Underground Mathematics newsletter

October 2016

underground mathematics

In this newsletter:

Introduction

Written by Professor Martin Hyland, co-director of Underground Mathematics

My role in Underground Mathematics is sheer pleasure. I get to think about serious mathematics and discuss it with the rest of the Team. The content of School Mathematics is far richer than is commonly realised and the enthusiasm of teachers to convey that to students is infectious. But there is a darker side to involvement in education: the politics. Right now there is no avoiding the excitement about grammar schools.

Prima facie that has nothing to do with Underground Mathematics. However in support of Grammar Schools it is claimed that new style smart tests will be able to assess the 'true potential' of each student. That makes no sense for reasons connected to our philosophy.

Unsurprisingly no examples of smart tests have been offered. In their absence, The Guardian recently chose to amuse its readers by publishing some 11 plus questions. The distracting headline was: 'Are you smarter than an 11-year-old?' Here, with my commentary, are the Maths questions. (There were also some even more problematic questions on so-called Verbal Reasoning.)

1) How many thirds are there in 9? A) 3 B) 18 C) 9 D) 27 E) 30.

That is a horrible question: the formulation subtly misleads by echoing the more natural forms - What is a third of nine? and How many threes are there in 9?

2) What is 21.7 times 9.4? A) 287.68 B) 532.42 C) 117.24 D) 203.98 E) 412.96.

Presumably the intention is: we have roughly 20 times 10 = 200 so the answer is obvious. That would be a good school question if ideas of approximation are being taught. But are they? If some students are going laboriously to long multiply, we simply distinguish those taught to approximate from those not.

3) Shania has 3 pieces of wool to make a bracelet. One piece is 160mm long, another piece is 26 cm long and the last piece is 0.45m long. What is the total length of wool, in centimetres, that Shania has?

Beware of questions with an artificial context. Why to make a bracelet? But more artificial is the use of different units to trap the unwary.

4) Which of the following statements is true?
A) Most prime numbers end in a 5
B) 2 is not a prime number
C) Prime numbers have only one factor
D) The sum of the first 3 prime numbers is 10
E) All prime numbers are odd.

I intensely dislike this. Students should know that there is something special about the factorisation of primes so they are directed to C; and then it is a question of definition - one might say primes have just one non-trivial factor with the intention not to count 1, which after all divides everything. But the 'correct' answer is a random fact relying on knowing the first 3 primes.

I have sympathy for the setters of these questions. They have to avoid the curriculum - else it is clear that schooling will affect results. The only alternative is some kind of brainteaser. But such questions rely on tricks which mislead the inexperienced. Evidently students can be and are trained to recognise tricks of various kinds. The idea of a tutor-proof test - at least in mathematics - is fantasy.

It is best that I emphasise that I write on my own behalf. I regard exams as a necessary evil: they are a crude method of assessment at best. But I respect the work of Exam Boards. They invest heavily in world-class research because they have to aim both for reproducibility of outcomes and assessment of real understanding. What (I hope) they do not do is try to assess potential.

Here the distinction between Training and Education is important. In Underground Mathematics we aim to provide the basis for a Mathematical Education - with the stress on both words. We try to do so in such a way that training for the examinations happens in the course of the education; but it is the education which matters. Potential of individuals emerges slowly in the course of genuine education. It involves the whole person. Wise teachers who interact with students on a daily basis help realise potential and have some chance of forming a view of it. But it is arrogant to think that we can test for potential with any kind of certainty.

In the spotlight: UM Champions

In each newsletter we will focus on an area of Underground Mathematics - this time we take a closer look at our Champions programme

Last week we had a wonderful two days of working with our new Champions and some of our partner school teachers in Cambridge. Following this, we are pleased to introduce our first cohort of Underground Mathematics Champions: Rob Beckett, Graham Coleman, Hannah Lees, Susie Parkin, Yvonne Scott, Heidi Steele, Becky Walters and Colleen Young.

During the year they will take on roles such as encouraging and helping other teachers develop their use of UM, raising the profile of the site, and giving feedback on resources to the UM team. They know our resources and practice our philosophy in their classrooms daily, and we are super excited to have these passionate, enthusiastic teachers as our spokespeople.

Teacher perspective

Hannah Page, from Brighton Hove and Sussex Sixth Form College, shares her experience of using the resource Integral chasing with her AS students

I chose this resource as a starter question for AS students after they had completed an independent study on finite integration and one lesson on the topic. I had the 4 integrals projected up in the classroom with the instruction to find a through to d. Then I left them to it! I love how the resource makes the students think 'backwards'. Even at that stage in their learning they were so used to progressing the normal way through integration problems - integrate, substitute numerical limits, end up with a numerical solution – that giving them this problem quite early on in their study of finite integration exposed them to an alternative view and deepened their problem solving. The brightest students quickly figured out the best way through the problem and weaker students used support to begin but quickly gained confidence in tackling the problems.

$$(1)\ \int_a^5 10x+3\,dx = 114$$

$$(2)\ \int_{2a}^9 b\sqrt{x}+\frac{a}{\sqrt{x}}\,dx = 42$$

$$(3)\ \int_{\frac{1}{2}}^1 \frac{1}{x^5}-\frac{1}{x^2}\,dx = \frac{c+1}{4}$$

$$(4)\ \int_6^{c+2} x^{\frac{b}{a}}\left(\sqrt{x}-\frac{1}{\sqrt{x}}\right)dx = ab^a d^a$$

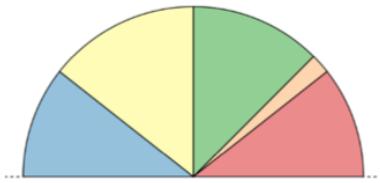
I left the students to work as they chose. Most began independently but quickly groups formed as they began discussing the best paths through the problem. Checking strategies became the focus of many discussions as the effects of carrying errors forward were felt as well as interesting discussions on the presentation of their solutions. For those students who completed the task ahead of time I encouraged them to have a go at creating their own chain of integrals. Some found this harder than they expected, especially if they wanted 'nice'

answers at the end! The students reported that the task helped them sort out their understanding of the topic and also raised some misconceptions they needed to clear up. An enjoyable experience for us all!

New and updated resources

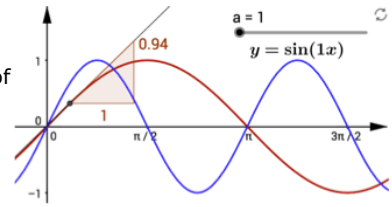
A selection of resources that are new to the site or now contain interactive card sorts

Slices of Pi



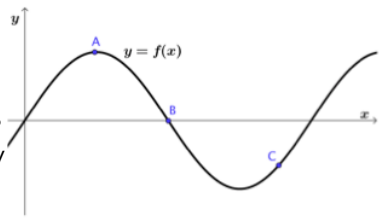
When is sin(x) bigger than cos(x)? When is tan(x) smaller than cos(x)? In this resource, inequalities of the form sin(x) < tan(x) < cos(x) have been used to slice up a semi-circle. Which inequality defines each slice?

Sine stretching



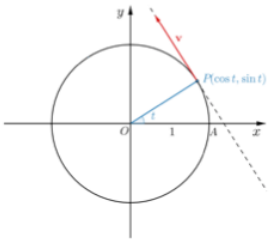
Students are asked to use their knowledge of the derivatives of sin(x) and cos(x), alongside some graphical reasoning in order to find the derivative of the function sin(ax) without having to use the chain rule.

Estimating gradients



Students are asked to estimate the gradient of a sine graph at three different points. Can they then sketch the graph of the derivative? This task offers students a chance to see why we use radians in calculus rather than degrees.

Rotating derivatives



By considering a particle or point moving around a unit circle, students are asked to interpret diagrams and create a chain of reasoning which lead to the derivatives of sin(t) and cos(t).

Card sorts

Several of our resources have been updated to contain interactive card sorts, meaning you can use them on an IWB, laptop or tablet. Check out Gradient match, Log lineup, Choose your families and To log or not to log to try this new feature.

Free CPD: UM Webinars

The first UM webinar was successfully held at the end of August. It was based on a bundle of resources with the aim of developing a mathematical classroom. If you missed it, you can find out more about the bundle here, as well as watching the webinar in full.

We are holding a second webinar on Wednesday 2nd November at 4pm (GMT). The focus of the webinar is 'Using student work as a resource' and will be exploring UM resources that include examples of student work that can be used to in the classroom. To register for the webinar please click here.

Free CPD: MEI courses

MEI are again running free CPD courses helping teachers to use UM in the classroom. The focus of the courses is 'Resources to address the requirements of the new A level' and they are being held at Maths Hubs around the country. For more details or to sign up, click here.

Underground Mathematics community

The Underground Mathematics site is accessible to all, and its design is rooted in teacher experience. So we would value any contribution you can make by sharing your experiences of using our resources with your students. You can join the conversation by creating a login for the site and using the 'Discuss' link that appears at the top of each page.

Our Twitter feed is @UndergroundMath, where we regularly tweet resource suggestions, events we are involved in and any interesting maths we come across. You can also find Underground Mathematics on Facebook here.

Meet the team

Over the next few months you can find the team at the following conferences

UM webinar: Using student work as a resource, online, 2nd November, 16:00 (GMT).
Educating the educators, Freiburg, Germany, 7-8th November.
FMSP: Sixth Form Student and Teacher Problem-Solving Conference, Cambridge, UK, 5th December.

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