Secondary & Further Education Magazine 92

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 92 of the Secondary Magazine (incorporating FE)

It's that time of the year when the clocks are put back, the leaves change colour and the nights are long. As the October holiday (?) approaches, it is time to take stock of the first half term of the academic year and to think about those new classes. How well are they learning? What do I need to do in the coming months to excite, enthuse and interest my students? Perhaps this issue will give you some suggestions.

Contents

From the editor – NCETM 'Essentials'
The latest addition to these valuable guidance pages focusses on resources and CPD for those working with students resitting GCSE mathematics – there will definitely some ideas here that you can use for your learners.

A resource for the classroom – NEW Bowland Mathematics tasks
In the past few years, the name BOWLAND has become synonymous with high quality, free, mathematics resources. Have you used them yet?

Focus on…learning from mistakes and misconceptions in mathematics
This issue contains the fourth in a series of *Focus on...* articles looking at an aspect of pedagogy in mathematics. Having an awareness of the typical misconceptions that pupils may have about mathematics, for example students believing that multiplying always makes a number bigger, can help you to tackle these areas as part of your classroom teaching. Here are some suggestions for further consideration.

5 things to do
The Olympic legacy, the new look NRICH website and some stunning firework displays are all part of the *5 things to do* in this issue. Be inspired!

Tales from the classroom
So how do you think about multiplication? Do you always have an image of repeated addition in your mind or are there occasions when the idea of scaling is more appropriate? Do pupils need both images? This *Tale* examines the case for using elastic bands in lessons…

From the editor – NCETM Essentials: resources and CPD for those working with students resitting GCSE mathematics

You probably know, if you are reading this, that the NCETM portal is amazing! There is such a wide range of interesting resources to support pedagogy and practice all in one place. Over the past few years the portal has grown and grown. One way I try to keep track of all those interesting things is to add them to my favourites by clicking the star/plus sign in the top left hand corner of the page then I can revisit those places easily via 'My Favourites'. Sometimes, however, it is hard to know what you are looking for. In this situation the NCETM Essentials is a good starting place. The Essentials are a set of guidance pages, pointing the way to various resources within the portal.

A new addition to the Essentials is for those working with students resitting GCSE mathematics. Wow – there are so many things in this 'Essential'. There are two generic sections Preparing to teach students resitting GCSE mathematics and Exam preparation. Within these sections there are numerous signposts to other areas of the portal where there are case studies and suggestions largely related to aspects of pedagogy.

There are also sections on

- algebra
- geometry
- measure
- number
- probability
- statistics

which catalogue a multitude of topic-specific resources from a variety of sources (including other areas of the NCETM portal, Improving Learning in Mathematics and the LSIS STEM Mathematical Moments) which encourage high quality pedagogy.

So how will I use this? I often wonder why students do not pass their GCSE the first time round and there are a range of reasons. When the obstacle is to do with understanding I don't think that repeating the same work all over again is the best way to address this so these mature learners would benefit from being given the opportunity to consider mathematical concepts in a different way. Some of these resources might help me to do just that. For example, the LSIS STEM mathematical moment Solving Simple Equations has the subtitle *Encouraging reasoning rather than 'answer getting'*. This mathematical moment encourages the learner to consider different ways of solving an equation and then picking the one that works for them; if the learners in the group have come from a variety of backgrounds there may be a range of different methods and this idea may enable them to see an old problem from a new perspective.

The link to this page would be a useful addition to your favourites, whatever the examination status of your learners – click the star/plus now.

A resource for the classroom – new BOWLAND mathematics resources

In recent years the Bowland website has hosted a range of free resources aimed principally at Key Stage 3 pupils. The resources aim to *help change pupils' views of maths by increasing their motivation and enjoyment, which should help increase their confidence and their competence.*

If you have not used these resources before, you could go to the Assessment Tasks, which are stand-alone lessons, or lesson episodes, with a focus on assessing pupils' progress in the Key Mathematical Processes. A particular favourite of mine is Cats and kittens, but there are 35 of these short tasks – why not try some and let us know how you got on?

Another part of the website hosts the case studies: teaching materials using a rich and diverse set of problems. These resources are mini-projects that can take several lessons; they were originally circulated on a DVD but can also be downloaded directly from the website. There is an NCETM forum where you can read about how other people have used these materials and have access to some of their resources. You can also read about teachers' experiences in using some of the case studies in their schools.

This year eight new case studies have been added to the Bowland site:

- AstroZoo
- Dance Star
- Design the Mascot
- Fashionista
- Football: the beautiful game
- Mission: Rainforest
- Olympics: Are women improving faster than men?
- Torbury Festival.

It is always hard to know where to start when there are new things available so I thought I would look at something that appealed to me: I plumped for Torbury Festival. Living in the South West, most pupils are aware of the Glastonbury Festival even if they have never been, so it would be a familiar context they could work in.

This case study has material intended to cover four lessons but it could take much longer – it depends on the detail you want to go into. There are lesson plans, video and audio clips, slides and resource sheets which present a series of challenges for pupils to work on during the lessons. The video clips did engage pupils who did not seem to mind the headline band being called 'The Prime Numbers'! The first lesson involved using a scale plan to work out how to pump water off a waterlogged festival site; the units in the calculations were complex and pupils had to make a decision what they would do, then justify their decision. There was no single correct answer for this task, which the pupils liked.

My favourite challenge was in lesson four, where pupils had to suggest the area of the stage on which the lead singer of 'The Prime Numbers' needed to stand to enable him to be winched to safety in the event of a rowdy crowd – which is followed by a video clip showing exactly that event taking place.

I hope this has inspired you to have a look at Torbury Festival – or one of the other new case studies on the website. Do tell us how you have got on.

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Focus on…learning from mistakes and misconceptions in mathematics

When pupils make mistakes in their mathematics it can be for different reasons. Some of these mistakes are made because they are not concentrating or trying to work too quickly however some mistakes are made as a result of a misconception; the pupil is thinking about their work but has not understood a concept correctly which is leading to incorrect responses. It is important to be able to distinguish between errors and misconceptions and have the tools to deal with them in the classroom.

There are some teachers who think that it is a mistake to draw attention to misconceptions but there is also a wealth of research evidence, which suggests that paying attention to misconceptions, building them into teaching episodes and drawing pupils' attention to them can be a valuable teaching technique. The resources highlighted on this page will give you the opportunity to make that decision for yourself.

The NCETM departmental workshop Use of mistakes and misconceptions to deepen understanding is designed to encourage you to make effective use of the common mistakes and misconceptions students make during lesson time. It explores some of the reasons students make mistakes and how you can use these to enhance students' learning. The workshop models how you could begin to address some algebraic misconceptions. This approach to developing lessons focusing on misconceptions could be replicated with other areas of the mathematics curriculum.

The Mathemapedia entry Misconceptions, Partial Conceptions & Errors: Mistakes – are they essential to learning? may give you something to apply in your own classroom.

The National STEM Centre eLibrary hosts the materials From Level 3 to Level 5 in mathematics – tackling misconceptions. Each of the four resources gives a sample of some pupil work with a commentary indicating the possible misconceptions, some test questions and an activity designed to work on possible misconceptions in that specific area of knowledge. The four areas covered are fractions and decimals, multiplication and division, area and perimeter and algebraic notation.

Improving Learning in Mathematics has a series of professional development resources which includes a module on learning from mistakes and misconceptions.

Finally, Mike Askew and Dylan Wiliam in their *Recent Research in Mathematics Education 5-16* (Ofsted, HMSO Publications 1995, ISBN 0 11 350049 1) make the following points regarding the use of misconceptions in mathematics:

One of the most important findings of mathematics education research carried out in Britain over the last twenty years has been that all pupils constantly invent rules to explain the patterns that they see around them.

Overcoming these kinds of misconceptions presents the teacher with a dilemma. When teaching multiplying whole numbers by ten, in order to present pupils with examples where adding a zero does not work, it would be necessary to stray far from the original topic and it may involve mathematical ideas that are, for the time being, beyond the pupils' capacity to understand.

The model of simple through to more complex examples can also lay the foundations of misconceptions.

It seems that to teach in a way that avoids pupils creating any misconceptions (sometimes called "faultless communication") is not possible, and that we have to accept that pupils will make some generalisations that are not correct and many of these misconceptions will remain hidden unless the teacher makes specific efforts to uncover them.
(Askew and Wiliam Recent Research in Mathematics Education 5-16, pages 12 and 13).

5 things to do

Have a look at the new-look NRICH website. All the previous content is accessible but the front page has been re-organised. I always find an interesting problem on NRICH – this time I found Shifting Times Tables (do look at levels 3 & 4).

If you are in your first year of teaching, or know someone who is, then they may find it interesting to look at these talking heads extracts of teachers in their first term of teaching who were asked 'What's the biggest challenge you have faced so far? How do your experiences compare?'

In preparation for Hallowe'en, you may want to use the Up2d8 Maths resource A big squash or another Up2d8 Maths resource for bonfire night, where students plan where to stand for a firework display.

You may want to continue to use the stimulus of the Olympic Games in your classroom so the blog hosted by the National STEM Centre Can the Olympic legacy be found in the mathematics classroom? may be of interest.

If you or your institution is involved with supporting other schools through providing mathematics professional development, then you should be aware of the free NCETM Professional Development Lead Support Programme that has been funded by the Department for Education. These two-day events, running throughout the year and in different locations across the UK, concentrate on Algebraic Proficiency in secondary schools, building on a primary school programme that considers Arithmetic Proficiency. Following completion of the programme, participants benefit from full NCETM accreditation.

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Tales from the classroom

Over the summer I spent quite a bit of time thinking about multiplication. I've always thought of multiplication as repeated addition. This was the way that I learnt it and is the way that I've always taught it. I've never really considered that it could be anything else. I mean, 3 x 4 is just 4+4+4 or 3+3+3+3. It's three lots of four or four lots of three.

But playing around on the internet I stumbled across this blog, the third in a series that looks at multiplication in a different way.

I think the first thing I felt on reading was a mild discomfort in that I wasn't really sure what he was talking about. I mean, it's just multiplying.

But I couldn't help feel that there was something that I was missing. It was thinking about the example of 3.174 x 2.95 which helped me to realise that my repeated addition image breaks down at a relatively simple stage. Can I really picture 3.174 additions of 2.95? I can just about make it fit it but it's very clunky and, for me, this isn't what maths is about. I want the images that I have for something as fundamental as multiplication to be slick and beautiful.

I read more, then had a look around the internet and found details of John Mason talking about using an elastic band to develop an image for multiplication. There's a webinar, although I must admit that I found the software less than intuitive - and it seems that the participants in the chat were also unfamiliar with it, leading to a less than fluid presentation. However, the content really helped me with my thinking.

I can see, in the stretching of an elastic band, the continuous nature of multiplication versus the discrete blocks of the repeated addition model.

So what impact did this reading and thinking have on my classroom? The first topic with my year 11 was similar triangles. I started by asking them to write as many multiplications as they could think of that gave the answer 12. Few got past the integers, one or two came up with 1.2 x 10 and we were then able to have a good discussion about the 'family' of multiplications that could be extended from this (ie. 0.12 x 100, 0.012 x 1 000 etc…).

I then asked the question "is it possible to get from 11 to 12 by multiplication?" and was disappointed but, if I'm honest, not surprised when the answer came back as no or, in one brave case, "what if you multiply by a negative?".

These are a reasonably good group. They sat GCSE early in Year 10 (school policy, not mine!) and most got Cs. They're aiming for Bs with the odd A but they couldn't get from 11 to 12 by multiplying and, even more surprising, they didn't think it was possible to get from 11 to 12 by multiplying.

I understand that the scaling or elastic band image for multiplication doesn't lend itself to a method in the way that repeated addition does, but I think that it's a valuable picture for students to have. I talked with my Year 11s and got them to visualise stretching an elastic band marked out as a number line. They could picture multiplying by 2 this way, and then 3, and could understand that the stretch took in all numbers in between. This led us to an image of multiplication that meant that there must be a multiplication that would stretch 11 onto 12. We just had to find out what it was.

This lesson was by no means perfect and I haven't quite got the imagery sorted out yet, but by shifting the idea of multiplication to scaling, it made sense to my year 11.

Now I plan to have a go with my Year 7 class. After all, the earlier I can get it right, the less time I have to spend fixing it!