Underground Mathematics newsletter

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underground mathematics

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Introduction

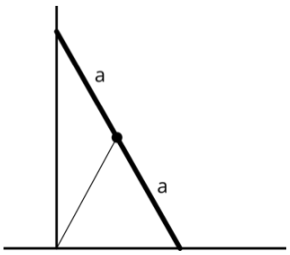
Written by Professor Martin Hyland, co-director of Underground Mathematics

The OECD PISA report from 2015 came out before Christmas and the UK results in Mathematics did not look great. The tests are influential though it is far from clear what they tell us. Some say that PISA tests problem solving and it is intended that the new Mathematics A Level will do the same. I worry about the emphasis on problem solving and think that it distracts attention from the factors inhibiting mathematical understanding.

Some of these factors are pedagogic issues which need to be addressed in the classroom. Underground Mathematics resources are designed to enable all students to have a go at problems, to develop a feel for mathematics and to build confidence. Good classroom culture is very important to address anxiety, fear of failure and the damaging belief that one is no good at maths. Recently we have developed Your mathematical classroom, an area of the site which is intended to help with issues of that kind.

What I raise here bears rather on the mathematics: time pressure as a factor inhibiting understanding. It is hard to prevent problem solving becoming a race but one does not acquire understanding in haste. Recently I gave a talk to students in Cambridge, encouraging VERY SLOW THINKING. Here is something along those lines to think about.

We lean a ladder of length 2a against a wall as in the diagram, and ask what curve the midpoint describes as the ladder slides down the wall. I give the diagram so that reasons for the strangely counterintuitive answer - a quarter of a circle centre O radius a - become apparent. (This was recently given as an example of an Oxford Interview Question. You might want to look on the web at the accompanying remarks.)



The obvious extension is: what happens to other points on the ladder? So now consider a ladder with a point distance a from one end and b from the other. The natural A Level approach is to draw the diagram and observe that $x = a\cos(t)$ and $y = b\sin(t)$. Then from $\cos^2(t) + \sin^2(t) = 1$ we deduce that $x^2/a^2 + y^2/b^2 = 1$, and the point lies on an ellipse.

So is that it? I want to say no. Rather we should feel puzzled. We should have the sense that we are missing something. What is that? Well I make a point by not saying for the moment. Why? Because it is a matter of mathematical understanding and that is the kind of thing which needs time. So I shall come back to this on another occasion.

In the spotlight: Bundles

We take a closer look at our Bundles of resources that can be found in the Your mathematical classroom area of the site.

Our tubemap provides an excellent way to navigate through our resources by content, whereas our bundles offer a slightly different approach. They are small collections of carefully selected resources from different parts of the tubemap. Each bundle has a particular focus related to a mathematical idea or concept, or is about helping your students to develop as mathematicians.

We currently have three bundles; Developing a mathematical classroom, Using student work as a resource, and Asking questions in the classroom. The resources in each bundle can be used in the suggested sequence to take students on a particular mathematical journey, or they may be used over a period of time, interspersed with other problems and activities.

With each bundle we run a webinar to support teachers to use the resources and think about how good mathematical habits can be developed in the classroom. Previous webinars are available on the site as videos.

Webinar: Asking questions in the classroom

Wednesday 1st March at 4pm

We have an upcoming webinar entitled 'Asking questions in the classroom' on Wednesday 1st March at 4pm.

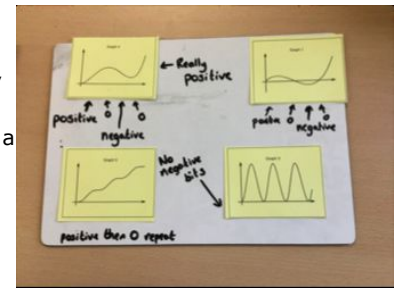
Register for the webinar here.

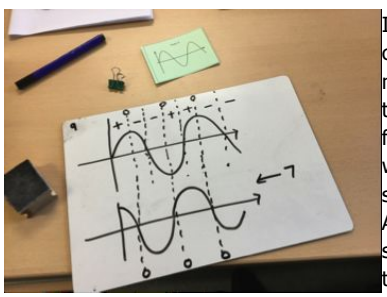
Teacher perspective

Hannah Lees, one of the Underground Mathematics Champions, shares her perspective on using Gradient match with her students.

I decided to start calculus with this activity after a short conversation with my further maths group. Initially I was really pleased when I overheard a student saying to the girl sitting next to him that he 'loved differentiation' but when I pressed him as to why he said that, his reply was 'because you just times by the power and take one off the power', and that was the end of his understanding - cue appalled face from me!

I started by putting the graph of $y = x^2$ on the board and asking the class, working in pairs, to write down anything they could say about the gradient. They were all happy to identify positive and negative sections, with a few students also able to recognise that the gradient was 0 when $x = 0$. I used their comments to draw the gradient function on the board and to introduce the idea of a stationary point for the first time.





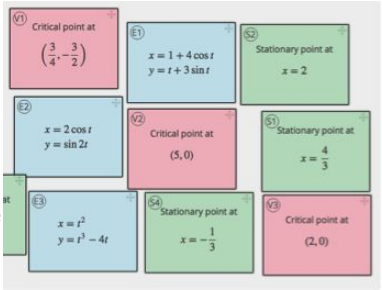
I gave each pair of students a set of the cards and let them get started trying to match them up. They were immediately able to match the straight line to its gradient function. They then reached for the whiteboards. Most pairs split the graphs into sections and considered each one separately. A few grouped them first by number of stationary points and then tried to match them to intersections with the x-axis. I asked them to use the whiteboards to provide evidence to back up their matches. All students in the group completed the task confidently as they could use the method we modelled for $y = x^2$.

We used the interactive cards on the board to complete the final matching and shared the different evidence the pairs had provided. For the students who finished the task early I asked them to sketch the graph and gradient function of $y = 1/x$. Students who had previously met differentiation at school said that they now understood how it related to the graphs and those who hadn't met it before looked forward to exploring the algebraic relationship. Following this activity we moved onto differentiation from first principles and I'm looking forward to using Gradients of Gradients in a few lessons time!

New and updated resources

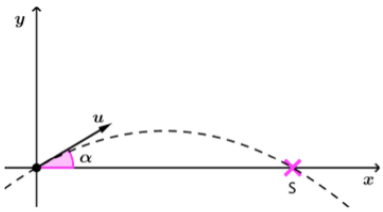
A selection of resources that are new to the site are shown below. To see all the resources published in the last month click here.

Parametric points



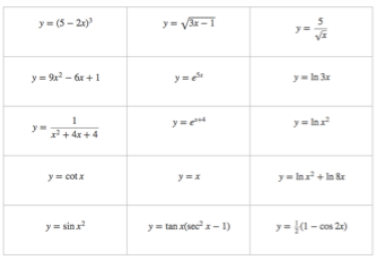
Students differentiate a collection of parametric equations in order to complete a matching exercise. This gives practice at the mechanisms of differentiation and encourages understanding of how the chain rule is used in this context. Matching with the graphs encourages students to think about how algebraic properties relate to features of curves.

Where did it land?



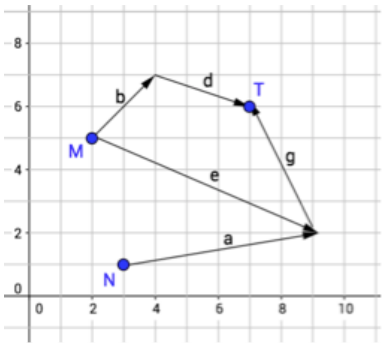
When students begin to think about projectiles they often encounter specific problems that demand numerical solutions. The problem outlined in this resource asks students to think more deeply about how a projectile behaves, and in particular about the effect of the angle of projection on its horizontal displacement.

I can see u!



This resource aims to help develop students' fluency with the chain rule using a variety of functions. Students are asked to identify a suitable u or 'inner function' for each of the given functions and then find dy/dx. Different ways of rewriting the expressions involved may lead to alternative options for u.

Hit the spot



This is one of the resources at the newly available Vectors station, where students are asked to convert between different representations of vectors and practise adding vectors in two dimensions. The task should help to reinforce the idea that a vector is unchanged by translating it in the plane and expose any confusion between vectors and positions.

Opportunity for students: PROMYS Europe

Enthusiastic school-aged mathematicians (age 16+) from across Europe are invited to immerse themselves in mathematics for six weeks this summer, at the residential PROMYS Europe programme at the University of Oxford. For more information about the programme and about how to apply, please see here.

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 join UMChat, a Facebook group for teachers to share experiences and ideas for using Underground Mathematics in the classroom.

Meet the team

Over the next few months you can find the team and the Underground Mathematics Champions at the following events.

Linear A Level Maths Conferences, featuring OCR, MEI and Underground Maths,
London, 1st February
Birmingham, 7th February
Manchester, 2nd March
Newcastle, 14th March
Exeter, 22nd March
Jo Boaler's Mathematical Mindset Workshop, London, 6th February
Underground Mathematics Regional Conference with MEI, London, 10th February
BSRLM Conference, London Mathematical Society, 3rd-4th March
Key Stage 5 Network Meeting, Reading, 15th March
Mathematical Association Conference, Royal Holloway, 7th-9th April
ATM Conference, Stratford, 10th-13th April

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