Secondary Magazine 150

National Centre for Excellence in the Teaching of Mathematics

Welcome the first edition of the NCETM's Secondary Magazine of the new school year, and a special welcome to all those NQTs and trainee teachers picking up their first classes. The Secondary Magazine aims to feature excellence in mathematics teaching in all its forms, as well as keeping you updated with the NCETM's work and the work of the national network of locally-based Maths Hubs – which is the first place to look for excellent professional development opportunities. Look out for the magazine in your Inbox every half term.

This issue features a discussion with the exam boards about this summer's GCSE papers, and we hear how a Mastery Specialist is getting on with introducing teaching for mastery in her school. As a third, new, feature, we'll be signposting an article from our Primary Magazine, that may be of relevance or interest to secondary teachers.

Don't forget that all previous issues are available in the Archive.

This issue's featured articles

An Audience with the GCSE Exam Boards
Where did GCSE students perform well this summer? And which are the areas that they still struggle with? What can teachers do to help students overcome these difficulties? For our latest podcast, we gathered together representatives from OCR, Edexcel, and AQA, to pick their brains about this summer's GCSE exam questions. This article pulls out what they told us about the areas students are still finding difficult.

Back to School: September with our Secondary Mastery Specialist
Wendy Smith, a Secondary Mastery Specialist, featured in the previous issue looking at a school starting to introduce teaching for mastery. Two and a half weeks into the new school year, she tells us how it's going.

"Subitising": what is it? And why does it matter?
In the current issue of our Primary Magazine we take a look at 'subitising', an important skill for young children to develop, but with relevance to teachers of all age groups. Subitising is recognising how many things are in a group without having to count them one by one. Dots on dominoes or dice provide good examples of where we, without thinking, subitise. Do you know if your secondary students subitise?

And here are some other things for your attention:

- Have you thought about professional development for you or your department this year? The Maths Hubs website gives an overview of national CPD projects, and your local Maths Hub will be able to tell you what's available locally. Register NOW, as most start this term
- **Research:**
  - **Read:** "Teacher shortages are having the biggest impact on pupils from disadvantaged backgrounds", says new research from Nuffield Foundation and FFT Education Datalab

- o **Participate:** The Education Endowment Fund is looking for volunteer schools for funded research into Realistic Maths Education (RME): training Key Stage 3 maths teachers to teach mathematical problem solving. Read more
- There are loads of good maths storybooks and ideas for teaching on the MathsThroughStories website. They even have a new competition for young writers (age 8-13), The Young Mathematical Story Author Competition
- No more shoe sizes! Wondering how to use real and meaningful statistics with your students, for data handling topics? The Royal Statistical Society has created eight short interactive activities to help students understand statistical concepts and their relevance
- Our partners, MEI, have published their September newsletter, with updates on the new Advanced Maths Support Programme (AMSP) and more
- Staying with MEI, they're running Ritangle, a free maths competition for AS/A level students (individuals or teams). 25 problems being released over the next 10 weeks will culminate in a final challenge in December. Register now – the first problem is already out!
- Those involved in Initial Teacher Education (secondary) are invited to come and find out more about teaching for mastery – the pedagogy, and how Maths Hubs projects are supporting secondary schools to introduce the approach – at a free NCETM conference for ITE tutors on 28 January 2019 in London. More information and booking details
- What is Core Maths? Find out from students and teachers in this video from STEM Learning
- Do you teach Functional Skills? The Education & Training Foundation is offering an opportunity to collaborate on innovation projects that will support delivery.

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Work out $\frac{1}{2} \times 5$

Circle your answer.

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An Audience with the GCSE Exam Boards

Where did GCSE students perform well this summer? And which are the areas that they still struggle with? What can teachers do to help students overcome these difficulties?

In our latest podcast, we gathered together representatives from AQA, Edexcel and OCR, to pick their brains about this summer's GCSE exam questions.

First, we wanted to know if students were **better prepared** for the second summer of the new GCSE

The boards were understandably hesitant, it being difficult to make like-for-like comparisons given different papers, shifting grade boundaries, and the effect, this summer, of having a cohort of post-16 resit students included in the figures (this makes results difficult to compare with 2017 when re-sitters took the legacy qualification). However, all three boards saw evidence of better preparation.

> **Andrew (AQA):** It's easier to do a like-for-like comparison with the Higher tier (because re-sitters at higher are negligible in number) and certainly with measures like mean performance, and performance across the different assessment objectives at all levels of demand, it's clear that those higher tier students are performing better than last year.

> **Graham (Edexcel):** I think there is some evidence they have been better prepared, yes. At Foundation, equation solving has been better. Standard form questions have been answered better too.

> **Neil (OCR):** There is certainly some evidence to suggest that students were better prepared. Last year we were seeing candidates struggling in some particular areas such as quadratics and completing the square and ratio – there are still some issues with candidate responses but there does look to be improvements in some areas.

When we interviewed the exam boards last year, we asked which topics students struggled with. Is it the same topics that are still giving headaches this year?

Is **'ratio, proportion, rates of change'** still an area that students are finding hard?

> **Neil (OCR):** In terms of raw marks, algebra and the ratio/proportion/rates of change topics seem to be the ones that students are struggling at more. That was the case across the two assessment series last year as well. There are a number of questions on the new specifications where different content areas are being brought together, and I do think that ratio, and algebra, are two areas that do commonly get bundled in with other topics.

But it's important to emphasise that we are not just talking about the narrow 'ratio' topic, where a student might need to know how to simplify a ratio, divide in a given ratio or solve a problem, typically to do with paint or orange squash. We are talking about an understanding of multiplicative relationships that pervades a huge proportion of the specification, and indeed, mathematics more generally.

> **Neil (OCR):** For this new assessment, the 'ratio, proportion, rates of change' has its own section on the DfE content document. That really puts the finger on how much it has come up in this new assessment – previously ratio and proportion were just covered in the 'number' section.

Andrew (AQA): Outside the section in the specification, proportional reasoning is key to understanding of trigonometry, it's key to algebra, it's key to a lot of number work, similarity, best value problems, anything to do with rates – speed, time, pressure – so it absolutely pervades the whole of mathematics at this level. The student who really understands and can work deeply with multiplicative reasoning will be successful at GCSE.

And what about **fractions**? Are students any **better at handling fractions**?

Graham (Edexcel) says that this is still an area in which they are finding that student understanding is not as robust as they would like: [with] numerical or algebraic fractions, but particularly numerical adding or dividing or multiplying fractions – and percentages sometimes – there seems not to be the strong understanding of percentages that we would hope. That does turn up in quite a lot of questions.

Andrew (AQA) agrees: In terms of questions that didn't perform as expected for their place in the paper – I would echo what Graham said about fractions. The first question on one of our papers was:

1   Work out $\dfrac{1}{2} \times 5$

Circle your answer.

[1 mark]

$$\frac{5}{10} \qquad 2\frac{1}{2} \qquad \frac{1}{10} \qquad 2\frac{1}{5}$$

AQA Paper 1(F), Q1 June 2018

…only 39% of Foundation students got that right, and there were other questions around fractions, and converting fractions to decimals, that proved to be unexpectedly difficult.

How's **algebra** looking this year…?

Andrew (AQA) says: At Higher tier, the difficult algebra questions performed as expected – the strongest candidates are clearly good at that, but some of the lower demand algebra questions surprised us with how poorly they performed. For example, in this question, a lot of students got order of operations wrong which was surprising at Higher tier.

3   Circle the expression that is equivalent to $3a - a \times 4a + 2a$

[1 mark]

$8a^2 + 2a$ $12a^2$ $5a - 4a^2$ $3a - 6a^2$

AQA Paper 1H Q3 June 2018

And is **geometry** getting neglected with increased focus on number and algebra topics?

Neil (OCR): Yes and no. It has a smaller weighting on the new specification, so you would expect to see a reduction in terms of schemes of work time. Students are still struggling in some areas of the content, particularly around similar shapes, trigonometry. But geometry is not leaping out at me as an area that students should be spending more time on.

However, here is an example that many examiners thought would be a decent question:
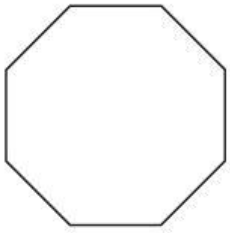
1   (a)   Write down the mathematical name of this triangle.
         Choose from the list in the box.

isosceles   equilateral   right-angled   scalene

(a)   ....triangle [1]

(b)   Write down the order of rotation symmetry of this regular octagon.

(b)   .... [1]

OCR, Paper 3(F), Q1, June 2018

But one out of ten foundation students weren't doing anything at all with that question, just left it blank. And less than 50% of students (F) picked up the mark for it. We would hope that students would be performing a bit better than that when faced with symmetry on a regular octagon.

Andrew (AQA): Whilst geometry gets a lower proportion of the marks than previously, there's still a lot of stuff in there, so it's going to be less sampled in an exam than other content areas. There's evidence that some parts of that big body of content are not getting the attention they should – things that have perhaps been covered in KS3 and are not revisited, such as enlargement questions – particularly at the higher tier, negative and fractional scale factors. Bearings, interior and exterior angles, properties of shapes – our worst performing question across all of the higher tier, was about the properties of a rhombus: It was a bit of an ask for one mark, but even given that, that only 4% got that mark was quite striking. It was the deepest dip in the performance.

13   Tick **all** the statements that are true for any rhombus.

[1 mark]

☐   The diagonals are lines of symmetry

☐   The diagonals bisect each other

☐   The diagonals are perpendicular

☐   The diagonals are equal in length

AQA, Paper 3(H), Q13, June 2018

Graham (Edexcel): I'll throw vectors into that too. We had a straightforward vectors question on the higher tier, that wasn't particularly well answered. Vectors is often tested as a 'vector proof' and can give some of the most difficult questions, but this time it was a much more straightforward question but maybe students just hadn't covered it:

26 $\mathbf{a} = \begin{pmatrix} 5 \\ 2 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} -1 \\ 7 \end{pmatrix}$

Work out 2**a** + **b** as a column vector.

$\begin{pmatrix} \text{......} \\ \text{......} \end{pmatrix}$

(Total for Question 26 is 2 marks)

Edexcel Paper 1, Q26(H), June 2018

Are students managing the increased **'reasoning and problem-solving'** demands better this year?

> **Neil (OCR)** tells us: within reasoning, it's the 'show that' questions that continually seem to be giving students more of a headache. Within problem solving, with both Foundation and Higher tier, it seems to be the questions that require you to translate problems into a series of processes. For Foundation tier only, it's those questions where students are required to bring together different areas of the content to solve a problem. Higher tier seem to be doing quite well with that - this is one of the few areas where there seems to be a distinct distinction between Foundation students and Higher students.

He also points out that evaluating assumptions is a very new area of the specification and one that students are still getting to grips with.

> **Graham (Edexcel)** concurs: follow-on questions that are often only one mark, but they are often 'interpret how this would have been different if some of the parameters had been changed'. For example, part (b) in this question:

22 A cycle race across America is 3069.25 miles in length.

Juan knows his average speed for his previous races is 15.12 miles per hour.
For the next race across America he will cycle for 8 hours per day.

(a) Estimate how many days Juan will take to complete the race.

(3)

Juan trains for the race.
The average speed he can cycle at increases.
It is now 16.27 miles per hour.

(b) How does this affect your answer to part (a)?

(1)

(Total for Question 22 is 4 marks)

Edexcel Paper 1 Q22(F), Q4(H), June 2018

Students do find those difficult to deal with, to be able to approach and give a descriptive answer – a lot of students think there should only be numbers on a maths paper. Part of the reasoning and interpretation is to follow up what you have done and show how the maths you have done applies, or tells you what it means, and those are still difficult areas.

Any other points that teachers might usefully think about?

Graham (Edexcel): Students and perhaps teachers, always seem to be better prepared if they've seen a style of question in a past paper. When it's something that's unusual, it's still difficult.

Where the question is unusual, it's more about the resilience of the student and their attempt to get something from the question than feeling familiar about something they've done in the past. … I don't think doing past papers carries you through everything. It's really getting a secure enough understanding that you can apply topics in different ways. For example – where in the past, we might have previously given the equation of a line and asked a candidate to draw it, this time we had the line, and the student had to find the equation and they did find that quite difficult:

22 The line L is shown on the grid.

Find an equation for L.

(Total for Question 22 is 3 marks)
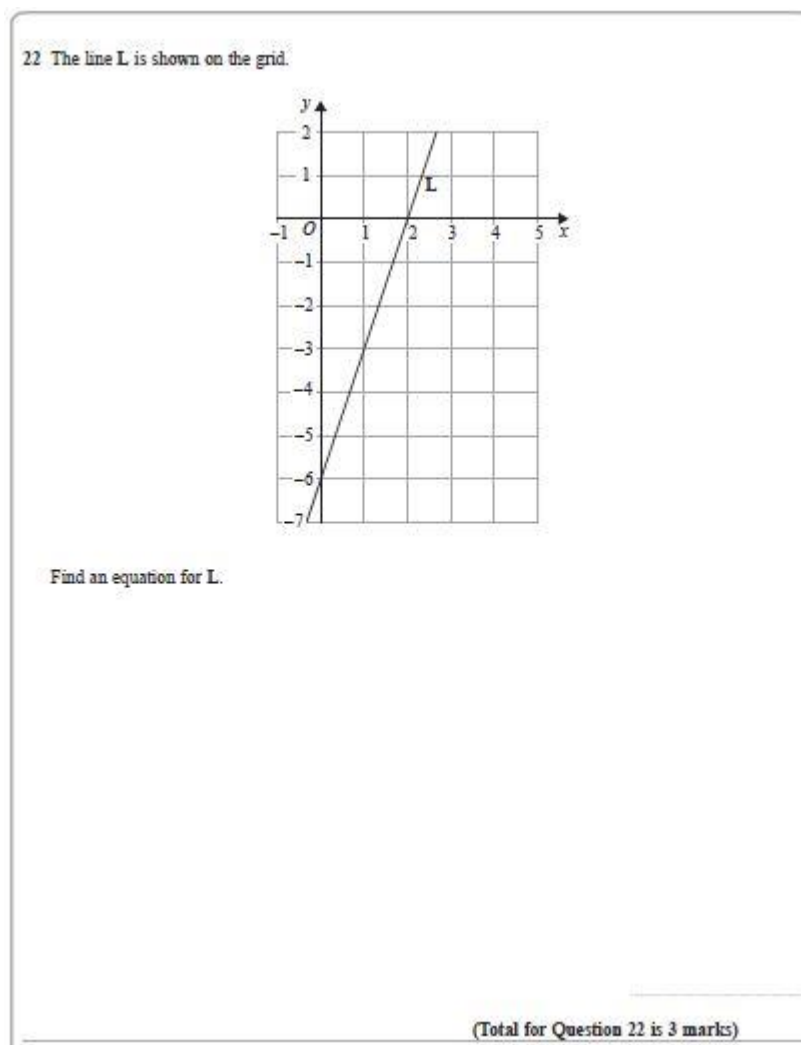
Edexcel Paper 2, Q22(F), Q3(H) June 2018

Andrew (AQA): I think perhaps a theme is that what we believed were lower demand questions on harder topics weren't performing to expectations. Perhaps higher tier students are expecting, and being led to expect, the seriously difficult stuff towards the end, but not performing quite so well on what we believed would be lower demand things.

What makes for a great exam question? And what makes examiners cringe and wish they'd never thought up that one? What makes students roar with frustration on social media? And how much notice do the exam boards take? Find out all this and more, by listening to the full podcast.

Talking to Gwen Tresidder (NCETM) were:
- Andrew Taylor (AQA)
- Graham Cumming (Edexcel)
- Neil Ogden (OCR).

Back to School: September with our Secondary Mastery Specialist

Wendy Smith is a Mastery Specialist (Yorkshire Ridings Maths Hub) from Headlands School in Bridlington, who began Mastery Specialist training in April this year. In the summer, we visited Wendy at her school and talked to her about teaching for mastery in her own classroom, and about her school's plans for introducing the approach (you can read the article here). Two and a half weeks into the new term, we caught up with Wendy to find out how it's going…

"Because I work part-time, somehow my days fell so that I was barely in school for the last week of term in the summer. In my absence, the decision was taken that only the two lower sets and one of the middle sets (of six) would follow the mastery scheme of work that I had put together with a couple of colleagues. There was concern amongst others in the department about a lack of stretch and challenge for students working at a higher level.

"This makes me reflect on my colleagues' understanding of teaching for mastery – and how my own has changed with the Mastery Specialist training I am engaged in. Change is something that requires good understanding, buy-in and collaboration, not something that can be imposed, however comprehensive and well-resourced.

"Those teaching the top sets were worried that some of the topics on the Foundation GCSE paper, that Y7s currently sit as an end of year test, would not be covered within a mastery scheme of work. I make no apology for this and instead would question the validity of sitting the GCSE paper as a sensible assessment of Y7 learning.
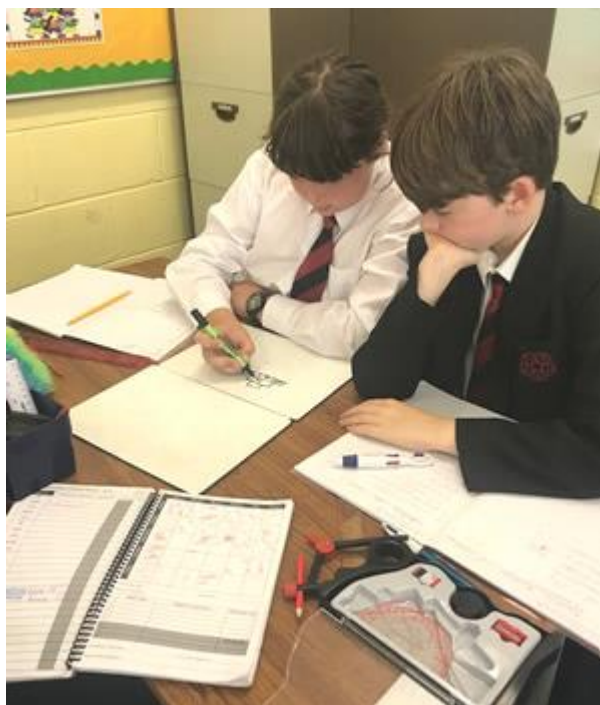
"So, I'm regrouping, and reconsidering my ideas of what can be achieved in my first year as a Mastery Specialist. The expectation is that we, as Mastery Specialists, take the first year to develop mastery techniques in our own classrooms, and I am beginning to see the wisdom in this staged approach. If I can show good outcomes this year – both in terms of learning and positivity towards maths – and develop my

own understanding and skills in teaching for mastery, then I may be more successful in bringing my department on board next year.

"In the meantime, I think my role with colleagues this year will be in sharing ideas for the classroom that encourage a teaching for mastery approach, and in developing an understanding of the use of variation theory in their lessons. I have moved on from my original plan, that I would produce strong and well-resourced lessons for teachers, enabling them to use teaching for mastery whatever their level of understanding of the approach. The first part of my scheme of work for Y7 is a unit on 'mental addition strategies'. Although this involved exploring some more complex ideas such as commutativity, I can see that my colleagues teaching the higher attainers could not necessarily see how this would be useful or challenging enough for their students.

"Meanwhile, I've been getting to know my Y7 class. It's a big class, 32 students, with SATs scores 100-106. I teach three out of four of their lessons. This week we've been looking at commutativity – something I would not explicitly have spent any time on in the past. I've been using a really interactive approach to lessons, that has helped me get to know what the students have been doing in maths up to now.

"I'm finding a lot of variety in the diet of maths that the kids have had at primary school, and trying to work out which of them have experienced a mastery approach. Two students had heard of 'commutativity', the others hadn't. About one third are familiar with bar models, but most are not. Lots, but not all, knew about 'fact families'. You can start to see elements of mastery beginning to seep through, but it is far from pervasive in our primary schools yet.

"There's going to be a challenge ahead in using an approach that is new to many and familiar to some, and in providing the commentary that allows them to value what teaching for mastery is achieving – both with my Y7s and my colleagues."