UNITED KINGDOM MATHEMATICS TRUST

Maths Challenges News

Issue 52   October 2016

20 years of UKMT

It's hard to believe that the UK Mathematics Trust is approaching its 20th birthday. Just over twenty years ago, around a quarter of a million students participated in the nine or ten mathematical competitions for UK schools, mainly due to the drive, energy and leadership of Dr Tony Gardiner. During 1995, discussions took place between the various mathematical bodies to seek a way of setting up a single body to continue to develop these competitions and related activities. This led to the formation of the UKMT in October 1996.

Since then, the number of entries to the Mathematical Challenges has increased to over 670000, and the Trust runs many activities to fulfil its aim of advancing the education of children and young people in mathematics.

In addition to the Challenges and an expanding suite of follow-on competitions, the first ten years saw brand new activities such as development of the Team Maths Challenges and Mentoring Schemes, and in 2002 organising and running the International Mathematical Olympiad in Glasgow.

We gathered our breath to celebrate ten years, and since 2006 we've seen an expansion of our programme of summer schools, introduction of Mathematical Circles, provision of primary materials, and running further international events including developing the European Girls' Mathematical Olympiad and hosting the Kangaroo setting meeting in 2013.

So what will the next ten years bring? It's hard to know for sure, but perhaps top of our wish list would be for all UK schools and colleges to be able to access the rich problems provided through the Challenges. We're really grateful for all teachers do to support our activities and enable the students to participate, and hope this will continue way into the future. We'll be looking more at how advancing technology can help the running of our activities, and we are very excited that the IMO will be returning to the UK in 2019, and look forward to organising associated outreach events alongside this.

But we could not have achieved anything over the past twenty years without the wonderful input from our fantastic group of volunteers. This extraordinary group of people do so much to enable us to organise and run our events, from setting problems, to running team events, to marking Olympiad scripts, to leading sessions at summer schools...the list goes on! Thank you to you all, and Happy Birthday UKMT!

MATHS CHALLENGE		FOLLOW-ON ROUND	
Senior	Tuesday 8 November 2016	MOG	Tuesday 11 October 2016
		Senior Kangaroo	Friday 2 December 2016
		BMO1	Friday 2 December 2016
		BMO2	Thursday 26 January 2017
Intermediate	Thursday 2 February 2017	IMOK Kangaroo	Thursday 16 March 2017
		IMOK Olympiad	Thursday 16 March 2017
Junior	Thursday 27 April 2017	Junior Kangaroo	Tuesday 13 June 2017
		JMO	Tuesday 13 June 2017

TEAM CHALLENGE	REGIONAL FINALS	NATIONAL FINAL
Senior TMC	to December 2016	Tuesday 7 February 2017
TMC	to April 2017	Monday 19 June 2017

Terrific top ten IMO finish!

Two young students representing the UK have won gold medals at the world's most prestigious mathematics competition, the International Mathematical Olympiad (IMO). Warren Li and Neel Nanda competed against other mathematically gifted students from over 100 countries worldwide. The remaining four team members, Joe Benton, Jacob Coxon, Lawrence Hollom and Harvey Yau, completed the UK's full haul of medals. Our congratulations go to all the team! This stunning performance gave the UK its best team placing since 1996, coming equal 7th (with Russia) out of 109 participating countries, and top of Europe.

The six students representing the UK were:

Joe Benton (St Paul's School), Silver Medal Jacob Coxon (Magdalen College School), Silver Medal Lawrence Hollom (Churcher's College), Silver Medal Warren Li (Eton College), Gold Medal Neel Nanda (Latymer School), Gold Medal Harvey Yau (Ysgol Dyffryn Taf), Silver Medal

The team was accompanied by the Team Leader and Chair of the IMO, Dr Geoff Smith (University of Bath), and the Deputy Team Leader, Dominic Yeo (University of Oxford).

IMO 2016
Problem 4, Day 2

A set of positive integers is called *fragrant* if it contains at least two elements and each of its elements has a prime factor in common with at least one of the other elements. Let $P(n) = n^2 + n + 1$. What is the least possible value of the positive integer b such that there exists a non-negative integer a for which the set $P(a+1), P(a+2), ..., P(a+b)$ is fragrant?

Publications snippets

Later this year, Ten Further Years of Mathematical Challenges will be published. It may not surprise you to hear this will contain all the papers for the Junior, Intermediate and Senior Challenges from 2006 - 2016! See shop.ukmt.org.uk to purchase copies.
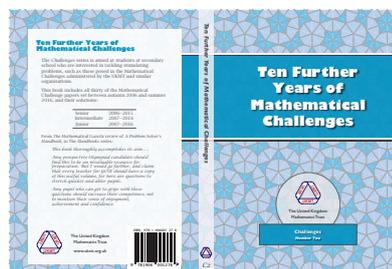
Who is Gill?

Gill appeared in question 14 of the first UK Schools Mathematical Challenge in 1988. The Challenge, initiated by Dr Tony Gardiner of the University of Birmingham, was an annual event until it split in 1994 to form the JMC and IMC, which have continued in the same format every year since then.

> **UK Schools Mathematical Challenge**
> **Question 14, 1988**
>
> Weighing the baby at the clinic was a problem. The baby would not keep still and caused the scales to wobble. So I held the baby and stood on the scales while the nurse read off 78kg. Then the nurse held the baby while I read off 69kg. Finally I held the nurse while the baby read off 137kg. What is the combined weight of all three (in kg)?
>
> A 142 B 147 C 206 D 215 E 284

Gill appeared in the 1989 paper, too, in a similar question concerning the difficulty of measuring here height, though it was not until 1990 that she was given a name.

> **UK Schools Mathematical Challenge**
> **Question 14, 1990**
>
> Baby's two years old now and drinks milk by the quarter pint, so we have decided to call her GILL. Getting her to recognise her name proved difficult, so we put the four letters G, I, L, L on separate building blocks. She loves arranging them, but rarely gets them in the right order. One day she managed to produce every possible four-letter 'word': L I L G is one such. How many different four-letter words did she produce that day?
>
> A 3   B 4   C 12   D 16   E 24

Though she was conspicuous by her absence in 1991, Gill re-emerged in 1992 and 1993 (when she was learning to spell), both times maintaining the tradition of appearing in question 14. During the following ten years, she made sporadic appearances in the Challenge paper.

> **Junior Mathematical Challenge**
> **Question 12, 2009**
>
> Gill is 21 this year. At the famous visit to the clinic in 1988, her weight was calculated to be 5kg, but she now weighs 50kg. What has been the percentage increase in Gill's weight from 1988 to 2009?
>
> A 900% B 1000% C 5000% D 9000% E 10 000%

In 2009, Gill celebrated her 21st birthday. Gill's 21st must have been a good celebration, as her birthday was referred to in the IMC a year later! In later papers, we had a further snapshot into Gill's life: JMC 2011 Q21 was about Gill's holiday and JMC 2013 Q4 showed us that Gill was a keen walker. Gill passed her driving test at the age of 26.

> **Intermediate Mathematical Challenge**
> **Question 9, 2014**
>
> At the age of twenty-six, Gill has passed her driving test and bought a car. Her car uses p litres of petrol per 100km travelled. How many litres of petrol would be required for a journey of $d$km?
>
> A $pd/100$ B $100p/d$ C $100d/p$ D $100/pd$ E $p/100d$

At the age of 27, as show in JMC 2015 Q21, Gill moved into a new flat. Most recently, it was pleasing to see Gill's chosen career!

> **Junior Mathematical Challenge**
> **Question 6, 2016**
>
> Gill is now 28 years old and is a teacher of Mathematics at a school which has 600 pupils. There are 30 more girls than boys at the school. How many girls are at Gill's school?
>
> A 270 B 300 C 315 D 330 E 345

Many thanks to Howard Groves, Chair of the IMC and JMC Problems Group, for the inspiration for this article.

> So what will the next ten years bring for Gill? Enter the 2016/17 Maths Challenges to find out! Entry forms will arrive in schools shortly or can be downloaded from www.ukmt.org.uk.

Teams' mathematical talents on display

At the Team Maths Challenge (TMC) National Final each June, qualifying teams compete for not one but two trophies: the TMC Trophy, for the highest-scoring team overall, and the Jacqui Lewis Trophy, awarded to the winners of the Poster Competition and named in memory of one of the TMC's founding volunteers and question setters.

The Poster Competition has played an integral role since the first TMC National Final in 2003 and the first Senior Team Maths Challenge (STMC) National Final in 2008, encouraging students to explore topics not on the curriculum and to present their findings in an informed and engaging way. Over the years, the TMC has seen hundreds of schools investigate and illustrate themes such as 'Concyclic points', 'Symmetry', 'Tiling', and 'Mathematical billiards'. The 2012 winning poster, 'Mathematical impossibility' by Ysgol Dyffryn Taf is shown below.

In advance of the National Final, teams are sent information about the research topic and encouraged to prepare materials for subsequent incorporation in their poster. At the event itself, their first challenge (before tackling the four main rounds) is to combine their intellect and imagination to design an A1 poster illustrating the relevant mathematical concepts while addressing related questions not seen beforehand. For the first 50 minutes of the day the hall teems with colour and creativity, with some teams abandoning their tables and decamping to the floor to allow additional elbow room for wielding pens, crayons, rulers, glue sticks and scissors.

Once the time is up, the posters are collected and exhibited at the front of the hall, where they can be viewed by the participants as well as the judges. The latter then face a sizable task, with 70 posters

to scrutinise before revealing the winners at the end of the day. Scored separately from the main competition, the total mark awarded for a poster is based on three criteria: 1) general mathematical content, 2) imagination and presentation, and 3) correct solutions to the questions. Each year the judges praise the amount of preparation and research undertaken by the teams, while also noting students' evident enjoyment in exploring and depicting the theme.

As well as lifting the Jacqui Lewis Trophy, the winning team then has the honour of seeing their design transformed into a professionally reproduced poster, sent to all UK schools eligible for the following year's competition. Look out for this year's poster, on the topic of 'Folding', with your TMC 2017 entry form in October.

Full details of past themes and winning posters can be found at: http://www.arbelos.co.uk/TMCposters.html (TMC) and http://www.arbelos.co.uk/STMCposters.html (STMC).

Geoff Smith, UKMT Vice-Chair and one of the original question setters for the TMC Poster Competition, was reminded of an early theme while watching the Rio Olympics last month: "There is a famous formula for the area of a cyclic quadrilateral in terms of its side lengths, a result ascribed to Brahmagupta (7th Century Indian mathematician and astronomer) to which many posters alluded in 2004, when the theme was 'Concyclic points'.

When watching the men's team gymnastics at the Rio Olympics last month, I noticed that one of the German team was called Andeas Bretschneider. In 1842, Carl Anton Bretschneider discovered a generalization of Brahmagupta's formula (involving an elegant correction term) which applies to all convex quadrilaterals.

I tried shouting at the TV to ask if Andreas was a relative, but he did not reply."

> Entries to both the STMC and TMC are now being taken. There are around 70 regional events taking place acrtoss the UK for both the STMC and the TMC. Find out more at https://www.ukmt.org.uk/team-challenges/.

Maths Circles coming round again

Keep an eye on our website for the dates and venues for this year's Mathematical Circle events, which are designed for pupils in year 10 (England and Wales), Year 11 (Northern Ireland) and S3 (Scotland) with an aim to: • Enrich participants' experience of mathematics both in relations to topics they may have already met, and new topics • Build enthusiasm for mathematics by providing engaging and stimulating sessions. • To alert participants to the benefits of continuing to study mathematics at school, and the possibilities opened up by studying mathematics at university. • To enable participants to meet and interact with other keen mathematicians from different schools. The two day, non-residential events take place at various locations across the country with the hope of reaching as many keen young mathematicians as we can, to bring them a new experience of mathematics and help develop their learning and appreciation of the subject. The first UKMT Mathematical Circle was held at Hutchesons' Grammar School in Glasgow in 2012 and the programme was expanded over the following three years. This year we hope to host around ten events from Dorset to Aberdeen and look forward to meeting the enthusiastic students who attend these events. Topics at the events are varied and sessions at past events have ranged from 'Modelling a Zombie Apocalypse' and 'Tetris, Candy Crush Saga and Hydrocarbon Molecules' to 'Diophantine Equations' and 'Chaos Theory'. The type of maths is different to that which students may have encountered before, but they are encouraged to think widely, ask as many questions as they like and hopefully come away from the two days with a new appreciation of, and increased love for, mathematics. We are keen to expand our pool of speakers to lead sessions at these events; would you be interested in attending one of these events to see what goes on? Alternatively, perhaps your school has a large classroom or suitable hall that would be a good venue? Please do get in touch at enquiry@ukmt.org.uk to discuss either of these, or if you have any further questions.

Thanks to our volunteers!

What fun it has been being a UKMT Volunteer for 20 years! The sheer camaraderie at a marking weekend or a Maths Circle cannot be underestimated. If you have not been there, you would find it hard to understand that the exhaustion at the end of a Summer School is totally mediated by the professional joy at watching young people grow in knowledge and confidence throughout the week. As for the six months spent setting up the TMC and running 20 events throughout the country, words cannot describe the satisfaction something like that brings. I have made many friends for life, at first terrified at seeing my submissions discussed at both Olympiad and Challenge setting weekends yet, the kindness and support I received through my learning curve was second to none. Perhaps the most daunting experience was my first Council meeting. Imagine the trepidation felt by a Glasgow teacher walking alone into the RI for that meeting. The urbanity of the then chair, Peter Neumann and the patrician grandeur of Roger Bray, the RI representative, made me feel that I did indeed belong there. Such is the charm and thoughtfulness of all UKMT individuals. As I become one of the elderly volunteers, I hope long to continue to work with such capable and considerate mathematicians and trust that I shall be able to mentor younger volunteers in the years to come. My life has been completely altered by a single phone call of help for a very able pupil. I owe the Trust and its founders an inordinate amount of gratitude. I know that the Trust will continue to grow and provide exciting opportunities for pupils and teachers for many years to come.

Mary Teresa Fyfe, Member of the Trust, and long-standing UKMT volunteer.

Summer School - participating as a student and a volunteer

I can still quite vividly remember cramming into the first three rows of the theatre at Woodhouse Grove School on my first UKMT summer school in order to watch the stunning 1997 Horizon documentary 'Fermat's Last Theorem'. I was totally inspired by what I saw, but particularly by the fantastic discussion which ensued after the film ended. In fact, it wasn't just that evening, but the whole week which captivated me and fed my previously unsated passion for maths (which would later become insatiable). I don't think I would be exaggerating to say that the reason I am studying Mathematics at university is largely to do with the UKMT and my good fortune in being invited to that first summer camp.

In the following years, I attended a couple of camps as a senior. There was still a lot to learn, in the sessions for seniors given in the afternoons, but also, I'm not ashamed to admit, in the junior sessions each morning too.

I am now lucky enough to be able to give back for all the great experiences the UKMT gave me as a student and am attending summer schools as an adult volunteer. Even now, maths camp holds a special place in my heart, and I come back from volunteering knowing each time that I have (again) had one of the best weeks of my life.

Jack Hodkinson, UKMT volunteer

> To find out more about volunteer vacancies, please contact us via email to enquiry@ukmt.org.uk or see our website at https://www.ukmt.org.uk/about-us/getting-involved/.

Sudoku

In Sudoku, every digit from 1 to 9 must appear in each of the nine rows, each of the nine columns, and each of the nine outlined boxes.

Enter our prize Sudoku! Entries are accepted from students and teachers, so do encourage others to enter. A draw from the correct entries will take place after the closing date and the winner will receive a book with a mathematical theme and a UKMT Megaminx. The winning name and affiliation will be published in a future edition of Maths Challenges News.

> Please send entries (photocopies accepted) by the closing date of Friday 2 December 2016 to:
>
> Sudoku, UKMT, School of
> Mathematics Satellite,
> University of Leeds, Leeds
> LS2 9JT
>
> Don't forget to include your name, school name, and full school address!

Prize sudoku

4		3			2	1		
	6						9	4
2		1						6
9			1	2				
		6	5	3	9	4		
			4	6				3
8						6		5
3	1						4	
		2	9			3		1

ISSUE 51 SUDOKU WINNER

Lucia Sagredo of Cheney School