ECC PD and elsewhere. The model emphasises the central importance of explicitly supporting children in connecting the different representations of mathematics available to them in the early stages of their development: language, images, symbols and concrete experience. Interestingly, this has a strong resonance with the emphasis in the new mathematics national curriculum requirement that children are taught '…to be able to move fluently between representations of mathematical ideas' (DfE, 2013).



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Denvir, B and Brown M (1986) *Understanding of Number concepts in low attaining 7-9 year olds: Part i and Part ii,* Educational Studies in Mathematics, 17, 15-36 and 143-164

Dowker, A (2004) *What Works for Children with Mathematical Difficulties*, DfES

Ginsburg, H. P. (1997) Entering the Child's Mind: *The clinical Interview in Psychological Research and Practice*, New York: Cambridge University Press

Haylock,D and Cockburn, A (2013) *Understanding Mathematics for Young Children*, London: Sage.

5 things to do

You may want to see the revised Primary National Curriculum to see how the experiences of learners coming into your school may change in the coming years? The NCETM also has a guidance section, Implementing the new curriculum, which might be of interest.

The Further Mathematics Support Programme offers a range of professional development opportunities for teachers. These include:

- **Live Online Professional Development courses (LOPD)** aims to help teachers improve their mathematics subject knowledge. These online courses are typically offered twice a year; scheduled in autumn (Oct – Feb) and spring (Feb – Jun). They offer between 5 and 10 hours' contact time with an experienced tutor and are delivered to small groups of teachers, allowing opportunities for interaction and discussion. Course sessions are scheduled after the school day and are recorded to enable participating teachers to revisit the content at a later date;
- **Teaching Further Mathematics (TFM)** is an extended course starting in July and running for 14 months. Applications for the next cohort open in February 2014. TFM has the option of Masters accreditation;
- **Teaching Advanced Mathematics (TAM)** is a year-long course, with the option of Masters accreditation, for teachers wanting to develop their teaching skills at A-level. Applications for TAM open in spring 2014.

Listen to a recent broadcast of The Life Scientific from BBC Radio 4 which features Ian Stewart, Professor of Maths at Warwick University who has had a dual career as a research mathematician and someone who popularises mathematics for a wider audience.

Watch this talk given by Ron Eglash about the fractals at the heart of African designs.

And spend some time considering this mind-bending puzzle.

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Tales from the classroom: reflections on being an NQT

Two dedicated professionals starting on their second year as "the Maths Teacher" reflect on accepting the responsibility of both being a teacher, and teaching the most important subject!

Xavier

When I think about my first year of teaching, the first thought that enters my mind is 'I made it!' I can't believe that already a year has gone by and I have not found one grey hair yet!

I've had my first 6 weeks holiday as a teacher and after the many jokes of 'must be hard to do nothing for six weeks', I felt that I deserved a bit of a break. I have absolutely loved being a maths teacher and starting my career in such a supportive school. Now, as a 'post-NQT' teacher, I have realised that not every day will be great or enjoyable but it is a job where I have been inspired by my colleagues and the children that walk into my classroom every day. In the last couple of weeks of my summer holidays, realisation hit me at how much I enjoyed my job. I missed being at school and around the hustle and bustle of all the pupils, their missing PE kits and even those 'OMG' moments of who is now going out with who and who said x to y.

Upon reflection as a maths teacher, I have realised that I cannot always help pupils in lessons the way that their friends and peers may be able to. There have been a couple of occasions where, having explained to a pupils several times how to work out a question, I can no longer explain to them using my own terminology. I am a firm believer that pupils often learn best from their friends and so throughout my first year, I have allowed pupils to do some of the teaching and helping of others where I know that my own explanation would not work.

As a new teacher I've not yet acquired the experience to "know" all the misconceptions of pupils in maths. For this reason, a lot of my classes would often be conducted as a discussion with whole class participation, rather than me explaining everything and asking pupils to build upon my own definitions and explanations.

I sometimes fear that if Ofsted were to ever walk in to a class, particularly a Key Stage 4, expecting an archetypal "maths lesson" they would be disappointed. However, I have found that my own style works for me. Quite often you could find a child shouting out, or raising their concern with what I have just explained but I would not have it any other way. I, myself, used to struggle with maths at the beginning of secondary school, resulting in my parents hiring a tutor for me. I am proud and pleased with the pupils who feel comfortable enough in my classroom to be able to speak–up, in front of their friends, and say they are not entirely sure what we have just covered, as I know I probably never would have done that so outspokenly. For me, I think that if a pupil feels comfortable and happy around me then I have done a good job of letting them know that I am there for them. They can let me in, and then together we can progress.

The main thing that I have learnt this year, as bizarre as it may sound, it that I need to ensure that I remember that the children in my classroom are in fact children. It is very easy to forget that, when they have not brought in their homework, have arrived with their shirts untucked or have turned up ten minutes late to lesson, that these pupils are still young and children.

This is something that hit me towards the end of my first year. It is very easy to get caught up in the whirlwind of teaching and ensuring that everyone is happy, that you forget that some of these children coming to school are maybe having to look after siblings on a regular basis, have come to school on an

empty stomach or actually have very little guidance from people at home, that they are still learning themselves and do not actually know right from wrong.

I can honestly say that teaching as an NQT has been the best year of my life. I have never been so excited to come to work, looking forward to every single class I have that day and to then look forward to coming back and doing it all again tomorrow.

Yves

NQT year, a once in a lifetime opportunity … I'll tell you what, never again! I've had it now, my year as a newbie… I'm out of excuses now, I've added my first notch to my tally of teaching years to come and I'm proud of myself for getting here. Starting at the age of 23, my favourite prime number, my mathematics tells me that I have over 40 years before I can even think about retiring… 40 long years to continue this journey that is 'the maths teacher' – my identity now. That is the biggest thing that has come out of this first year, discovering my role and living it. Sure you spend plenty of time in training as a 'teacher' but it isn't until you move into YOUR own school, into YOUR own classroom, teaching YOUR own classes, teaching YOUR own style and spending time with YOUR own department; that you really begin to appreciate what it is to be a TEACHER.

I have had the most exciting year, moving into the next phase of my development, exploring who I am and who I want to be as teacher. I have been so blessed to come into a school where my head of department has given me such trust, freedom and encouragement in what I do. Of course there have been days, and classes, after which I have been mortified with my 'performance' as a teacher. I have also had days in which I have come home on an absolute high after cracking that tough class, tricky topic or having a breakthrough with an individual pupil. These days come and go and rolling into what I like to call 'school life'. If I had any advice to give a prospective teacher it would be to relax - good days and bad days happen, let them be, try your best with every student… persevere, learn and adapt. Inspiration comes from both colleagues and pupils. This is what I have learned to do as a teacher.

As a mathematician, somebody who appreciates and enjoys the fine intricacies in this subject, this year has been equally exciting. I'm 'one of those' who openly states that maths is beautiful and it has not let me down. This year mathematics has continued to supply me with little pockets of awe and wonder, pretty much on a weekly basis. It isn't until you are faced with the task of teaching something that you really, and I mean really, really, explore it in depth. Each week I get to truly pick apart the subject that I am most passionate about and, as a perfectionist, I delve right into each topic so deep that golden nuggets of new learning and understanding pop up all over the place. To do this with a class and share in that awe and wonder of mathematical discovery is what I live for.

I am not just any teacher… I am a fresh, slightly eccentric and passionate, post-NQT … Mathematics Teacher.

The authors are mathematics teachers working in the South West