Welcome to Issue 109 of the Secondary Magazine

It is our intention that this issue of the Secondary Magazine will distract you from all those chocolate eggs that are available in the shops. Comfort reading rather than comfort eating! Have a relaxing break.

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Pupils' progress and attainment in mathematics remains an important measure in the school accountability system. How well are *you* doing?

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This article is the fifth in a series of six, written by the authors of the recent publication *Key Ideas in Teaching Mathematics*.

A resource for the classroom – problems involving quantities and algebraic expressions
In response to the article featured in the *Key Ideas in Teaching Mathematics* section, this article features some problems designed to develop algebraic reasoning.

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How to teach Maths, an update on Maths Hubs, mathematics teaching in Shanghai, pupil voice, and a fascinating video clip of a ghost cube all feature in this article.

Tales from the classroom
The author of our *Tale* reflects on his priorities as a teacher whist he takes his daughters to a concert…

From the editor: How well are you doing?

Do pupils in your school do well in mathematics? In recent years, the performance of pupils in mathematics and English has become a prominent indicator in judging the performance of your school, both in the proportion of pupils that attain a C+ grade at GCSE (in five subjects including mathematics and English) and also the proportion of pupils making and exceeding the expected three levels of progress from Key Stage 2 to Key Stage 4.

In the recently-published Secondary School Accountability Framework, mathematics remains prominent. It has been announced that schools will be required to publish:

- pupils' progress across eight subjects. So, a parent will see whether pupils at a school typically achieve one grade more than expected, or one grade less
- the average grade a pupil achieves in these same 'best eight' subjects. This will show, for example, that pupils in a particular school average a high B grade or a low D grade in their GCSEs
- the percentage of pupils achieving a C grade or better in English and maths
- the proportion of pupils gaining the EBacc, which will continue in its current form.

Additionally, in calculating the Progress 8 measure mathematics (and English) will be double weighted.

There is no doubt that mathematics remains an important component of the curriculum in secondary schools – so how well are you doing?

The Ofsted school inspection handbook states:

> Inspectors must take account of **the learning and progress across year groups of different groups of pupils currently on the roll of the school**, including disabled pupils, those who have special educational needs, those for whom the pupil premium provides support and the most able.

So in considering the performance of these different groups of pupils, there are some external sources of data that you might use to answer the question – how well are you doing?
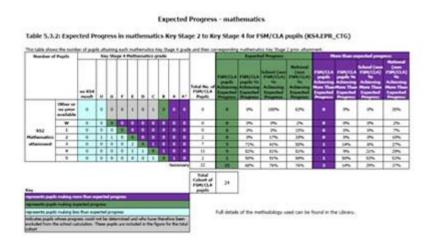
The DfE Performance Tables allow you to compare the performance of pupils in your school with other schools against a range of measures such as the performance of disadvantaged students, or consider the gender gap or the achievement of the most able:

The annual RAISEonline report is not in the public domain but your school can access this report with a password. A new feature in the reports for the 2013 data is a transition matrix to show the progress of pupils from Key Stage 2 to Key Stage 4 for FSM/CLA pupils (Free School Meals/Children Looked After):

This table allows you to see the progress made by FSM/CLA pupils from their Key Stage results and compare this to the national progress for this group.

As ever, scrutiny of data identifies issues and allows you to pose questions. What issues will you identify from your school's data? What questions will you ask? How will this improve the attainment and progress of your pupils?

So, how well are *you* doing?

Key Ideas in Teaching Mathematics – Algebraic reasoning

In this and other issues, the Secondary Magazine will feature a set of six articles, written by Anne Watson, Keith Jones and Dave Pratt, the authors of the recent publication Key Ideas in Teaching Mathematics. While not replicating the text of this publication, the articles will follow the themes of the chapters and are intended to stimulate thought and discussion, as mathematics teachers begin to consider the implications of the changes to the National Curriculum. This article is the fourth in the series and focusses on Reasoning with decimals in Key Stage 3. Future articles will feature Place Value, Algebra and Probabilistic Reasoning. Previous articles focussed on similarity, ratio and trigonometry in Key Stage 3, Geometric and spatial reasoning in Key Stage 3, statistical reasoning in Key Stage 3, and reasoning with decimals in Key Stage 3.

Algebraic manipulation without any meaning or purpose is a source of mystery, confusion and disaffection for adolescents. 'Meaning' in school algebra comes from the way relations between quantities and variables are expressed. 'Relations between quantities' and 'algebraic reasoning' – used in the title of the chapter of the corresponding book – pervade mathematics. Manipulating algebraic expressions enables us to express mathematical relations in different ways, and know more about them, when it is associated with some underlying meaning or purpose.

Algebraic reasoning involves:

- formulating, transforming and understanding generalisations of numerical and spatial situations and relations;
- using symbolic models to predict and explain mathematical and other situations;
- controlling, using, understanding and adapting spreadsheet, graphing, programming and database software

Expressing school algebra in these three ways links it to what young students know about relations between quantities. The simplest uses of algebra express relations between numbers when students already understand the relations. For example, finding x when
$2 + x = 5$ involves the additive relation $2 + 3 = 5$; similarly, $a + b - a = b$ expresses the relation that students can spot when asked to calculate $37 + 49 - 37$.

There is wide availability of symbolic manipulators which can transform expressions, solve equations, and carry out other algebraic techniques. Their use will help students answer questions which reflect all three statements above, rather than the more limited use of traditional algebra questions focusing on manipulation.

Students' problems with early algebra mainly stem from incorrect interpretation of notation. As with any notation, it is more effective to know what you are expressing before having to use standard notation to do so. If a student writes that $a+b = ab$ it does not mean that they do not understand addition, but that they do not understand what '$a+b$' and 'ab' and '=' are telling them. Saying that 'letters stand for numbers' is not sufficient as there are several different uses of letters in mathematics. They need to have a purpose for writing the sum of two unknown numbers or variables, and know that '$a+b$' is how we write that. For example, writing $a + b = b + a$ is the way we represent a fact about addition of numbers that they will already know. There are too many sources of particular confusion to list them here, but many are in the book *Key Ideas in Teaching Mathematics*.

We could talk endlessly about problems, so what about successful learning in algebra? There is no guaranteed way to teach and learn algebra. All approaches have limitations and many have significant

strengths. We do know that traditional ways of teaching leave many students confused and switched off mathematics, so diving in with rules and practice and mnemonics is probably not a good way. In this table, we summarise eight main approaches and some of their strengths and weaknesses.

Keith Jones, Dave Pratt and Anne Watson

In keeping this series of articles brief, there is no space for full references; these can be found in the book Key Ideas in Teaching Mathematics

National Centre for Excellence in the Teaching of Mathematics

A resource for the classroom – problems involving quantities and algebraic expressions

This issue of the magazine has an article linked to the recent publication, Key Ideas in Teaching Mathematics. There is a website that accompanies the book which provides links to some relevant resources. Our article this month is related to problems involving quantities and algebraic expressions, so the resources for the classroom are a suite of problems connecting measurement and decimals. Some of these problems may be familiar whilst others may be new to you; all have been chosen to develop and deepen understanding.

The website identifies five themes within the context of quantities and algebraic expressions which it lists as notations and conventions, structures and relations, the equals sign, modelling, and using algebra to reason. It states:

> *Much manipulation of expressions and equations can now be done by software, but students still need to be able to construct and recognise algebraic statements in their various forms.*
>
> *A range of tasks is available, including using algebraic methods to model, understand, control and make predictions about relations between quantities and variables. At the heart of all teaching methods is the need to recognise and move between equivalent expressions, equations and representations.*
>
> *There remains a fundamental need to understand what letters and other symbols represent, and how manipulations provide different, but equivalent, expressions.*

The individual problems are:

- Perimeter
- Performing number magic
- Evaluating algebraic expressions
- Number spirals
- (Generating) by using a formula
- Language
- Equivalence
- Keeping the pizza hot

What will you do now?

You could:

- select a problem and try it out with a particular class
- select a problem and work with a colleague to consider how you can use the problem to develop understanding for a group of pupils
- include some of these problems in your scheme of work
- consider how these problems develop the powerful aspects of the curriculum and the links between them.

Do tell us what you find out…

Image credit

5 things to do

Download or listen to the BBC Radio 4 programme How to Teach Maths, presented by Alex Bellos.

If you have done some pupil voice interviews in your school, you may have found out that pupils' perceptions of mathematicians and scientists may not be totally accurate. You may be interested to view the opinions of these pupils after a visit to Fermilab in Chicago. Would it be a good idea to replicate this project in your school?

Read a recent article about teaching mathematics in Shanghai from the perspective of an English visitor, and read NCETM Director Charlie Stripp's latest blog entry, Shanghai Surprise!

Read a little about the evolving Maths Hubs programme, which is being coordinated by the NCETM. The aim is to establish around 30 new, localised structures, drawing in maths education expertise from a range of institutions and individuals. This structure (the hub) will aim to work collectively to develop locally-tailored solutions in all fields of maths education, for the benefit of all schools and colleges in its area.

If you, or your school, already have a record of excellence and/or leadership in maths education, then your local hub will want to work with you. Schools leading each hub will be announced in early June.

This isn't strictly mathematics but have a look at Erik Åberg's website, or watch the video of the Ghostcube, and prepare to be enthralled.

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Tales from the classroom

Last Saturday I was lucky enough to be able to take my own daughters to see last year's finalist of BBC Young Musician of the Year. The concert was a fair way from home so we had decided to make a weekend of it. By the Friday preceding the concert I was beginning to regret my decision. I was getting grumpy, and with me not getting in before 7pm on any evening, my daughters were also getting cross

My working week had been a busy one. I had the latest Year 11 data trawl to analyse, my own lesson being observed by the Head, and three lessons to observe and feedback on for the teachers I performance manage. I knew all of these were valuable activities and required due attention, nonetheless, each seemed to pinch time from the other. Added to that the constant stream of Year 11 students wandering into my room and office with a "can you just show me how to" …. "I looked on YouTube, but"… "I still don't seem to get it"… I don't usually mind, but this week all of my Year 11 lessons had been disrupted by either language assessments or sports fixtures. Had these students been in my lesson, I would not be having to "catch them up" now. All that extra in the week against the usual busy backdrop of lessons, supervising the miscreants, and facilitating restorative meetings. And the constantly building pressure, knowing that I had to be out of the door prompt on Friday, and no catch-up time all weekend. Why, why, why did I think this concert was a good idea - should I have not have found one in half term?

Cutting a few corners I made it to Friday. Then, without knowing what happened, I'm home and jumped on by three exceedingly excited girls. Momentarily the stress of the week feels worth it - music is a valuable thing. Then as their excitement rose I realise it is the opportunity to pack "special clothes" that is really generating the peak in excitement not particularly the music! Soon we are driving up the motorway, each plugged in to our own music, and each of us just catching breath at the end of a week. It feels good, and it will be worth it.

Twenty-four hours later we were again in the car (Trusty Rusty) on a short drive to the concert. This time the excitement was about being at the event. I was anxious as I had booked the tickets a little late, the only remaining seats were six in the front row. There would be no easy exit with a fidgeting five-year old, we were in for the duration - well until the interval at least. We had arrived early to get organised, toilet checked etc. I had also invited my ninety-one year old, partially sighted, grannie, which brings its own challenges when you also have three under tens. We were so early that we had actually arrived before the ushers, so were in before the doors had "opened". This precipitated a conversation with the conductor, which itself then opened a discussion with the gentleman sat to my left.

His kind and humorous "you've your hands full there", my jocular responses of "I've usually thirty, but these four (3+1) are the most testing yet" found the common ground. He too was a teacher. I naively assumed music. Later I learned he too was mathematics. He appeared to be very knowledgeable about the young violinist we had principally come to see. I then realised that he was one of her teachers. He was explaining to my daughters that her school day started with violin practice at 7 am and finished with a final half hour of practice between 10:30pm and 11pm. My daughters' eyes opened wide. "She's allowed to stay up that late!" I too was a little taken aback. After all, I too am allowed to stay up that late - I just rarely seem able to make it!

When I had sorted sweets, drinks, spectacles and the obligatory, final (actually n-1) visit to the toilets, I had the opportunity to talk again. The teacher next to me explains how exceptional he feels the violinist is. He is no music buff, and his comments are not particularly about her musical abilities. They are much more about her as a young person. It transpires that he teaches her A-level Further Maths, they are both hoping for an A*. The A* at A-level appears a given. He then reflects that the week ahead will be a busy with lots of catch up. In the past three weeks the violinist has only made it to one lesson, and then just the last 20

minutes of that lesson. "She'll make it up though, it's just how she is." He clearly admires the talent, but also the sheer dedication, commitment and understated confidence. As the applause for the conductor gathers I'm left wondering if I would be so flexible, or is it that I've yet to encounter a talent that would make me so flexible.

The performance was inspirational. My own daughters inspired in their own ways. My eldest is outwardly excited and chatty. My middle daughter, less so, yet she is always more pensive and reserved. She has also practised her violin every day since, without need of a single word of encouragement. I too have found that the extra help I'm giving to my own maths students is done far less grudgingly than before. I hope that I had not let them see the annoyance I previously felt. I'm constantly on at them to be confident, committed learners of mathematics, and I know that the vast majority of their teachers do the same in their own subject. I'm far from convinced that my students or their parents choose to be placed in the multi-directional tug-of-war that Year 11 inevitably becomes. They may not have an exceptional talent that starkly reveals the individual complexity of demands on their time. However, for many of them there is no doubt it is keenly felt. I could practise a bit more often, and perhaps get a little better playing myself. The violinist showed me practice is important. The mathematics teacher taught me more: understanding and humility towards others even when you are stressed is not to be underestimated. I would do well to remember that more often and keep the door open, and the welcome warm.

The author is a mathematics subject leader and assistant principal working in the South West