



Hello, and welcome to the last secondary Magazine of the school year. In here you will find Secondary Mastery Specialists talking about changes they've made to their practice in their first year, and we hand over to our partners at MEI to tell you about their exciting new resources.

As a bonus extra, particularly of interest to our FE readership, we have a feature on Citizen Maths.

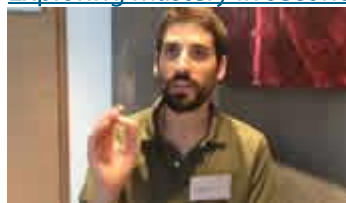
Don't forget that all previous issues are available in the [Archive](#).

### [New, practical, interactive resources, from MEI and IET – FREE](#)



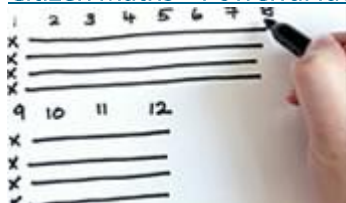
Apps, videos and short contextualised KS4 problems – in this article, MEI will give you a brief rundown of them all, with a few tasters. And of course, links to where you can find them.

### [Exploring mastery in secondary maths teaching](#)



July sees the first cohort of Secondary Mastery Specialists attending their third and final residential NCETM/Maths Hubs training. We caught them in between workshop sessions and asked them to describe changes in their practice.

### [Citizen Maths – Powerful Ideas in Action](#)



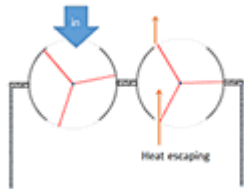
Seb Schmoller, from Citizen Maths, explains where he sees the strength of his organisation's approach.

And some other things to draw to your attention:

- Currently thinking about the new A level? You may like to take a look at two blogs: [alevelmathsthoughts](#) documents one department's journey as they navigate the issues in preparing for the new A-levels, while [this entry](#) from [sxpmaths](#) compares what the different exam boards are offering schools.
- In your NQT or training year and interested in getting your A-level knowledge and pedagogy polished up? ATM's [FREE three-day courses](#) in the summer holidays are now full but they are inviting expressions of interest for October
- Harry Baker, mathematician and poet, writes hilarious maths poetry. Here's one of our favourites, [A love poem for lonely prime numbers](#).

#### Image credit

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## New, practical, interactive resources, from MEI and IET – FREE

Our partners, Mathematics in Education and Industry (MEI), have recently collaborated with The Institution of Engineering and Technology (IET) to create a new collection of resources for maths teachers, and students. Stephen Lee, Research and Evaluation Manager at MEI, writes about the collection:

Three distinct strands of activity were developed:

1. 'A Bundle of Graphs', an app available online, or for mobile phones/tablets,
2. Short contextualised KS4 problems (ideal as starter activities),
3. A series of YouTube videos looking at AS/A level mechanics practical experiments.

All are available on [MEI's website](#).

Here we will look in a little more detail at some of the resources that have been developed.

### 1: 'A Bundle of Graphs'

The project has seen MEI adding a new app, A Bundle of Graphs, to their suite of already successful apps.

The app can be downloaded from either [Apple's app store](#) or the [Google Play store](#), for use on mobile devices and tablets; the online version is available on [MEI's Integral website](#).

A Bundle of Graphs involves six mini-games, played for points, against the clock. Each of these involves interpretation of some form of graph. Real-life applications and contexts for the graphs are linked from within the app, and held on a [webpage](#) that will continue to be updated.

Try your skills on this mini-game from the [online version](#):

The screenshot shows a mini-game interface. On the left is a coordinate grid with x and y axes ranging from -4 to 4. A red point is plotted at (1, 3). To the right of the grid is a 'PLAY' button. Above the grid is a blue button that says '< QUIT TO MAIN MENU'. Below that, the text reads 'Points: 200' and 'Time remaining: 26'. Below the grid, the question asks 'Which straight line is this point moving along?'. There are four options in colored boxes: A (orange) with  $y=5x$ , B (blue) with  $y=3x$ , C (blue) with  $y=2x$ , and D (orange) with  $y=4x$ .

There is a mini-game for each of the following types of graph: straight line; quadratic; position-time; velocity-time; and bar graphs (used to find mean and median).

Guidance on how to play and to learn about the techniques is built within the app, as is a 'learn mode' option. This allows the user to play ten examples in each mini-game and to study the correct answer if

they get one incorrect. The 'gameplay' scenario is more competitive where the user tries to get as many correct answers (and thus points) in a 60-second period.

Having both an app and web browser version allows teachers to use the resource flexibly, for example:

- at the front of class on an interactive white-board, engaging students in answering the questions.
- in class, with students using the app themselves on tablets or computers.
- encouraging students to download and use the app out of class.

MEI's other apps and games can be found on their [website](#).

## 2: Short contextualised KS4 problems

A set of 20 KS4 activities have been created which aim to:

- address a range of GCSE Mathematics content,
- promote the development of reasoning and problem-solving skills,
- make connections with real life applications/context,
- promote student discussion and communication.

As a minimum each resource includes a 'problem PowerPoint' (usually two or three slides) and a set of teacher's notes. Then, depending on the individual resource, student worksheets, spreadsheets or GeoGebra files may also be included.

One such short contextualised problem is 'Flow Rates Through Revolving Doors':

**IET** Education Faraday  
The Institution of Engineering and Technology

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### Revolving Doors

The diagram on the right shows two revolving doors in the entrance to a building. The doors are equally spaced and turn around a central pillar.

The architect is unhappy with the design as the doors allow heat to escape from the building at certain times during the rotation (see the far right door).

in

Heat escaping

Tomkins Engineers  
Active engineering careers at  
www.tomkinsengineers.org.uk

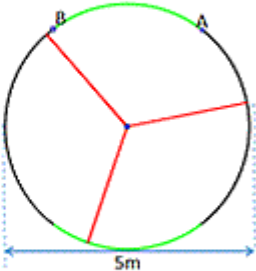
www.ietfaraday.org

**IET Education** Faraday  
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The solution is to reduce the size of the entrance and exit space on the door.

What should the length of the arc from A to B be reduced to in order to stop heat escaping?



**Tomorrow's Engineers** Explore engineering careers at [www.tomorrowsteachers.org.uk](http://www.tomorrowsteachers.org.uk)


[www.iefaraday.org](http://www.iefaraday.org)

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The architect is also worried that queues of people will form between 8am and 9am when 200 people arrive to start work, and again at 4pm -5pm when most of them leave to go home.

The doors revolve automatically and make one complete  $360^\circ$  turn every 5 seconds. Decide whether queues are likely to form at the start and end of the day. Justify your reasoning.



**Tomorrow's Engineers** Explore engineering careers at [www.tomorrowsteachers.org.uk](http://www.tomorrowsteachers.org.uk)

[www.iefaraday.org](http://www.iefaraday.org)

By considering flow rates of people through revolving doors, and the need to exclude drafts, students engage with the following curriculum areas:

- circumference of a circle,
- length of an arc,
- proportional reasoning,
- estimation,
- rates of change/compound measures,
- developing a mathematical model.

[This GeoGebra file](#) allows students to interact with the question posed.

Sets of resources for all the KS4 short contextualised problems can be downloaded [here](#); GeoGebra software can be downloaded free from the [GeoGebra website](#).

### 3: AS/A level mechanics practical experiments YouTube videos

With the 2017 A level Mathematics curriculum having a compulsory mechanics element, we wanted to emphasise the benefits to undertaking practical experiments and investigations. Therefore, a series of videos demonstrating relevant, practical activities that a teacher could use with students in maths AS/A level classes have been created. There are five that will shortly be available on YouTube, which consider:

- connected particles in motion,
- friction and resolving forces on an inclined plane,
- pulleys,
- exploring moments on a beam,
- projectiles in two dimensions.

The videos will be available soon on the [MEI website](#) shortly: bookmark the page now!

MEI are inviting feedback from teachers on these new resources. If you have any comments please contact [stephen.lee@mei.org.uk](mailto:stephen.lee@mei.org.uk).



## Exploring mastery in secondary maths teaching

The process of mastering maths is more easily imagined when pupils are starting from scratch: building mathematical knowledge from a base of almost nothing. Partly for that reason, the work in this field by the NCETM and [Maths Hubs](#) has been concentrated in primary schools.

But the objective of achieving deep understanding of maths is just as valid, of course, in secondary schools, even though pupils are mid-way through their journey of mathematical learning, some with vastly more accumulated understanding than others.

During the school year just coming to an end, a group of around 100 secondary maths teachers - a couple or more from every Maths Hub - have been working together on the secondary Mastery Specialists programme. The aim has been to explore 'what mastery means' in the secondary maths context, and try out some teaching, and teacher-collaboration ideas.

Here's a snapshot of what some of the teachers have been trying in their own classrooms. And you can hear them speak for themselves in these [video interviews](#).

### More time for 'productive struggle'



*Nick Wong, Lead Practitioner, Longsands Academy, St Neots, Cambridgeshire*

"The biggest thing we're doing is spending more time doing rich, long problem-solving tasks, and that teachers are feeling comfortable allowing time in class for that 'productive struggle' so that students hopefully play around and explore their maths a bit more and apply it to new problems. 'Productive struggle' means that students are having to think hard about what method they use: how to get started and progress through a problem. They're not just doing the same procedure several times over."

### One simple, focused target per lesson



*Irina Tolchenova, Lead Practitioner, Nobel School, Stevenage*

"The one thing I have changed is to teach only one, really, focused and specific target per lesson. For example, if I planned a Year 10 lesson on using the quadratic formula, I would now have one lesson to recognise the coefficients  $a$ ,  $b$  and  $c$ . So, I would change the positions of the terms, and I would target misconceptions, for example when the  $x$  squared term has no coefficient, children think that  $a=0$  rather than 1. The next lesson would just concentrate on the discriminant."

### More use of pictorial representations



*Jose Salinas, Head of Maths, Heathside School, Weybridge, Surrey*

"For me the main difference in my lessons has been (increased use of) pictorial representations of the topics I'm trying to get across to students. So there's a lot more bar drawings and diagrams. And I find myself, when students ask me for help with a question, saying 'Draw me a picture. Let's see what it looks like.' And then we take it from there."

### Deeper mathematical discussions



*Teresa Booth, Head of KS3 Maths, Tomlinscote School, Frimley, Surrey*

"I've tried to make sure that I tighten up my use of language and be very precise mathematically. Then, modelling that, I require that of the students as well. So I don't just accept an answer any more. I want them to explain what that answer represents and the from that, there would be a question about 'How have we got to that?' and 'Why have we done that?' ...and 'What does that tell us?' ...and exploring lots more around the problem, rather than thinking that the objective is just to come up with a number that is 'right.'"

### Emphasis on visual representations

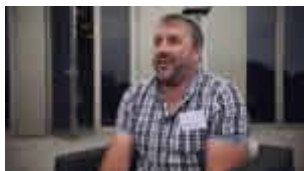


*Christian Walsh, Responsible for teaching and learning in Maths, Tewkesbury School, Gloucestershire*

"Putting the emphasis on visuals to a far greater degree has enabled me to teach much more powerfully. For example, with fractions this year, I spent a lot longer on adding and subtracting fractions just with diagrams, and the students understood it much more powerfully. Rather than saying 'Here's the method; let's get the common denominator and then let's fly through 20 questions,' it was much more 'Why do we need a common denominator; let's look at this picture,' with students drawing more pictures in their books. The understanding there was so much more powerful, in a Year 8 class that wasn't the best, than anything I'd seen previously."



## Slower pace develops confidence to tackle unfamiliar problems



*Terry Butler, Maths Teacher, Lipson Cooperative Academy, Plymouth*

"The main thing is the pace of the learning in my lessons. There's a lot more discussion and time taken to understand what's going on. Gone are the days when it's question, question, question. It's now one question which could take three lessons worth of work to get through. There's no point whizzing through the curriculum just to say you've ticked the boxes. They have to understand the mathematics.

"Now students are willing and able to attack any problem I set them— just because we've built the foundations quite strong. The discussions that we have, the way they praise each other's efforts, the way that they spot different ways of doing things. I don't praise the answer any more, I ask them, 'How did you get there? How does that work?' I try to confuse them as well. They are willing to get stuck now – they didn't used to be."

### Variation theory



*Garry Potter-White, Lead Practitioner for Maths, Purbeck School, Dorset*

"The main thing for me in my classroom is the introduction of variation theory, so I like to try to bring in lots of diff ways of posing questions but still focusing on the same concept.... We tend not to rush on and move on to making the concept more difficult but sticking to the same concept and seeing it in different sorts of ways. And maybe bringing in previous knowledge and different ideas into that one concept that I'm teaching. Students like to be reminded of skills they've covered previously."

### Narrowing the curriculum in KS3



*Linda Greaves, KS3 Maths Coordinator, Priory City of Lincoln Academy*

"We've narrowed the curriculum on Years 7 and 8 to Number and Algebra, to make sure that by the time they enter Year 9 they are GCSE-ready in Number and Algebra, and then we can build the Data and Measures in later. Because of that, they are much more confident and fluent in Number and starting to make links between different concepts."



### **The answer is only the beginning**



*Andy MacDonald, Head of Maths and Computing, Marling (Grammar) School, Stroud, Gloucestershire*

"We've made more of the idea of the answer being just the beginning. There are two strands to this. First, the idea that multiple solutions to the same problem are better than the same solution to five highly similar problems. And second, giving students the answers and making them communicate and write the journey of getting to the answer. This makes the answer almost the trivial part of the task, rather than the main achievement, and this means their sense of achievement comes from communicating the reasoning rather than getting the answer. That's had a significant impact on my practice."

### **Engaging with the pedagogy to support teaching for mastery changes**



*Peter Mattock, Head of Maths, Brockington College, Enderby, Leicestershire*

"The programme has given me that grounding in the background understanding and the research, that as a teacher, is so hard to come by, and so hard to find time to assimilate. I have had time to take a step back and engage with the writing and what the people are saying about teaching for mastery, and then been able to identify those elements that already exist in my own practice, and those I would like to develop further. This has been the major benefit for me. As head of department, I've found that being exposed to some of the background materials, resources and articles, which I've shared and discussed with my department, has meant that other teachers have been able to take that into their practice with more assurance and confidence."



## Citizen Maths – Powerful Ideas in Action

*Seb Schmoller, Citizen Maths Project Director*

[Citizen Maths](#) is designed for self-motivated adults who want to improve their grasp of maths. It's a free, open online course that looks at maths from a different perspective, engaging learners in activities that reveal the 'maths inside' - in effect, the practical power of mathematical ideas. With this audience in mind, Citizen Maths resources could be particularly useful for FE teachers, but many secondary teachers will also be able to use them in class, or for directing their students to. Indeed, of the approximately 13,000 people who have so far signed up, about 8% give their age as 16-19, as do over 15% of those who have completed Citizen Maths.

The focus is on the immediate relevance of maths to the problems people need to be able to tackle. Instead of abstract routines, the course uses practical problems to help learners grasp and use some "powerful ideas" in maths. The course covers five such ideas:

- Proportion
- Uncertainty
- Representation
- Pattern
- Measurement.

Learning about each idea is supported by a mix of short video tutorials, practical exercises, and quizzes, involving five to ten hours of study.

Citizen Maths may also be of use to:

- colleges and other learning providers who want to give enrolled learners an additional or alternative route to improving their maths;
- parents who want to be better able to help their children with their maths.

### How does the course work?

The tutorials feature the hands and faces of maths educators Noel-Ann Bradshaw (University of Greenwich) and Paula Philpott (South Eastern Regional College, Lisburn).



The practical exercises use a range of approaches, including:

- tools, like spreadsheets;

- purpose-built self-standing apps of various kinds;
- a modicum of coding in the educational programming language, Scratch.



Each powerful idea is shown in action in several different contexts. For example, 'Uncertainty' involves the following situations:

- Making decisions - value of insurance, risk comparisons;
- Judging - the meaning of cancer screening results;
- Gaming - appreciating odds in roulette, dice, horse-racing;
- Modelling - the uncertain prediction of the weather.

The overall approach of Citizen Maths, the powerful ideas, and the situations in which they are shown in action have been selected in consultation with post-16 mathematics teachers (including Jane Imrie, Deputy Director of NCETM), and with the involvement of maths education specialists at the UCL Institute of Education including Dave Pratt, Piers Saunders, and Graham Griffiths.

Learners work at their own pace, and can choose which parts of Citizen Maths to focus on. They can spread the work on each idea over several weeks or a few days and also go back over areas at will. There is no pressure, nor do learners have anyone looking over their shoulder to see how they are doing.

Here are a couple of short videos with learners and teachers talking about Citizen Maths:

### Learners talking about Citizen Maths



*CTRL+Click to view*

### Tutors talking about Citizen Maths



*CTRL+Click to view*

To find out more, go to the [Citizen Maths website](#), where teachers and learners can sign up for the course, and where you can find a wide range of support resources for learners and for teachers.