How will we teach maths in the future?

Chris Budd

GRESHAM COLLEGE

IMI

UNIVERSITY OF BATH

2011 Vorderman Report

A world-class mathematics education for all our young people

Mathematics the language by which the sciences, commerce, the internet and the global economics structure all communicate, it is also an essential part of all of our personal and working lives. Mathematics is not only a great subject by itself, it is also critical in fostering the logical and rigorous thinking so essential to the modern world

Unfortunately the great language of mathematics in general, and of numbers in particular, is one which great swathes of our population cannot speak. This is why mathematics education is so important, and its future is important for the well being of us all

The importance of a good maths education

1. It's very useful

CBI 70% of all jobs require numeracy

Deloitte Report mathematical research contributes £208 Billion and 10% of all jobs in the UK economy

BBC A degree in maths in 2018 will give a higher boost to your earnings than almost any other subject

However utility isn't everything!

2 + 2 = 4

Is a highly creative statement. As is

$$e^{i\pi} = -1$$

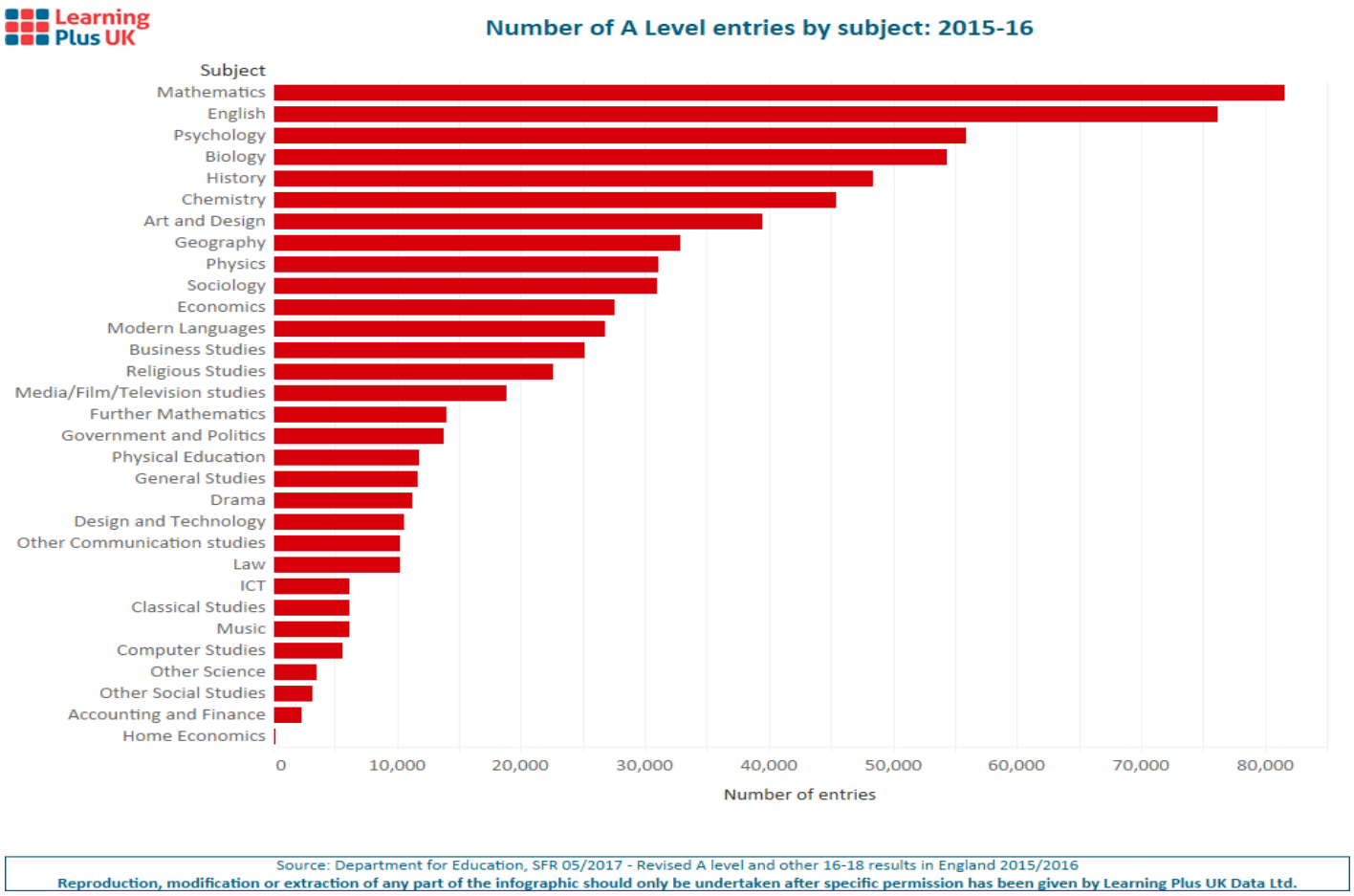
The creativity is in the ideas not (just) the calculation

2. Maths helps us to understand the world

Maths is best thought of a collection of strongly connected *ideas* and ways of *logical thinking* and of *understanding the world*. [Hoyles]

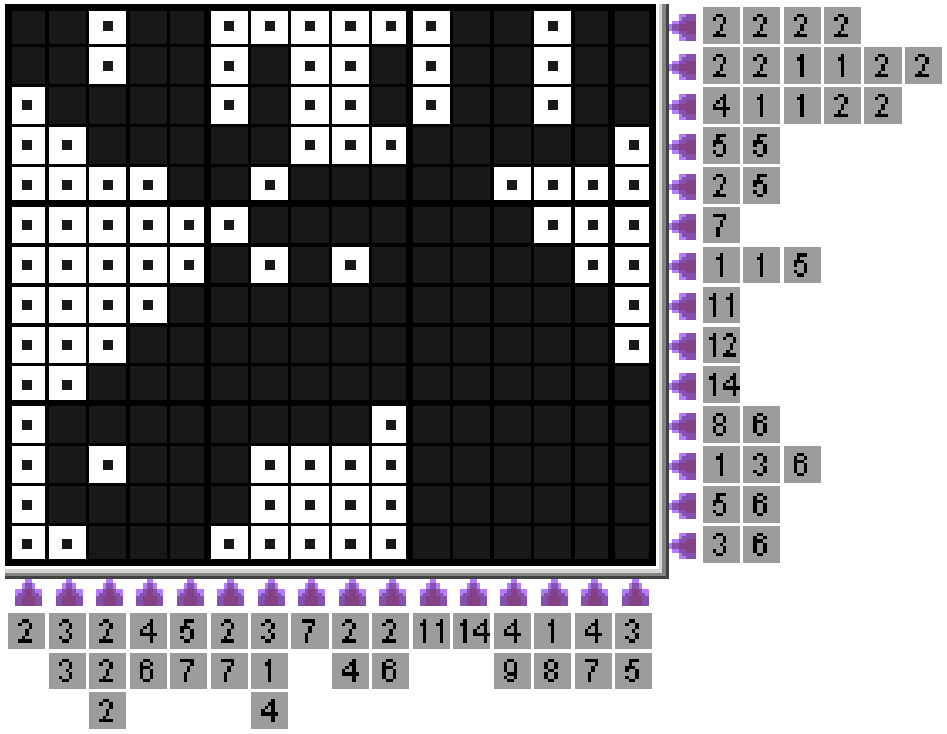
It is those ideas and modes of thinking, which have led to the invention of Google, the Internet, Mobile Phones and much, much more besides

Mathematics is currently the most popular A-level



The students who study it make use of the ideas that they learn in many other subjects, including engineering, medicine, economics, music and the social sciences

3. Maths has the potential for being both fun and hugely creative



Both adults and young people enjoy the challenge of solving mathematical puzzles

The UKMT were really great for me. They enabled me to study topics exterior to the A level syllabus and treated everyone as very capable mathematicians, imbuing us with confidence to attempt problems we would have else been content to ignore.

Luke Betts, medal winner in two IMO competitions

A UKMT puzzle to try during the lecture

It is evening and Meg, who is 1m tall, casts a 3 metre long shadow. If she stands on her brothers shoulders, which are 1.5m above the ground, how long is the shadow which she and her brother will cast?

Problems with the way that mathematics has been taught in the UK in the past and present

1.False perceptions of what maths is and how it should be taught

Maths has an image problem.
Perceived (by the media and some teachers) as

- Hard
- Irrelevant
- Uncreative
- Only for geniuses

Puts people off and leads to ‘maths anxiety’

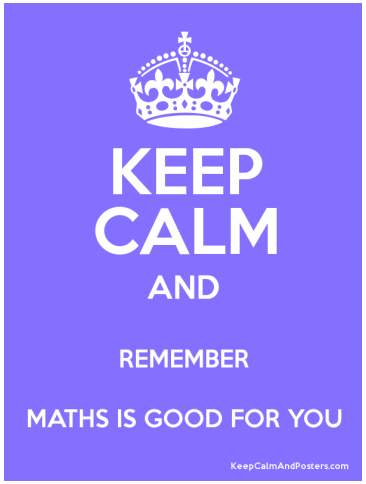
Example: Speech at the NUT advocating that we should not be teaching quadratic equations at schools

Led to a debate in the House of Commons

This is very unfair

Maths is very useful eg. Quadratic equation

Maths is highly creative eg. Quadratic equation



Maths may be hard, but so are many other worthwhile things eg. sport and music

People are anxious about many things
eg. Sport, public speaking, food, the outdoors, speaking a foreign language, catching a train, the clothes they wear, …

Only in maths does the anxiety get celebrated by the media and lead to criticisms of the subject

2. People have been giving up maths too early

In the UK until recently most people gave up maths at 16

2011 Vorderman report

Royal Society report

1 in 4 of adults are functionally innumerate

Students taking mathematics post-16[7.4]

	Any mathematics	Advanced mathematics
Japan	All	High
Korea	All	High
Taiwan	All	High
Estonia	All	Medium
Finland	All	Medium
Sweden	All	Medium
Russia	All	Low
Czech Republic	All	–
France	Most	Medium
USA (Mass)	Most	Medium
Germany	Most	Low
Ireland	Most	Low
Canada (BC)	Most	–
Hungary	Most	–
New Zealand	Many	High
Singapore	Many	High
Australia (NSW)	Many	Medium
Netherlands	Many	Low
Hong Kong	Some	Medium
Scotland	Some	Medium
Spain	Some	Low
England	Few	Low
Northern Ireland	Few	Low
Wales	Few	Low

Key

Any mathematics	5–19%	20–50%	51–79%	80–95%	95–100%
Advanced mathematics	0–15%		15–30%		30–100%

Data on participation in advanced mathematics were insufficient in Canada (BC), Czech Republic and Hungary.

Consequences

Most English politicians, civil servants and the media have had little contact with serious maths

In danger of missing out on the technological revolution that maths is bringing

In contrast: recent Singapore president Tony Yam has a PhD in maths

Primary school teachers have had little serious training in maths

In a recent survey it was found that **only 2% of those graduates studying a PGCE to become primary school teachers had a STEM degree**

Unless the mathematical needs of primary school teachers are addressed in the future we will be locked into a cycle of poor mathematical performance of their students for generations

Fortunately this is now changing

3. Poor perceptions of girls and maths

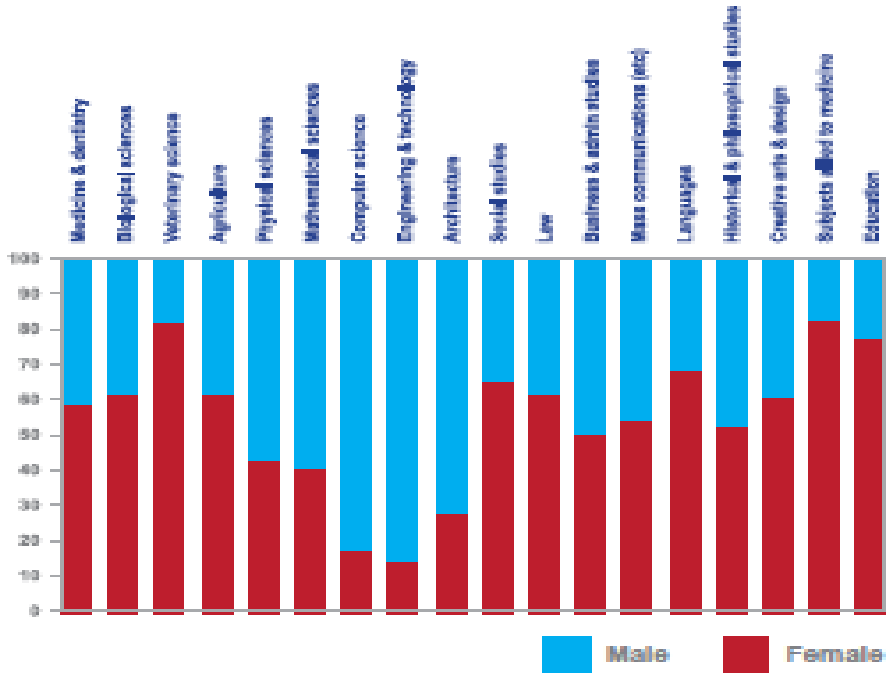
Maths is often perceived in the media as being male dominated

This is a self-fulfilling prophecy

It is also not really true!

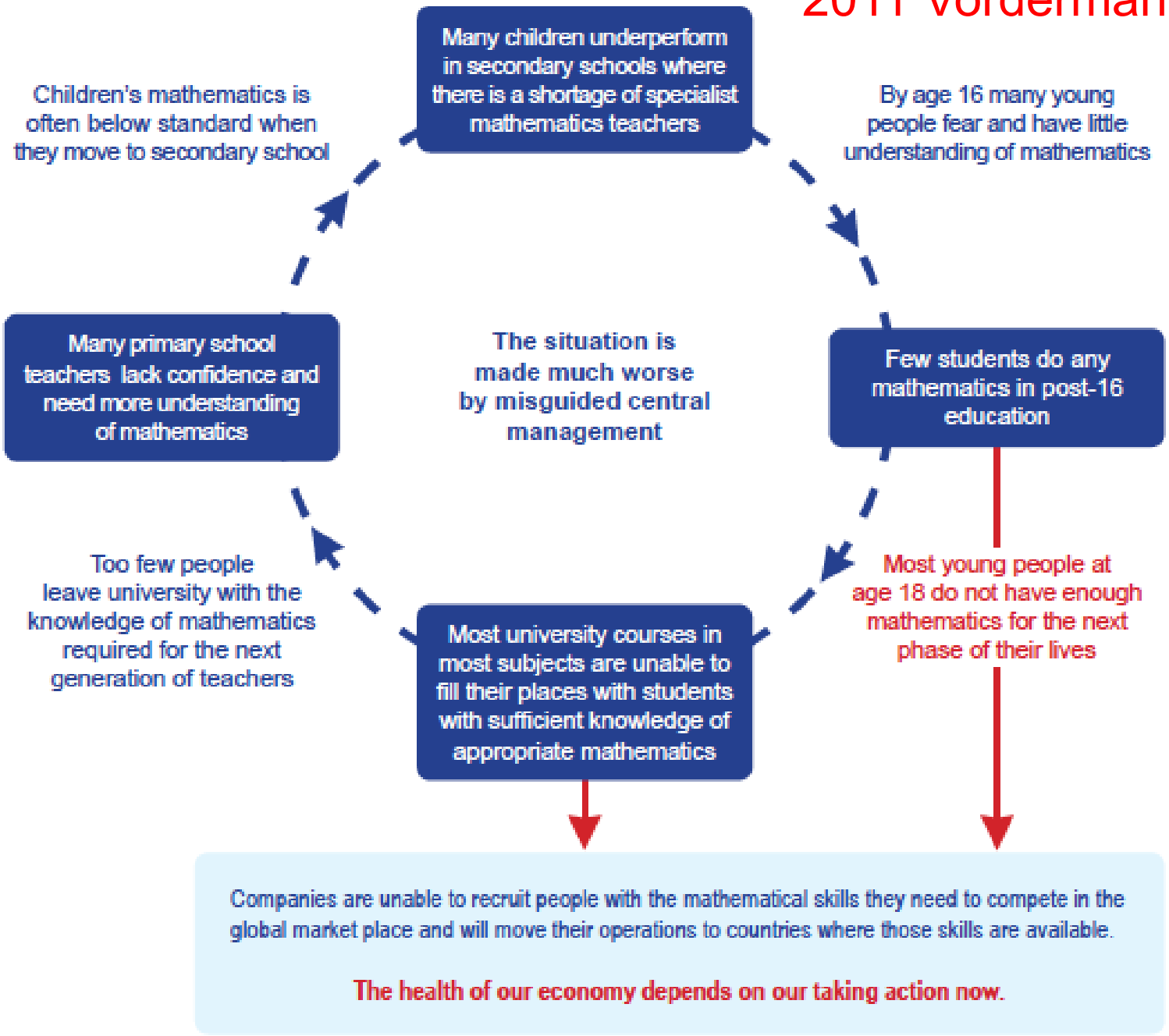
42% of all maths undergrads are female

But only 29% of lecturers
6% of professors



This is also changing in the future **Athena Swan**

2011 Vorderman Report



How to encourage young people to learn maths; now and in the future?

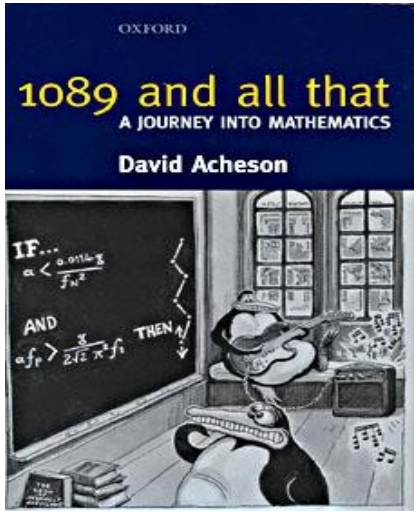
1.Show the magic of maths

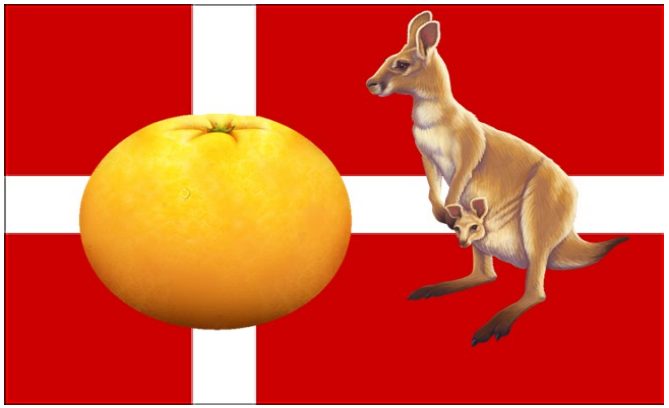
Take a 3 digit number eg. 729
Reverse it 927

Take smaller from larger 198
Reverse it 891

Add them up 1089

1089 Every Time





Teach the magic of maths, by using magic!

Mathematics is perceived as being dry with no excitement and surprise

Instead it is deeply mysterious, creative and surprising

Magic tricks makes this clear

2. Show the creative side of maths

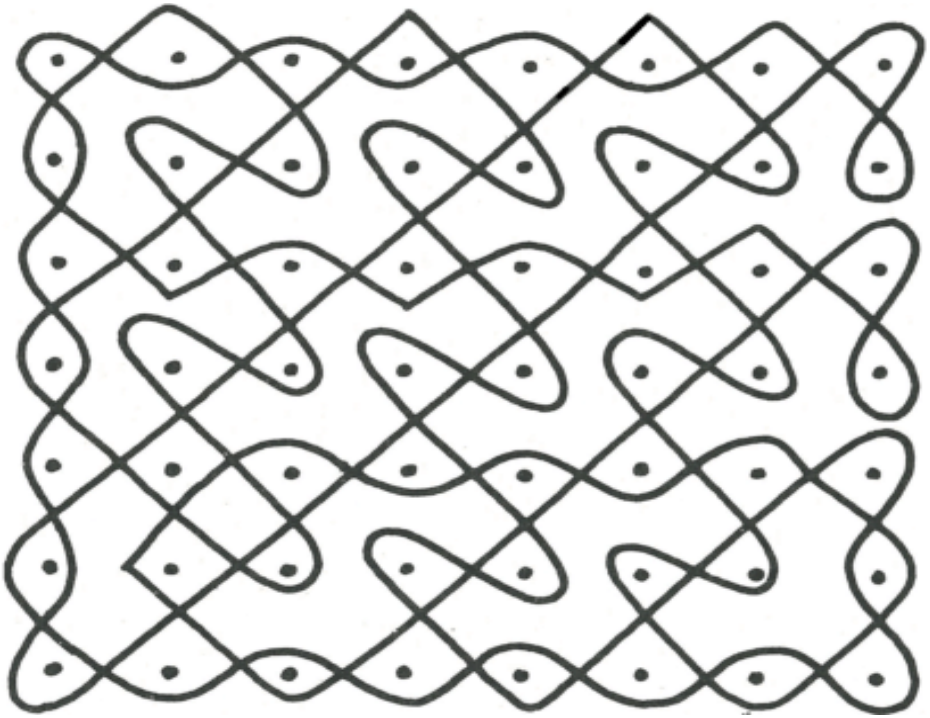
Show links to

Music

Art

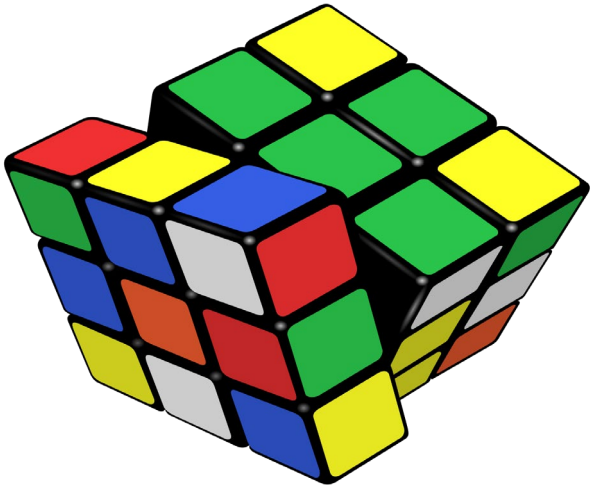
Dance

People and history



Explore and discover new patterns

3. Play with maths



4.4 Talk about careers

70% of all jobs need some level of maths

Many of these are amazing!

maths careers

ENDLESS OPPORTUNITIES

Recent big changes in maths education; Some Case Studies of Excellence

Fortunately things are now changing for the better with lots of new initiatives and grounds for hope for the future

1. Changes at the top

Government and the learned societies are taking maths education much more seriously

ACME: Royal Society
JMC
Smith Reports

Advisory Committee on Mathematics Education

2. Core Maths: Maths post 16

In July 2011, Michael Gove MP, who was the then minister for education, announced that

‘ ... we should set a new goal for the education system so that within a decade the vast majority of pupils are studying maths right through to the age of 18.’

ACME was asked by the DfE to produce a report about Core Mathematics qualifications

3 Pathways for post 16 mathematics

Core maths = middle path

Aimed at students who will be using maths in their careers of university courses but who are not taking A-level maths

Eg. Social scientists, medical students, plumbers, fashion, tourism and leisure, ….

Problem solving approach to maths

Modelling, data handling, digital technologies

3. Great Educational Initiatives

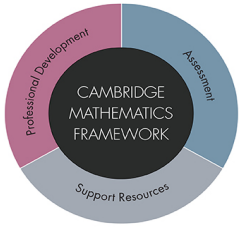
A number of bodies are now taking the lead in developing a creative approach to the way that mathematics is taught and delivered, and making extensive use of digital and web-based learning methods in the creation of high quality resources

These bodies also realise that to learn mathematics you need to do mathematics .. for example ..

Advanced Mathematics Support Programme®

MEI Mathematics Education Innovation

A MANIFESTO FOR CAMBRIDGE MATHEMATICS



4. Changes in teaching maths at HE

Smith report (2004) *'Higher education has little option but to accommodate the needs of students emerging from the GCE process'*

Led to a significant increase in the amount of help and support that is given to students learning maths: 81% of all universities

MASH at Bath

Sigma network

HEA

5. Explosion in mathematical outreach

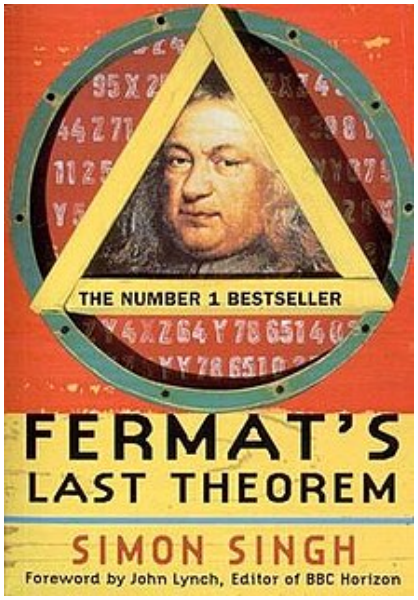
1978 Royal Institution Christmas Lectures
by Christopher Zeeman

Royal Institution mathematics masterclasses

MATHS *inspiration*

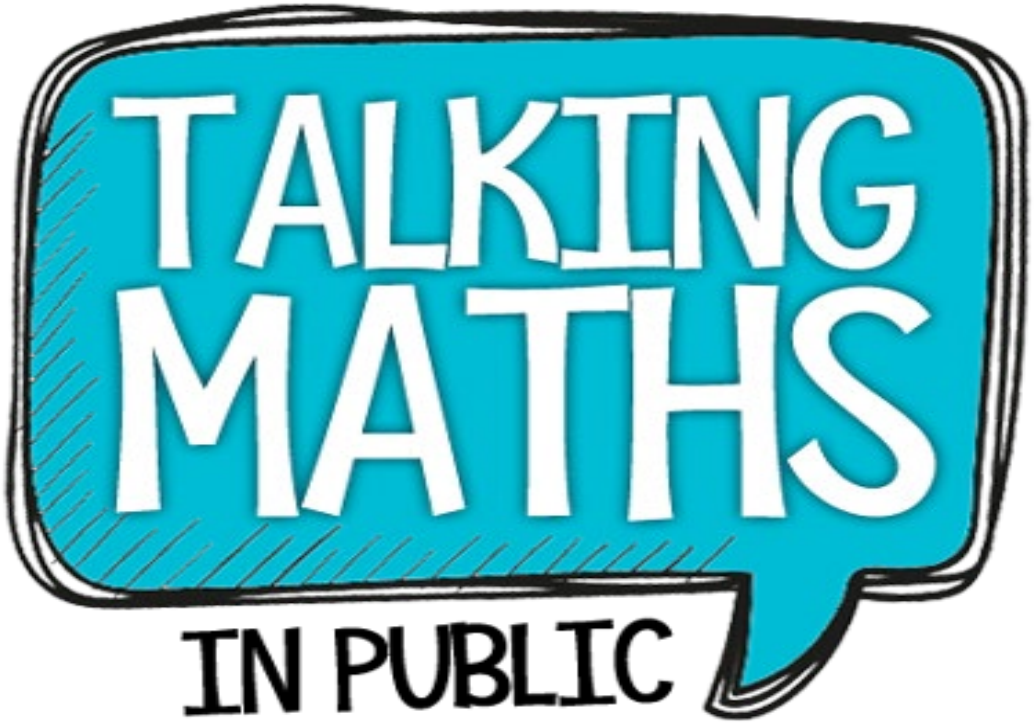
Maths Inspiration

Maths in books and on TV



Maths on the Internet

A growing network of people working in maths outreach

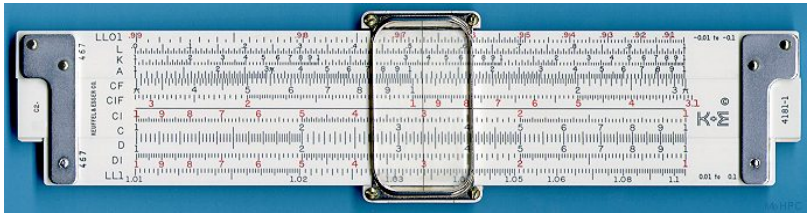


Teaching maths in the future will mean an increasing use of computers and technology

The UK is world leading in this!

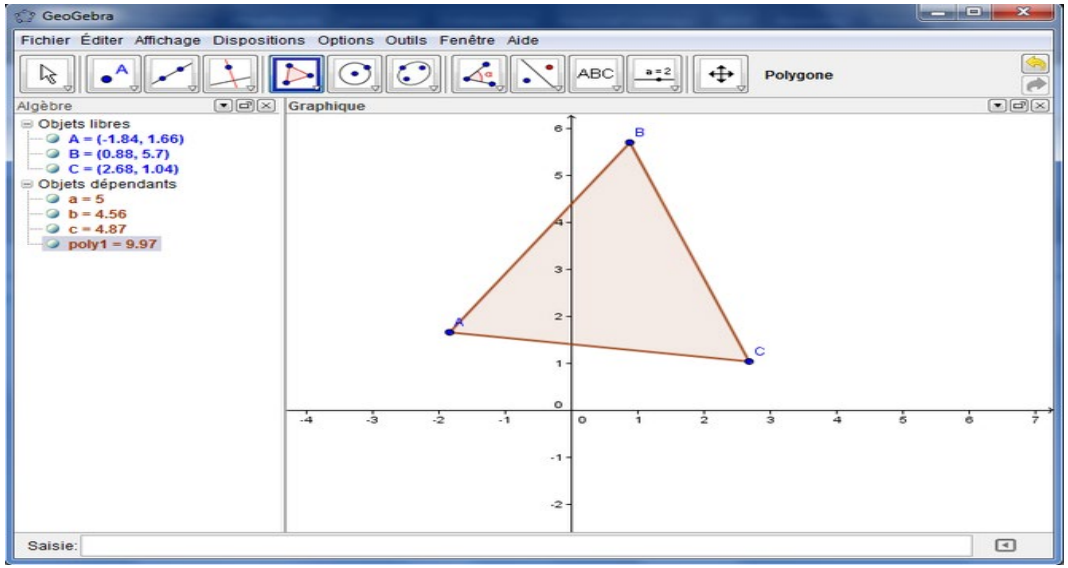
Celia Hoyles

1970s Introduction of calculators



1980s Digital technology to illuminate different areas of mathematics such as geometry, trigonometry, arithmetic, statistics, ….

Eg. GeoGebra

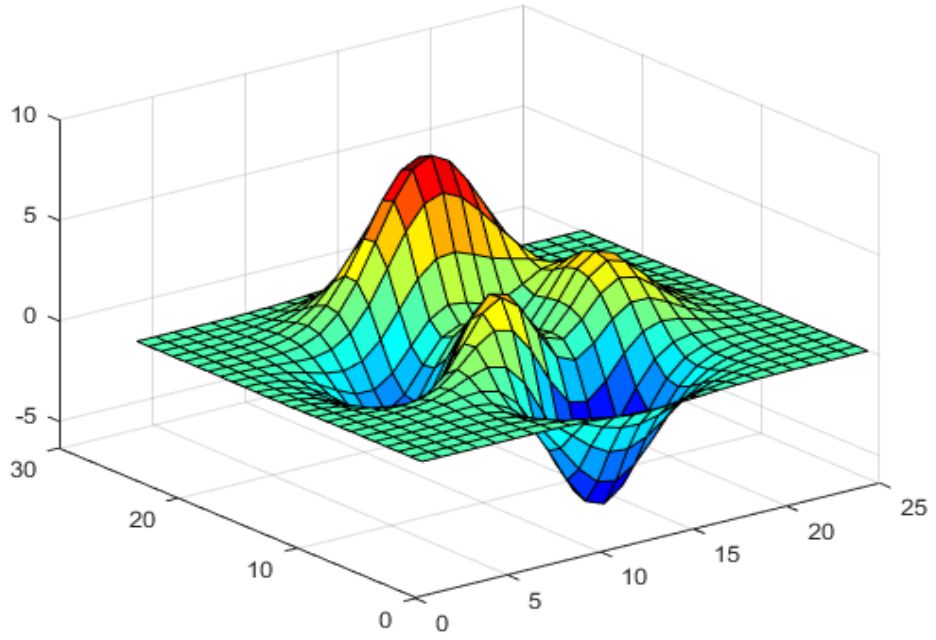


Programmable Robots to teach mathematical concepts such as geometry

Eg. Turtles, Logo programming language

1990s Programming languages allowing high level mathematics calculations and plotting

Matlab, Python, Maple, Mathematica, R, JuPyTr, …



Revolution in teaching maths at HE and in applying maths to the real world

Teaching of programming in schools

1970s Programming taught in the SMP project

1980s BBC/Acorn Microcomputer.

Progamming in Basic

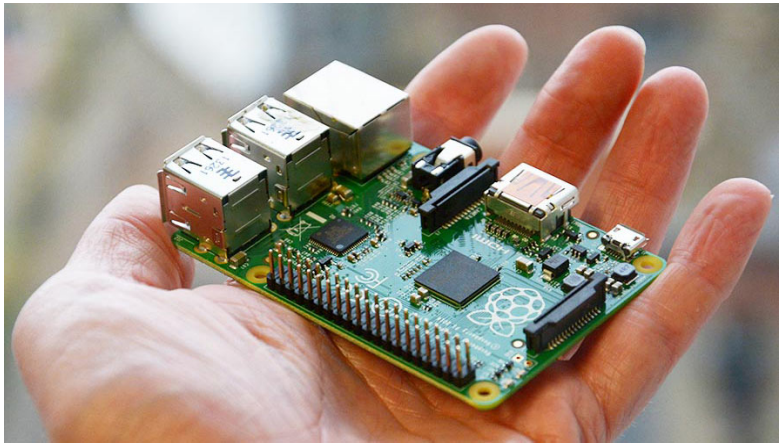
2000s Increasing sophistication of computers led to a decline in the teaching of programming at schools instead of teaching IT

2011 Eric Schmidt, CEO of Google

'I was flabbergasted to learn that today computer science isn't even taught as standard in UK schools. Your IT curriculum focuses on teaching how to use software, but gives no insight into how it's made'

Now changing for the better

- Computers at Schools (CAS) initiative
- Availability of languages such as Python
- Cheap and sophisticated computers you can program such as the Raspberry Pi



I am very excited about the future of teaching programming, and the impact that this will have on the future of mathematics education

The development of computers is having the same effect on mathematics as the invention of the printing press had for literature

Computers allow students to do independent creative work in mathematics that would otherwise not be possible

They are not a substitute for mathematical thinking!

They complement it, and make it more fun!

The real key to the future of maths education

Technology is vital, but the future of mathematics teaching lies in the hands, primarily, of mathematics teachers

Teacher numbers are under pressure

Forecast that pupil numbers will rise by 19% by 2026 putting significant pressure on teacher recruitment and retention

As does the extra teaching needed for Core Maths etc.

But, only 50% of maths teachers continue to teach in state-funded schools five years after qualifying

We MUST recruit, and keep more maths teachers in the future? How can we do this?

Improvements in Initial TeacherTraining:

NCETM

And CPD online or through organisations such as MEI etc

Improvements in teacher recruitment

Teach First Scheme

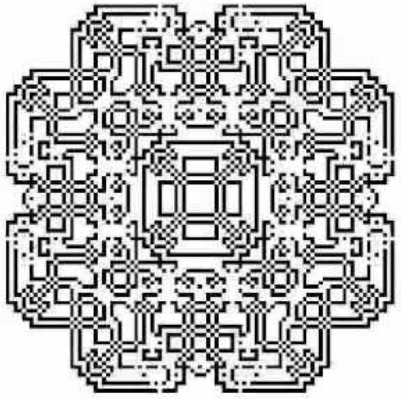
IMA bursaries

Encouraging more maths undergraduates to go into teaching

Undergraduate Ambassadors Scheme (UAS)

Communicating Maths (Bath)

I started this lecture on a down beat note. But hope I have finished with a much more positive vision about how maths can be taught in the future



I see a bright future where a combination of technology and creative teaching will open windows of mathematical opportunity to a new generation who can really appreciate the relevance of maths to their lives

Provided, of course, that we can recruit enough teachers in the future!

Answer to the puzzle. *7.5 m*

The ratio of height to shadow length is 1:3.

The shadow will therefore be 3(1+1.5) = 7.5m*

Now …

Work out the maximum and minimum number of Friday the 13ths. that there can be in a regular calendar year