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Introduction

Written by Martin Hyland, co-director of Underground Mathematics

Readers of this Newsletter will know that I worry away at the notion of mathematical understanding. One aspect is that simple ideas frequently have depth but depth which is hard to capture. As an example I shall discuss something which occurred to me when I was first trying to convince decision makers of the importance of taking mathematics seriously.



Vladimir Igorevich Arnol'd (1937-2010) was an extremely influential mathematician, albeit a highly opinionated one as I saw the one time I heard him lecture. In 1995 he was interviewed by S. H. Lui for the American Mathematical Society. I quote something which he is recorded as saying about his early mathematical experience.

The first real mathematical experience I had was when our schoolteacher I. V. Morozkin gave us the following problem: Two old women started at sunrise and each walked at a constant velocity. One went from A to B and the other from B to A. They met at noon and, continuing with no stop, arrived respectively at B at 4 p.m. and at A at 9 p.m. At what time was the sunrise on this day?

I spent a whole day thinking on this oldie, and the solution (based on what is now called scaling arguments, dimensional analysis, or toric variety theory, depending on your taste) came as a revelation. The feeling of discovery that I had then (1949) was exactly the same as in all the subsequent much more serious problems —

The problem is a charming one and I used it years ago in arguing for real mathematics. I suppose that we would say that it is most obviously an exercise in proportional reasoning and we probably have some sense of why that relates to scaling arguments and dimensional analysis. (That Arnol'd mentions toric varieties - an important topic in algebraic geometry - is just showing off.) But the range of ideas like this is wider than may appear.

I realised this a little later, when I thought to use another Arnol'd related problem in discussions about the teaching of Probability and Statistics. The problem comes from a collection of exemplary problems which Arnol'd published under the title (in English translation) A mathematical trivium. Here is problem 99 of 100.

One player conceals a 10 or 20 kopeck coin and the other guesses its value. If he is right he gets the coin, if wrong he pays 15 kopecks. Is this a fair game? What are the optimal mixed strategies for each player?

My thought was this. The mathematical technique required to answer this is not hard but you do need some feel for Probability. For me the problem represents a basic test of understanding. If you don't have it then there is little

Of course 'Is this a fair game?' is a question expecting the answer no - a *num* question in Latin. Perhaps readers will see the parallel with the earlier question but just in case I offer a suggestion. What should the guesser pay if wrong in order to render the game fair? There is depth there but hard to capture so I say no more.

We take a closer look at how we can help you plan for teaching the new A level

[illegible]

To download this document visit our [Prepare for the new A level](#) page. You can also follow [@UndergroundMath](#) and keep an eye out for our posts with the hashtag [#UMprepare](#).

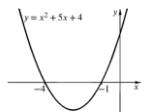
A selection of resources that are new to the site are shown below. To see all the resources published in the last month click [here](#).

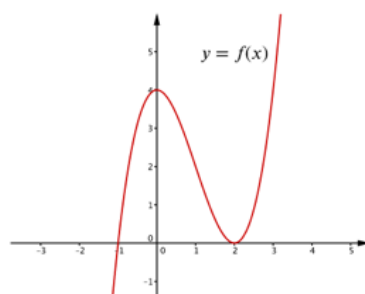
$$f(x) = \frac{(x-1)-(x-2)}{(x-1)(x-2)} + \frac{(x-2)-(x-3)}{(x-2)(x-3)} + \frac{(x-3)-(x-4)}{(x-3)(x-4)} + \frac{(x-4)-(x-5)}{(x-4)(x-5)}.$$

Parametric preliminaries

This resource encourages students to think flexibly about inequalities by providing a table where they are asked to fill in the blank spaces so that each

row contains a solution set, a graph and an inequality.

Solution set	Graph	Inequality
$\{x : x \leq -4\} \cup \{x : x \geq -1\}$		$x^2 + 5x + 4 \geq 0$



Order! Order!

Students are asked to think about and describe combinations of graph transformations with a view to seeing when the order matters and when it does not.

UM blog

[Read the new post 'Reflections on thinking mathematically' by Yvonne Scott from Ranelagh School](#)

Since attending a Mathematical Thinking skills workshop lead by Prof John Mason I have found myself thinking about students doing problem solving. John talked about a shared language to be negotiated with students so that the teacher and the class understand what is happening but this is only part of the picture that might help. I certainly don't know the answers to this and I'm not sure my reflections give any answers but they are worth thinking about and discussing with other teachers.



[Read more](#)

Free CPD: UM conference

Teachers who have attended any Underground Mathematics professional development sessions are invited to attend a free, one-day conference at the National STEM Learning Centre, York, on 12th July 2017.



The aim is to help you to get more out of Underground Mathematics as you prepare to teach the new A Level courses, including the following.

- Share your experience of using Underground Mathematics in the classroom
- Discuss ways to develop your students as mathematical thinkers

- Explore the website and new resources with the Underground Mathematics team

Bookings for this conference are managed by [MEI](#). If you would like to attend please

[Book now](#)

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

[MathsConf10](#), CEME Conference Centre, London, 24th June

[MEI conference](#), Keele University, 29th June – 1st July

[Doing Maths: Learning through activity](#), IoE, London, 8th July

[Mathematics Education beyond 16 conference](#), University of Birmingham, 10-12th July

[Underground Mathematics teacher conference](#), STEM centre, York, 12th July

[New to teaching A Level summer school](#), STEM centre, York, 20th – 23rd August

[BERA conference](#), University of Sussex, Brighton, 5th – 7th September

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