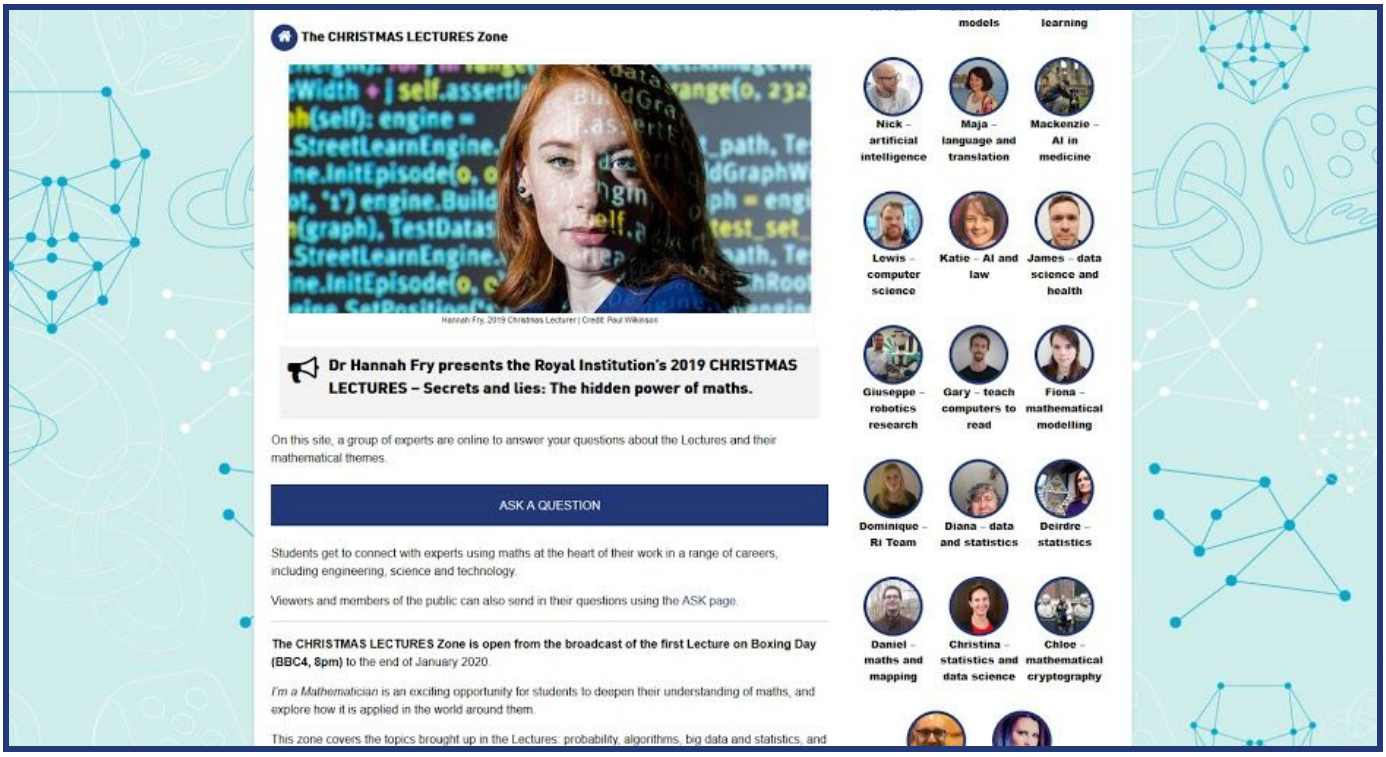


2019 CHRISTMAS LECTURES Zone: Secrets and lies

6–31 January 2020

The 2019 *I'm a Mathematician* CHRISTMAS LECTURES Zone (**secrets.imamathematician.uk/**) was commissioned by The Royal Institution with support from Lloyd's Register Foundation, UK Research and Innovation, KPMG, and Schlumberger.

The online event gave school students, the viewing public, and the LECTURES attendees the opportunity to continue the conversation about the Royal Institution's CHRISTMAS LECTURES series, *"Secrets and lies: The hidden power of maths"*, as well as the surrounding mathematic, scientific, societal, and ethical themes.

Who took part?

Mathematicians

Mathematicians, scientists, and engineers were invited to take part:

- Mathematicians, scientists, and engineers who had previously taken part in *I'm a...* projects, and whose work related to the LECTURES themes (probability, modelling, statistics, algorithms, machine learning).
- Mathematicians from the RI Maths Masterclass Network.
- General call over Twitter
- Contributors and Lectures team invited

The LECTURES presenter, Hannah Fry, was not able to give any time to the Zone, and no profile was created on the site.

23 mathematicians actively took part in the Zone (pictured below), see their profiles at: secrets.imamathematician.uk/mathematicians/

Schools

Teacher applications for the 2019 CHRISTMAS LECTURES Zone were opened to all schools from 1–22 November 2019. Teachers registered on the UK *I'm a...* activities lists were emailed invites to take part. Promotion was also carried out via Twitter, via the Association for the Teaching of Maths newsletter, and the RI sent out information through their channels.

71 teachers applied to take part with their students, with 57 from 55 schools being allocated a place; given log in details for the Zone and instructions on how to book their live chat(s) and create log in details for their students.

It was not expected that all teachers would take part; over-allocating the Zone in this way was done to ensure a good level of activity.

Participating schools

Teachers from 29 schools logged in and generated log-ins for their students. 27 schools took part in live chats.

Participating schools are shown on the map (right) and listed in the table (below).

The aim was to have the majority of participating teachers be maths teachers. Of 27 teachers who told us what subject they intended to use the activity with, 22 (81%) said they were taking part with a Maths group, 4 (15%) with a STEM group in general, and 1 (3%) with a Science group.

Abingdon School, Abingdon	All Saints Catholic College, Huddersfield (WP)	Aquinas College, Stockport
Arbroath High School, Angus (U)	Ardrossan Academy, North Ayrshire (WP/U)	Ashton Community Science College, Preston (WP)
Baltasound Junior High School, Shetland Islands (U)	Berkshire College of Agriculture, Maidenhead	Colne Community School and College, Colchester
Irchester Community Primary School, Wellingborough	King James Academy, Royston	Kingsmead Academy, Taunton (U)

Leeds City College, Leeds	Llanyrafon Primary School, Torfaen (U)	Lostock Hall Academy, Preston
Merton Park Primary School, London	Northampton Academy, Northampton (WP/U)	Penicuik High School, Midlothian
Portpatrick Primary School , Portpatrick (U)	Reading Girls' School, Reading (WP)	Reepham High School and College, Norwich (U)
Sandymoor, Runcorn (WP/U)	St Bridget's Primary School, Glasgow City (WP)	St Ursula's Convent School, London
Summerhill School, Kingswinford (U)	The Petchey Academy, London (WP)	Touch Primary School, Fife (WP)
Turnbull High School, East Dunbartonshire	[Home Education Group]	

Widening participation (WP) and underserved (U) are marked in the table above.[1]

LECTURES audience and social media registration

The CHRISTMAS LECTURES studio audience were given access to the Zone through question cards distributed during the filming. Questions submitted on these cards were uploaded to the Zone, and accounts created to allow audience members to receive email notifications when their questions were answered (for those who provided email addresses).

95 people submitted questions using the log in cards; this is a reduction from the previous year where 170 people submitted questions.

In addition, 20 public users registered on the site through social media login options.

[1] We have found that schools that are more than 30 minutes travel time from their closest Higher Education Institution are less likely to receive visits and benefit from engagement activities. Find out more about our research at: **about.imascientist.org.uk/2017/school-engagement-in-stem-enrichment-effect-of-school-location/**

Zone activity

Key figures from the Zone and comparison with previous years

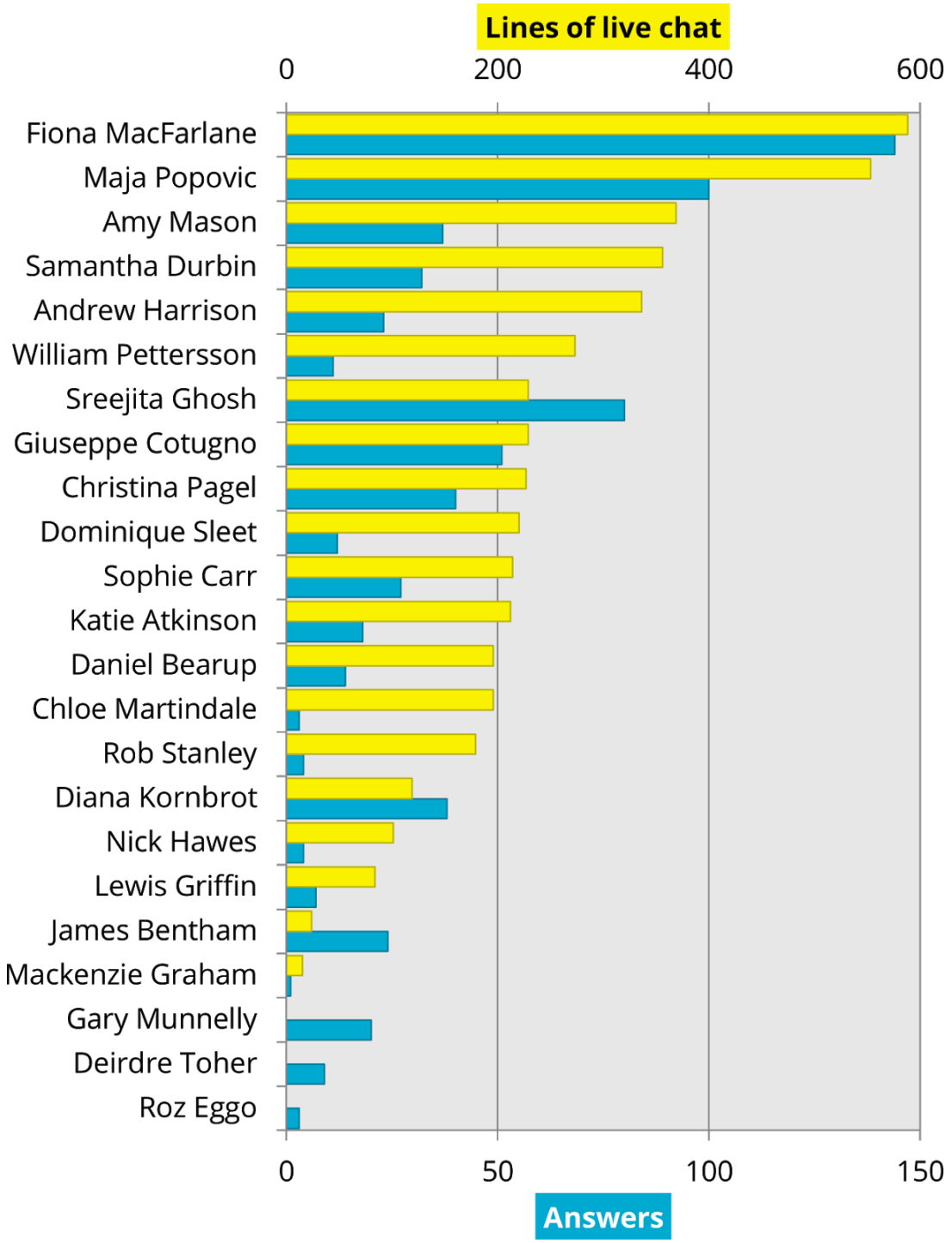
- There were more than 200 additional registered users compared to the previous year (1,156 up from 953).
- Over 400 more questions were asked (1,037 up from 623) and over 250 more answers given (702 up from 434) in comparison to the previous year.
- The Zone saw more than 20,000 additional total page views when compared to the previous year over a similar period (52,102 up from 30,852).

		2019 ZONE	2013–18 RI ZONES AVERAGE
Page views	***Total zone***	52,102	25,399
	ASK page	3,051	1,756
	CHAT page	4,738	3,405
Registered users		1,156	635
% of registered users active in ASK, CHAT, or comments		92%	85%
Questions asked total		1,037	493
Questions approved		368	229
Answers from experts		702	310
Comments		46	40
Schools		29 [2]	27
School live chats		51	33
Lines of live chat		15,866	8,846
Average lines per live chat		311	271

[2] Teachers from 28 schools and 1 home education group generated log in details for students

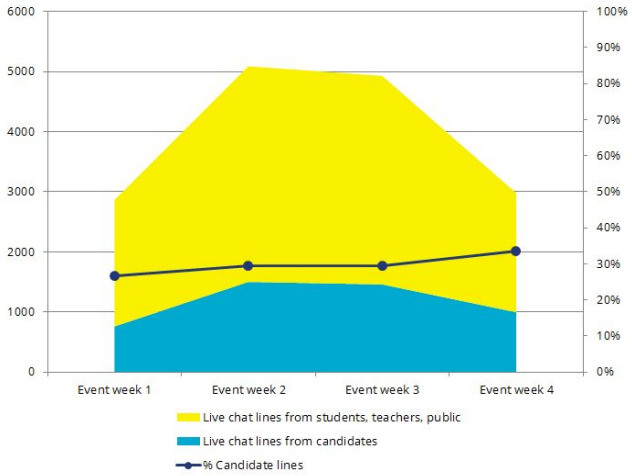
Expert activity

Expert activity in is shown separated by questions answered in ASK, and lines of live CHAT contributed:

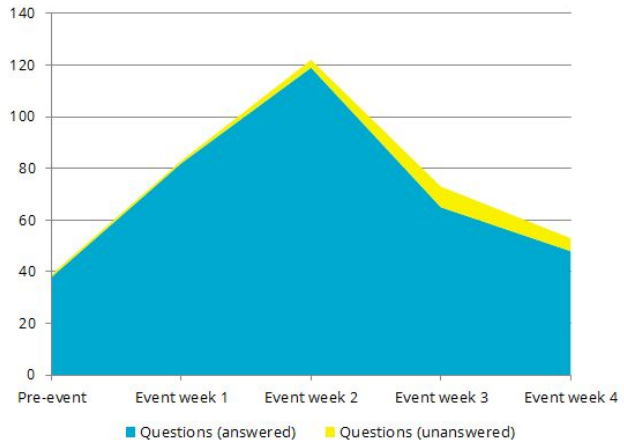


Zone activity by week

Live CHAT activity by week



Questions posted in ASK by week



The charts (left) show varying activity in ASK and CHAT across the four weeks of the event.

Activity in live CHATs was at its highest during weeks two and three of the event, though maintained a good level of activity throughout the event.

Week two of the event saw the most questions posted in ASK.

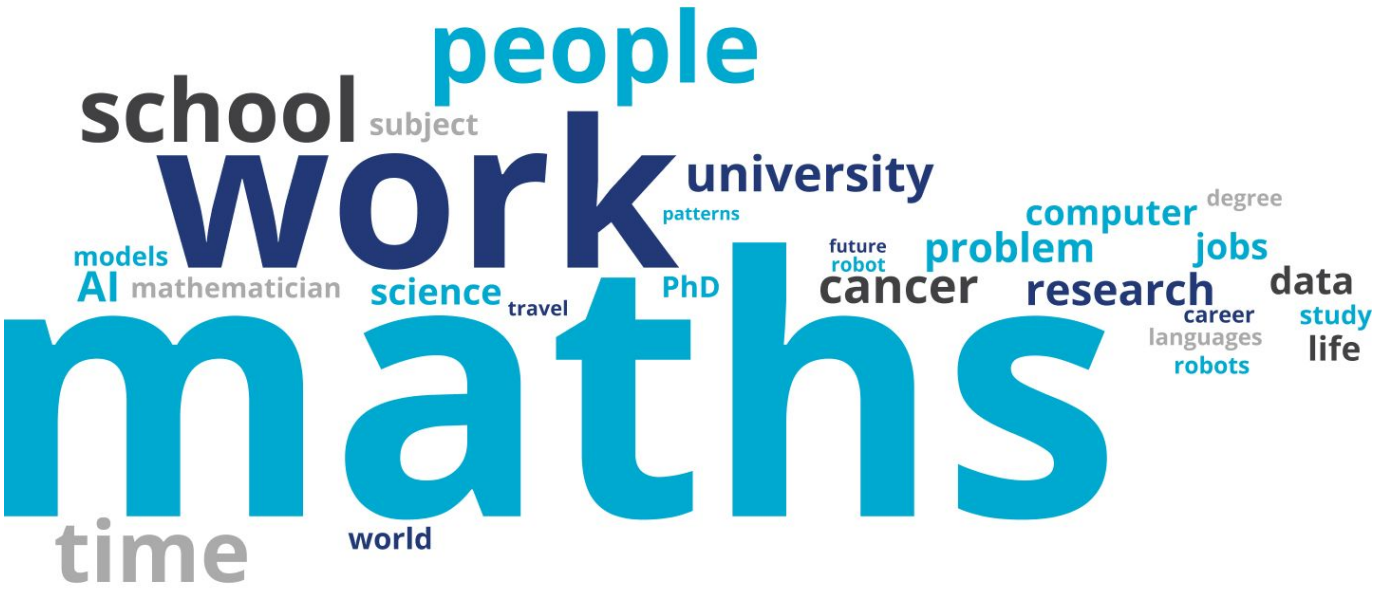
Popular topics

The questions in ASK and live CHATs covered a wide range of themes and ideas related to mathematics and AI, as well as questions focused around how science and mathematics work, the processes, and their context in the wider world, and mathematicians' motivations.

Additionally, students had questions for the mathematicians about their careers, what they studied in school, and how they use maths as part of their work.

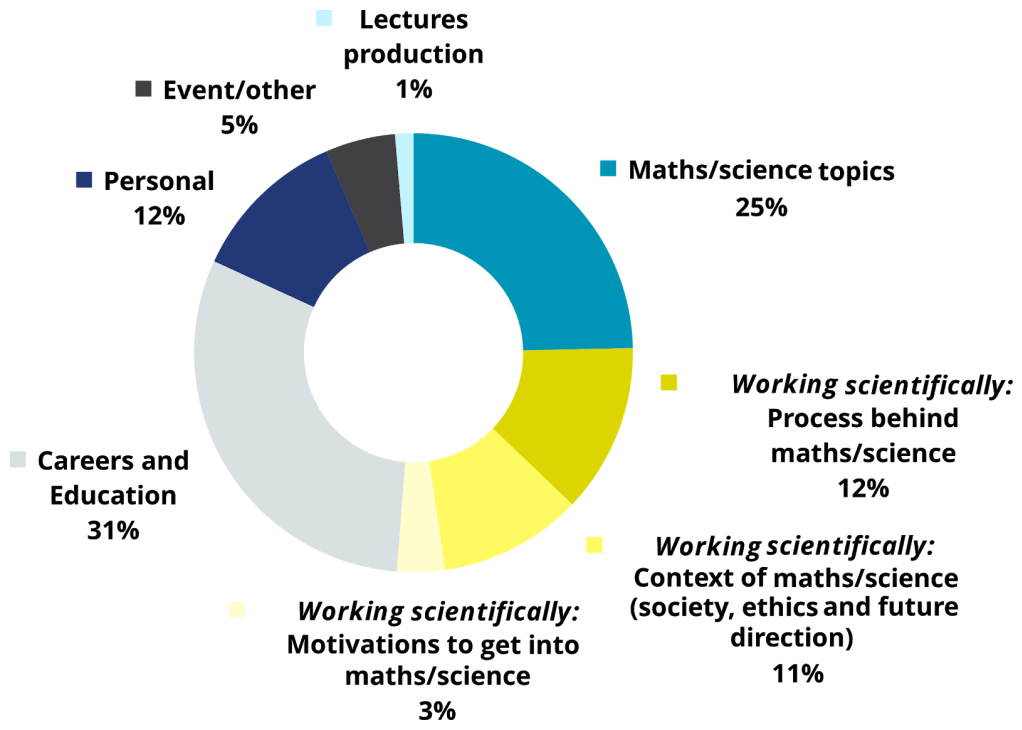
Popular topics in live CHATs

Popular words used by participants (both students and experts) during live chats; size of each word represents its frequency (colour has no significance):



Question themes and example questions in ASK

Questions posted in ASK, categorised by theme. Find out about how we've coded the questions at: about.imascientist.org.uk/what-do-students-ask-about/



Examples of questions asked:

Science topics

how does the robots memory work. like does it create a memory of the instructions you gave it if the instruction were to last for a month or does it just keep doing the same motion (depending on the instructions) for moths on end.

Beyond reinforcement, what other kinds of machine learning are common?

How did quadratics help find an object trajectory? And why only two outcomes?

What are some rules AI's have to follow?

Working scientifically: Process behind maths/science

When you use data to help people make better decisions, are there any problems that don't categorize into the data that you use to help people and how would you configure the data to help solve those problems?

Is it possible to predict what diseases might emerge in the future?

How does the people predict the weather? Is there any equations to predict the weather?

Working scientifically: Context of maths/science (society, ethics and future direction)

How can maths help end the bush fires in Australia?

You mentioned that computation can be used to remove bias from a court of law. What are some famous problems/mishaps that mathematics/game theory et cetera have been able to solve in law?

Do you think that robots should have installed restrictions regarding the freedom they have over their control of tasks that could have dire consequences if done wrong?

Do you think algorithms can at one point replace surgeons because they can execute instructions to near-perfect precision? If so, which aspects might limit that? If not, why not?

Is it possible to influence probability in your daily lives quickly to make us happier?

Working scientifically: Motivations to get into maths/science

what inspired you to become a mathematical biologist?

have you always enjoyed robots and all things linked or was it more of a discovery that then turned to a later on interest

Careers and education

Is there anything you would like to do in the upcoming years to improve your job?

what has been the hardest pattern to find in a set of data, what was the set of data about?

Do you think that if you don't want to do anything that relates to math in the future [for example, something like an animal trainer], you should be able to do something else in highschool instead of wasting your time on maths?

How would you recommend to get started with coding

What did you take at GCSE?

i know some details may be private and confidential, but could u give an example of something you have helped the doctors solve?

Personal

Are any part of your family mathematicians??

whats your favorite video game (if you play them)

Event/other

how does these workshops help general maths and how people learn in different ways?

what is you favourite maths song to jam to?

Lectures production

What is the probability of a Christmas lecture demo working first time? (Based on all the recorded Christmas lectures)

Why did you pick yellow and blue hats for the demos. And what is the probability of picking these two colours out of all the known colours?

Examples of good engagement

Discussions between students and mathematicians in the Zone covered a wide range of themes and ideas around mathematics, artificial intelligence, robotics, and the role and applications of mathematics in the wider world.

Students were interested in the applications of robotics and mathematics around health:

> ***Student 1:*** *do you work with robots*
>
> ***Lewis (Mathematician):*** *I don't - but I no people who do. What would you get a robot to do?*
>
> ***Student 1:*** *help with my diabetes*
>
> ***Lewis:*** *interesting. How do you think a robot could help? Reminding you? Noticing when you don't look well? Any ideas?*
>
> ***Student 2:*** *i would use it as a assistant*
>
> ***Lewis:*** *how? If it was just a reminder a phone app could do that. I know that some people have thought about phone apps that could estimate your carb intake from a photo of a meal. Would that be useful?*
>
> ***Student 1:*** *yes and the canteen at school weighs my lunch*
>
> ***Lewis:*** *one day I think people could build you a little robot parrot that would sit on your shoulder, watch everything that you eat, and whisper reminders in your ear when you forget about your insulin. Would that be good?*

> ***Student 1:*** *Do you work on any type of cures to cure cancer and others stuff*
>
> ***Fiona (Mathematician):*** *My research has mainly been related to immunotherapies, which are treatments that try and boost the natural immune system and try and attack the cancer*
>
> ***Student 1:*** *ok thats good*
>
> ***Student 2:*** *how do you process the treatments for immunotherapies?*
>
> ***Fiona:*** *My work is based on suggesting food targets for the therapy, but people who do develop therapies have to do lots of tests in the lab and then months/years of testing on animals before it is allowed to be tested on humans.*

In other discussions, students wanted to know how mathematicians became interested in maths and what their motivations were in selecting their careers:

> ***Student:*** *Was there an area of maths that really interested you when you were younger? I feel like I'm just working through textbooks at the moment...*
>
> ***Sreejita (Mathematician):*** *I liked geometry and trigonometry since it was fun. When I learned Calculus I found it practical since it was helping me find the max and min values of something. The key is to find the real life application of the math that you are doing*
>
> ***Student:*** *I hadn't really thought about how I might use Calculus in real life. Thank you. Is there anything you have learnt that you think it would be useful for people to learn younger in Maths?*
>
> ***Sreejita:*** *Ofcourse. You can also use calculus for calculating areas :) (integration). When doing %tages, interests, you can think of it as application in banking- you can manage your own finances. Next you can use geometry for even art work- origami, and if you like to study art and architecture*
>
> ***Student:*** *Why did you want to do your job?*
>
> ***William (Mathematician):*** *I wanted to be able to help people. I've found something that I think I'm good at (computer programming) so now I wanted to do something with that to help people, and this seemed like a good way to help people.*
>
> ***Student:*** *that's good, how does it help people*
>
> ***William:*** *One of the problems I work on is how to assign organ donors and organ recipients together. So at the start, my algorithm just has a whole heap of data, and by following a large number of steps, it works out who should donate to who.*
>
> ***Student:*** *How were you like in school*
>
> ***Fiona (Mathematician):*** *I wasn't particularly good at school, and got average grades. I was also very shy and quiet*
>
> ***Student:*** *wow so why did u decide to work in a place thats surrounded by maths*
>
> ***Fiona:*** *I started to enjoy maths in my final few months of high school, and then really enjoyed it at uni. As I grew up I became more confident too which helped*

Feedback during the event

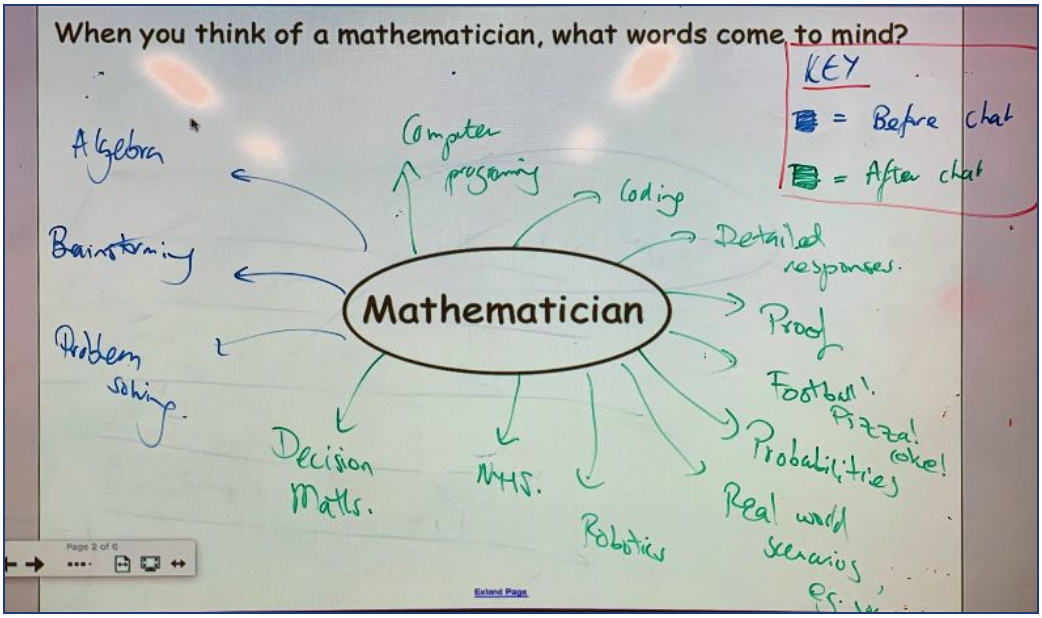
We're still collecting feedback from participants, here are a few of the comments made during the event:

> *"We were really pleased to join in with this year's 'I'm a Mathematician'. It was a great opportunity to engage students with maths and give them an insight into where mathematics could take them in the real world beyond school and studies. Our students enjoyed chatting to the mathematicians and it helped them to see that mathematicians aren't just 'professor types' working in universities but mostly they are real people with similar interests to themselves! It was pleasing to hear comments such as 'I'm going to join in the chat tonight', 'I wish the chat was longer' and 'Can I take a photo of my answer' give you an idea of how much my class enjoyed the experience. Thank you for providing this opportunity and we hope to join in with any future opportunities."* **— Teacher, email**

> *"Thank you so much for your efforts. Many of the pupils are volunteering to join the chat this evening. They have found the lectures to be a wonderful inspiration for them, please pass on our thanks to all involved."* **— Teacher**

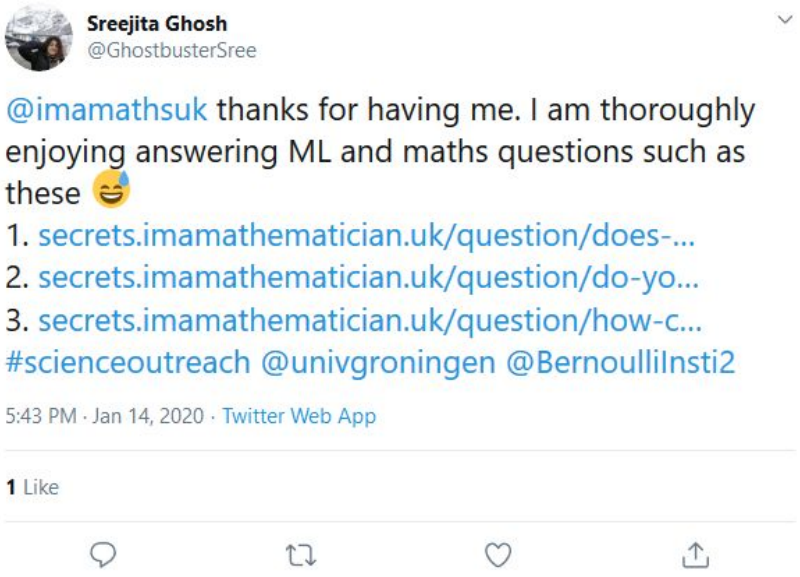
> *"Thankyou very much for the last session, I think the class learnt alot from the Mathematicians and just from the experience of taking part in a Live Chat! ... They get instant feedback from 'actual' professionals, not just their teacher and learn a bit about their manners when online! Thanks again"* **— Teacher**

A teacher from Abingdon High School shared a picture showing a summary of the class' thoughts about mathematicians before and after taking part in the live CHAT:



"Logging in to talk to the classes was incredibly convenient. Often doing outreach takes up 1/2 a day or a whole day, where here I managed to easily incorporate a session into the middle of my working day. It made a nice break too." **— Mathematician, post-event survey**

"I liked very much that the kids asked not only about maths but also general questions, such as where do I work, which movies I like, do I have pets, etc. I think in this way the kids can really see that we are "normal" people :)" **— Mathematician, post-event survey**



twitter.com/GhostbusterSree/status/1217140116520607745

twitter.com/chrischirp/status/1220723285215850499