

# NANAMIC Annual Conference

## Building Bridges between STEM Subjects

**Tuesday 27 June 2023**

Michael Anderson, STEM Learning



# Welcome!



[www.stem.org.uk](http://www.stem.org.uk)



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@STEMLearning\_MA



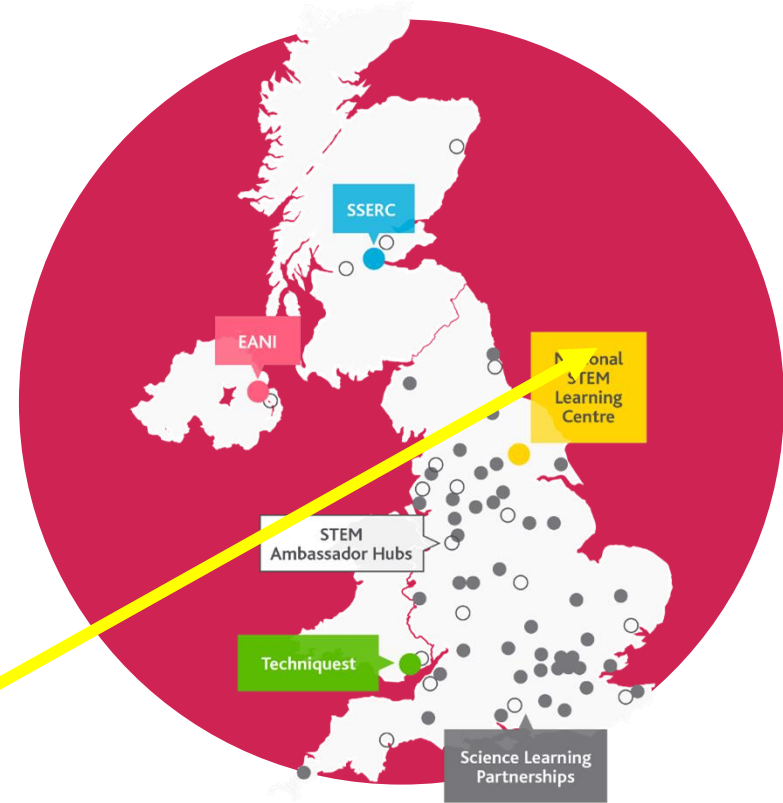
# Building Bridges between STEM Subjects

At STEM Learning our aim is to provide a world-leading STEM education for all young people across the UK.

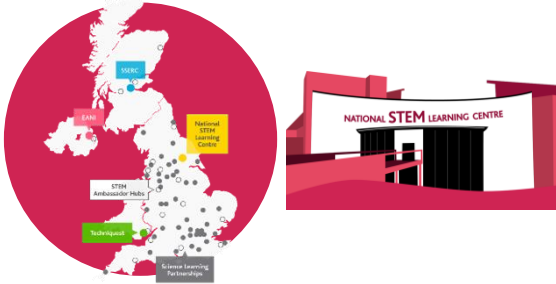
In this session we'll explore collaborative approaches between science and maths teachers, dip into our vast resource archive and discover how our STEM Ambassadors programme is inspiring the next generation by showcasing real-world applications of their learning.

# STEM Learning Network

The National STEM Learning Centre is part of our UK STEM Learning Network.



# What we do



Training



Thousands of curriculum-linked, quality-assured STEM teaching resources alongside materials produced by the STEM teaching community themselves.

Resources



STEM Clubs



Nuffield  
Research  
Placements

Inspiration Programmes



Rewards and Recognition



STEM Ambassadors



# Maths and science



**STEM Learning's mathematics CPD support for teachers of science**

**✔ Mathematics and science teachers working together**  
An opportunity for one teacher from the mathematics department and one teacher from the science department to jointly attend our face-to-face, residential continuing professional development (CPD) programme at the National STEM Learning Centre, in York.

**Developing shared approaches to maths in science and science in maths**

One teacher of GCSE mathematics and one teacher of GCSE science working together over three days will:

- understand the similarities and the differences between requirements of the two specifications
- consider approaches to teaching the mathematical topics common to the mathematics and science curricula
- develop and implement practical, sustainable models for departments working together back in school
- create a joint action plan to be implemented

> [More information](#)

## A level mathematics and A level physics working collaboratively

One teacher of A level mathematics and one teacher of A level physics working together over two days will:

- explore how mathematics pedagogy may be applied in physics
- consider how the use of graphing technology can be used consistently in the teaching and learning of each subject
- the benefits of using simple practical activities in the mathematics classroom
- consider how best to support A level physics students who are not studying A level mathematics

> [More information](#)

## ✔ Mathematics support for teachers of A level science

Our series of mathematics subject knowledge and pedagogy for A level teachers of science as part of our face-to-face continuing professional development (CPD) programme at the National STEM Learning Centre, in York.

### Maths for A-level biology

For teachers of A level biology working over two days will:

- explore how to support students apply their level 2 mathematics knowledge in a level 3 context
- the interpretation of logarithmic scales in graphs
- understand why statistical tests are used in biology
- chi-squared test
- t-tests
- Spearman's rank correlation

> [More information](#)

### Maths for A-level chemistry

For teachers of A level biology working over two days will:

- explore how to support students apply their level 2 mathematics knowledge in a level 3 context
- use of graphs in A level chemistry
- the use of log base 10 in the pH scale
- the use of natural logs in the Arrhenius equation
- techniques to develop mathematical reasoning, problem solving and resilience

> [More information](#)

### Maths for A-level physics

For teachers of A level physics working over two days will:

- explore how to support students apply their level 2 mathematics knowledge in a level 3 context
- use of graphs in A level physics
- effects of differentiation and integration
- teaching mechanics
- logarithms and exponential functions

> [More information](#)

Our Science Learning Partnerships (SLPs) combine local expertise in teaching and learning in science, facilitating CPD, and providing school-to-school support.

Further mathematics support for teachers of science, from support with graphs to rearranging equations, is available through your local Science Learning Partnership.

> [You can find your local Science Learning Partnership here](#)

# Mathematics in the Science programme of study

## Appendix 3

Mathematical skills required for biology (B), chemistry (C), physics (P) and combined science (CS)

Mathematical skills		Subject			
<b>1</b>	<b>Arithmetic and numerical computation</b>				
a	Recognise and use expressions in decimal form	B	C	P	CS
b	Recognise and use expressions in standard form	B	C	P	CS
c	Use ratios, fractions and percentages	B	C	P	CS
d	Make estimates of the results of simple calculations	B	C	P	CS
<b>2</b>	<b>Handling data</b>				
a	Use an appropriate number of significant figures	B	C	P	CS
b	Find arithmetic means	B	C	P	CS
c	Construct and interpret frequency tables and diagrams, bar charts and histograms	B	C	P	CS
d	Understand the principles of sampling as applied to scientific data	B			CS
e	Understand simple probability	B			CS
f	Understand the terms mean, mode and median	B		P	CS
g	Use a scatter diagram to identify a correlation between two variables	B		P	CS
h	Make order of magnitude calculations	B	C	P	CS

# Why are maths skills important?

The content sections also set out the mathematical skills required for each science discipline. In order to be able to develop their skills, knowledge and understanding in science, students need to have been taught, and demonstrate competence, to select and apply the appropriate areas of mathematics relevant to the subject as set out under each topic and the mathematical skills listed in appendix 3. The mathematics should be at levels up to, but not beyond, the requirements specified in GCSE mathematics for the appropriate tier.

GCSE Science specification



# Research review series: science

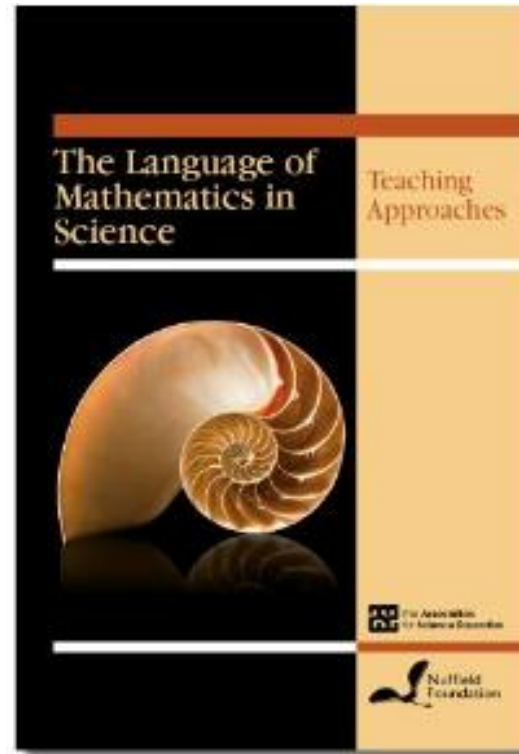
## April 2021

### **Coherence between mathematics and science**

As well as seeking coherence within and between the scientific disciplines, pupils need to make relevant connections between knowledge from other subject disciplines, for example between mathematics and physics.

Subject leaders and teachers of mathematics and science should work together to understand how and when knowledge taught in their respective subjects is similar and different.<sup>[footnote 104]</sup> Where there are good reasons for differences, it is important that these are made clear to pupils, including any rationale for this. Pupils will then be clear on what knowledge to use and when. It is also important that teachers do not assume that pupils can easily transfer their learning from mathematics to the science classroom.<sup>[footnote 105]</sup> Pupils will need to be taught how to use mathematics in science.

# The Language of Mathematics in Science



# Themes of the courses

*Awareness* – do science teachers know exactly of what is, and what is not, taught in maths? Are maths teachers aware of the mathematical demands in science?

*Shared content* - Where we teach the same topic, how do we manage this?

*Resources* – Are there mathematics resources that can be used in science? Which examples from science can be used in mathematics lessons?

*Skills* – What are the skills common to both subjects and how are they embedded?

# Themes of the courses

*Methods* – Does the maths department have a preferred method for particular topics? Is there consistency within and across departments? Where there is not consistency, how can we address or acknowledge this?

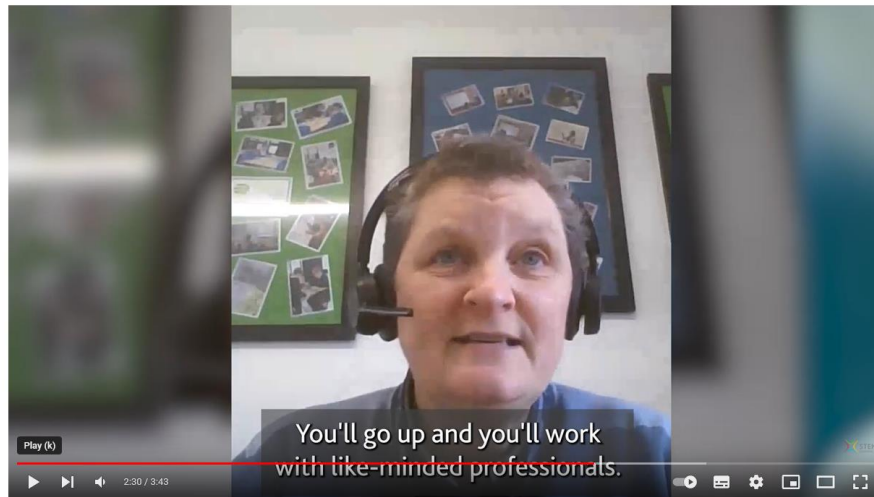
*Language* - Do we use the same language and notation? Is there consistency here too?

*Timings* - Are there areas in which maths skills are required in science before they are taught in maths?

*Joint activities* - Could activities to help get the message across to staff, students and parents that maths and science are linked?

# What are we aiming for?

Students to feel confident when faced with mathematics in a science context.



[www.youtube.com/watch?v=UxeDkKwxqpM](http://www.youtube.com/watch?v=UxeDkKwxqpM)

# Resource collections

## Secondary and A level mathematics



### Secondary Maths (11-16)

The best resources for teaching the secondary mathematics curriculum.



### A Level Mathematics

Explore our selection of key stage 5 mathematics teaching materials chosen from the STEM Learning resource collection.



### Core Maths

All the resources you need to bring Core Maths into your school or college.

# Our favourite collections

The collage features several resource cards:

- A selection of our favourite KS3 and KS4 resources by topic**: Secondary mathematics resource packages | STEM
- SMILE workcards by topic**: SMILE Cards, SMILE workcards and booklets arranged by mathematical topic
- SMILE cards by number**: SMILE Cards by Number, SMILE workcards and booklets arranged by their number
- SMILE Mathematics Books**: Standalone SMILE books full of ideas and teaching suggestions
- National Strategies: Secondary Mathematics**: Materials designed to help teachers and schools improve teaching and learning, offering support to both new and experienced teachers, subject leaders and senior leaders. Here is a selection of the best materials for mathematics across all the phases.
- The Standards Unit: Improving learning in mathematics**: Teaching activities and materials and more
- Mathematics Assessment Resource Service (MARS)**: Mathematics Assessment Resource Service (MARS)
- GAIM Activities: Investigations**: Nelson Thornes, 40 open-ended tasks in using and applying mathematics
- GAIM Activities: Practical Problems**: Nelson Thornes, 40 practical problems covering real-life situations that require students to apply their mathematics.
- Mathematics Enhancement Programme (MEP)**: Mathematics Enhancement Programme (MEP), MEP online textbooks from CIMT
- Task Maths**: Nelson Thornes, Comprehensive programme of task based maths textbooks from Barbara and Derek Ball
- Core Maths support programme**: Core Maths resources, Complete CMSP resources for Core Maths teachers
- BEAM**: BEAM | STEM, Interesting, challenging and enjoyable activities from BEAM (Be a Mathematician)
- Mathematics Assessment Resource Service (MARS)**: Lesson plans and resources developed by the University of California at Berkeley and the Shell Centre team at the University of Nottingham
- Bowland Maths: Assessment Tasks**
- Bowland Maths case studies**
- Something in Common**
- Teaching Resources on Line (TroL)**
- Graphing stories**: Graphing stories, Videos of practical situations that prompt students to think
- 1001 Math Problems**: 1001 Math Problems, Problem Solving for Young People

- you need:**
- 0-9 digit cards
  - pencil and paper

## Difference add For 2 players

**First of all**

Shuffle the cards and deal 5 to each player.

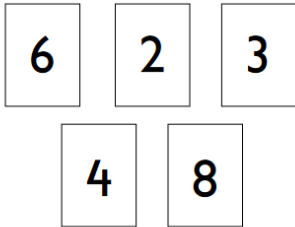
**Round 1**

Both players, choose 4 of your cards and arrange them to make a pair of two-digit numbers.

Find the difference between your two numbers.

That is your score for the first round.

For example, Karin had these cards.



She chose the 8, 2, 3 and 4 and made 82 and 34.

$$82 - 34 = 48$$

So Karin's score is 48.

**The rest of the game**

Shuffle the cards again and play another round.

Keep adding on your new scores.

The first player to reach a score of 300 wins the game.

## Percentage Puzzle

You will need: scissors, glue

- Cut out the numbers at the bottom of this sheet.
- Place them on the sheet to make four true statements.
- Do not stick them down until you are sure that all four statements are true.


% of                      =

10	15	20	25	35	45
50	65	70	75	80	150

# Number words

Start with a number.



How many letters are there?

3

Write down the number.

THREE

How many letters are there?

5

... and so on ...

FIVE

4

FOUR

4

Start chains with different numbers.

What do you notice?

Try making chains in other languages.



<p>F1</p> <p><math>(x - 3)</math> is a factor of  <math>f(x) = x^3 - x^2 - 3x - 2</math></p>	<p>F2</p> <p><math>(x - 3)</math> is not a factor of  <math>f(x) = x^3 + x^2 - 3x - 2</math></p>
<p>G1</p> <p>If <math>f(x)</math> is a cubic function and              if <math>f(1) = 0, f(3) = 0</math> and <math>f(0) = 12</math>              then <math>f(4) = 0</math></p>	<p>G2</p> <p>If <math>f(x)</math> is a cubic function and              if <math>f(1) = 0, f(3) = 0</math> and              then <math>f(-4) = 0</math></p>

For each set of 3 expressions find the odd one out and create a new expression that matches it.

$8^{\frac{x}{3}}$	$4^{\frac{x}{2}}$	$2^{2x}$	
$27^x$	$9^{2x}$	$3^{3x}$	
		$2^{3x}$	
		$2^{\frac{5x}{3}}$	

H1

If  $f(x) = x^3 - 6x^2 - x$   
 $f(6) = 0$  then it would be a good  
 idea to test  $f(0)$

**Risp 3: Brackets Out, Brackets In**

Pick three different integers between -4 and 4 inclusive.  
 (0 is not allowed!)

Replace the squares below  
 with your three numbers in some order (no repeats!)

$$(x + \square)(\square x + \square)$$

How many different orders are there?

Write down all these expressions, then...  
 multiply them all out, then...  
 add all the results together.

Now take this sum: can you factorise it?

# 20 years of the STEM Ambassador programme



[www.stem.org.uk/STEM-Ambassadors-20](http://www.stem.org.uk/STEM-Ambassadors-20)



<https://youtu.be/cZQ2ycf8NuA>



## My job

**Day-to-day role:** I'm responsible for making buildings and bridges stand up. My day at work varies depending on what stage my project is at. We start with conceptual design – meeting architects and clients to turn ideas into something that will stand up once built. During the design phase we do calculations, running computer models to test our design. Finally, during construction, I visit site regularly to solve problems that occur as a building takes its physical form. There is a lot of team work involved which I really enjoy.

### STEM Ambassador Profile:

**Name:**  
Roma Agrawal

**Job title:**  
Associate Structural Engineer at WSP

**Location:**  
London

**Favourite part of my job:** My job is always challenging and creative, requiring quick thinking, communication and problem solving, and I find it extremely rewarding. The most exciting part is seeing your ideas turn into a real, usable object, something that people point to and admire every day.

**Most challenging part of my job:** I normally love going to site, but with my fear of heights and the cold, I don't always enjoy being high up in the winter!

**Motivation:** I love new subjects in my job. I want, which I find in

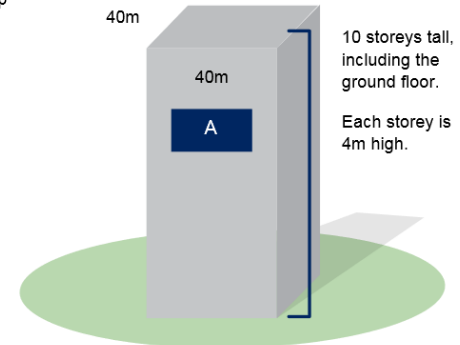
When architects design a new building they need to make sure it won't sway too much or be damaged in high winds. Structural engineers calculate the forces the wind will exert on the building. They help the architect design a structure that's strong, stiff and safe.

**The wind force on any area of building is proportional to:**

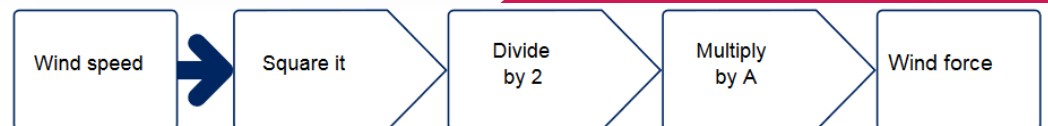
Half the square of the wind speed  $W$

The area the wind is acting on  $A$

**This new building needs to stay steady in a storm:**



Wind speed varies with height, it decreases closer to the ground, and increases as you get higher:



$$\text{Wind force } F = 1/2 w^2 A$$



## My job

**Day-to-day role:** I support teaching and learning activities at NewRail by mentoring students, engaging with stakeholders (people who own or have invested in the company) and organising and coordinating rail education activities and events.

**Favourite part of my job:** Creativity and freedom! I like mentoring students, sharing my research or public engagement ideas with them and watching them grow in confidence, as well as upgrading their knowledge and skills when developing projects with me.

**Most challenging part of my job:** Sitting and writing reports or scientific publications (papers) when exciting hands-on projects are waiting for my attention.

**Motivation:** I like challenges and my ideas and creativity, supported and flourish. The university environment which I love!

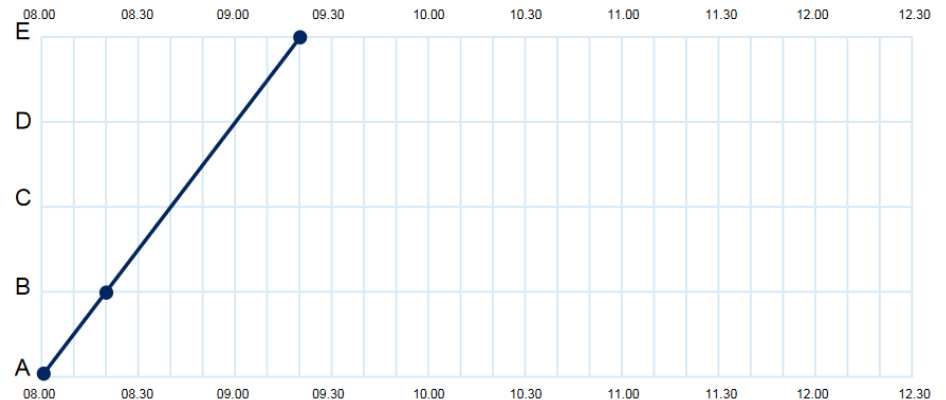
## Network Map

Trains can only overtake one another on the double track between stations B and D, including at stations B, C and D.



## Train times string graph

String graphs are a visual way to show train timetables. Each line shows a train's journey from station to station. The 08:00 express has been added:



## STEM Ambassador Profile:

**Name:**  
Anna Fraszczyk

**Job title:**  
Researcher

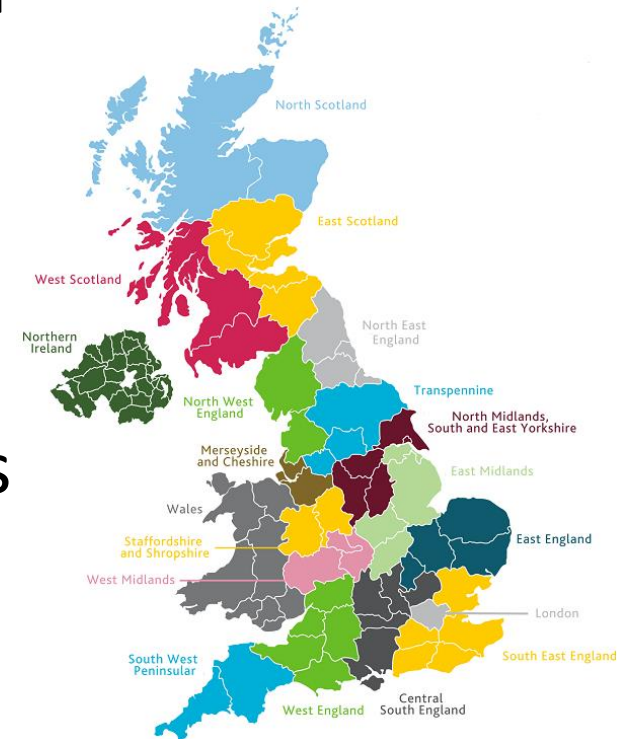
**Location:**  
Newcastle University, NewRail

- Education:**
- A levels: Maths, English, Polish, Geography
  - Degree: Master of Engineering in Geomatics, finishing PhD in Transport

# STEM Ambassador Hubs

**A Network of 19 Hubs** across the country supporting 47,000 volunteer STEM Ambassadors, of which:

- **50%** are under 35
- **50%** are female
- **16%** are from BAME backgrounds



# Who are STEM Ambassadors?

- Product Analyst
- Director of Government Affairs
- Neuromodulation clinical specialist
- Intelligence Coordinator
- Rail Automation Engineering Intern
- Graduate Engineer
- Lecturer
- Cardiographer
- Finance EID Intern
- Analytical Chemistry Graduate
- Air Quality Consultant
- Software developer
- Lab scientist apprentice
- Head of Marketing
- Early Careers Coordinator
- Scrum Master (IT)
- TV Presenter
- Economist
- Research Assistant
- Medical Director for Immunology and Inflammation
- Sales Assistant
- Chief Technology Officer
- Head of Laboratory Services
- Policy advisor, EU exit
- Met Office - Climate science communicator
- Polar Explorer
- Civil Engineering Apprentice
- Offshore Wind Turbine Installation Manager
- Biomedical Scientist
- HR Assistant
- Troop Sergeant

# What can STEM Ambassadors do?



Classroom



STEM Club activities



Careers talks



Speed networking



Online mentoring



Site visits and hosting work experience



Large science festivals and fairs



Non-school group



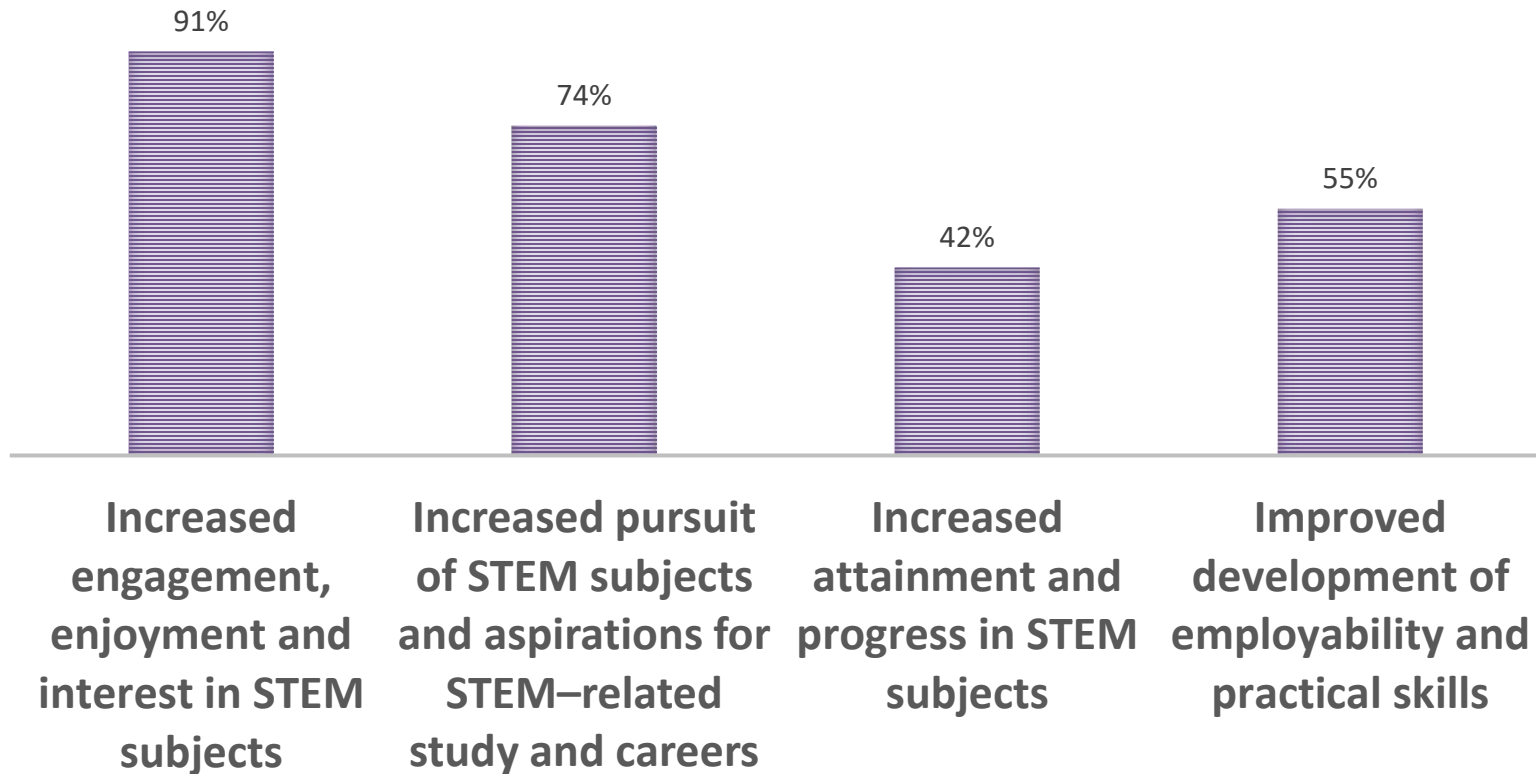


**STEM Ambassadors  
introduce children to a world  
of science beyond the school  
gates and make it fun.**

Children's Worker, Glasgow



# What impact do STEM Ambassadors have?



# Booking a STEM Ambassador

## How it works



Sign in to your dashboard or create an account now.

[www.stem.org.uk/stem-ambassadors/schools-and-colleges](http://www.stem.org.uk/stem-ambassadors/schools-and-colleges)

<https://stemmobile.app/>



**STEM LEARNING**

### Apps from STEM Learning

STEM Teacher	STEM Community	STEM Ambassador
Many teachers are already using this new app to collaborate quickly and easily with UK STEM Ambassadors. Join them today. Access your STEM Learning online account and request volunteers who can support learning, illuminate careers and raise students' aspirations in your lessons.	STEM Community is a UK-based online community of teachers, technicians and all those invested in STEM education at primary, secondary, post-16 and FE level. Here you will find a supportive environment in which you can share ideas, seek solutions and help shape the teaching of science, maths, computing and D&T.	Manage your volunteering on our app for STEM Ambassadors. It lets you easily access your online account, volunteer for activities and collaborate with teachers wherever you are.

# Sampling the River Itchen

A Toxicologist from Johnsons helped a home-education group over several weeks to sample different areas of the River Itchen.

The children then presented their data as part of the project.





# STEM Ambassador activities

- STEM Ambassador Garry Packer from Highways England
- Fractal Workshops – Sierpinski Triangle
- Delivered to Teachers & STEM Ambassadors both in schools and online
- Masterclass session included contributions from the team at the National Numeracy – “Making Maths Fun for families outside the classroom” resource

Maths Week – a STEM Ambassador presentation to primary pupils about the maths he uses as part of his job.

KS3 weekly after school Maths Puzzle Club. Activities included:

- *Solving maths/logic puzzles (7 bridges)*
- *Carrying out experiments (probability spinners)*
- *Craft activities (mobius strip, snowflakes)*



# Kids in Data Workshop

STEM Ambassador Kabir, a  
Solutions Architect


Looks at what is data literacy  
Children use his website  
[www.kidsindata.com](http://www.kidsindata.com) to play  
a series of Space Invaders  
games

Using league tables, he  
teaches how to create bar  
charts.



**Learn using games**

Start your data literacy journey through game play experience. Space Invaders is our first offering to gamify the learning experience.



**Step by step**

Learn through step by step interactive process, making learning fun and simple.



**Create your own data story**

Play games, have fun and create your own data story.

# Masterclass with Operational Research Society

STEM Ambassadors work with OR on activities such as the Lego Furniture Factory – using Lego for a real-life scenarios.

“Can you help the production manager find out how many tables and chairs should be made in order to create the greatest profit?”



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# Thank you!



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[@STEMLearning\\_MA](https://twitter.com/STEMLearning_MA)

