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MAKING + CONNECTIONS

MATHEMATICS NUMERACY

5-6 DECEMBER

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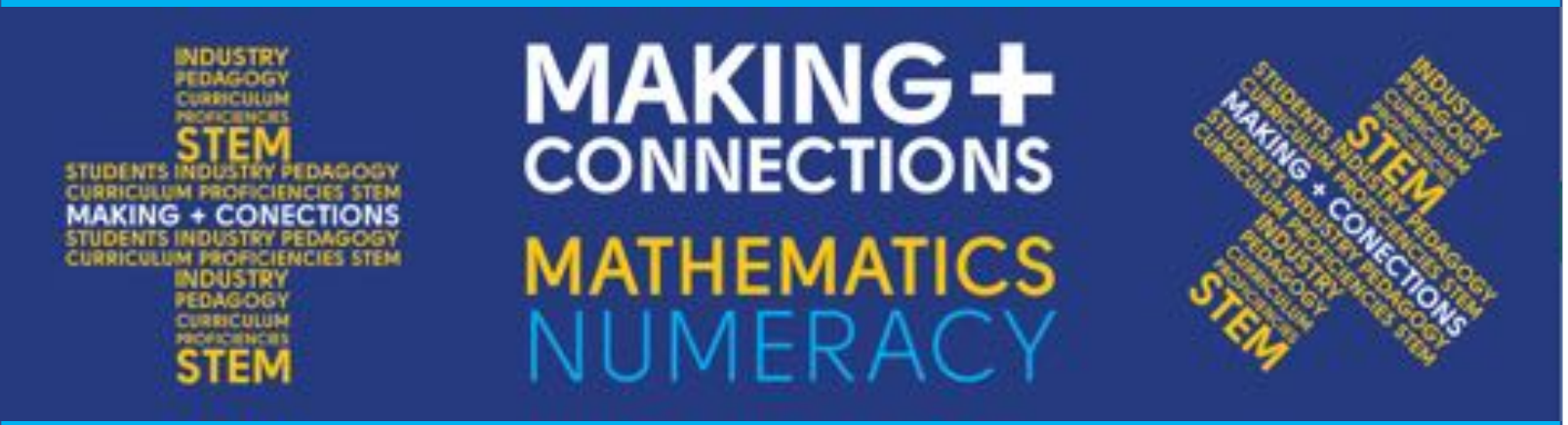

5-6 DECEMBER

#MAVCON

Keynote Sponsor

MATHSPACE

MAV:

- Professional Officer at MAV 2005 to 2017
- Published many resources for MAV around real life maths including RIME (Reality in Maths Education)
- Developed digital ‘Teach Maths for Understanding’ resource
- Prolific presenter at MAV conferences and events and in-school PD
- Development of MAV program for out of field teachers
- Project with Victorian Responsible Gambling foundation (VCAL)
- Volunteer for 20 years at the annual Somers Mathematics Camp

Other:

- Teacher: Melbourne and Canada (under DET scholarship)
- Lecturer mathematics education (including here at La Trobe Uni for many years and currently)
- Also worked with Deakin, ACU, Monash, RMIT
- *Mathematics at Work: Modelling Your World (*Australian Academy of Science)
- Published extensively for Nelson, Year 7 to 10 and VCE
- Significant international work in Malawi (Southern Africa, training hundreds of primary teachers

THE MATHEMATICAL ASSOCIATION OF VICTORIA

Life member

Dr Ian Lowe

MAV:

- MAV Council member from November 2006 to 2012
- Four years on Conference Committee
- Actively supports MAV's professional development program as a presenter
- Actively presented at MAV conference, including previous keynotes
- Wide support for MAV activities

Other:

- President of AAMT in 2009 and MAV delegate to the AAMT Council. Significant contributions made to the progress and structure of AAMT.
- Career spans LaTrobe University, Australian Catholic University, and Monash University
- In the mid-1980s Peter articulated the use of 'open questions'. His first book of tasks (with Pat Lilburn) remains a favourite
- More than 10 mathematics education research projects awarded by the Australian Research Council
- Current publications used widely by teachers
- Produced at least 52 articles, 35 conference papers and 24 chapters in books
- Involved in *reSolve: Maths by Inquiry*
- *Focused on engagement, effective teaching and effective classrooms, problem solving, etc*
- Significant work on committees and review panels (e.g., Australian Curriculum)

THE MATHEMATICAL ASSOCIATION OF VICTORIA

Life member

Emeritus Professor Peter Sullivan

MAV:

- 2002 Council Member
- 2003 & 2004: Vice President
- 2005 President & 2006 Immediate Past President
- 2007 Council Member.
- Conference presentations in most years from 2001 through to 2019, including a number of keynote presentations
- Reviewer of Annual conference proceedings

Other:

- Professor of mathematics education in the Faculty of Education at Monash University
- Also worked at Deakin University and Victoria University
- Researched and lectured in both primary and secondary education
- Ongoing focus on equity and social justice in mathematics education
- Research interest in out-of-field teachers, linked to provision of professional learning programs for teachers in low-socio economic schools
- Involved in *reSolve: Maths by Inquiry*
- Commonwealth Government funded study of the assessment of mathematical reasoning
- Member of the international *Teaching across Subjects (TAS) Collective*

THE MATHEMATICAL ASSOCIATION OF VICTORIA

Life member

Professor Colleen Vale

THE MATHEMATICAL ASSOCIATION OF VICTORIA

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KEYNOTE PRESENTATION

Kate Smith-Miles

Mythbusting Mathematics

MYTH-BUSTING MATHEMATICS!

Challenging student perceptions that maths is irrelevant, boring and too hard

Professor Kate Smith-Miles

School of Mathematics and Statistics
The University of Melbourne

MAV 2019

OUTLINE

- PART 1: Popular Myths about Mathematics
  - Why do they exist?
  - How can teachers debunk them?
- PART 2: Classroom ideas to inspire curiosity
  - Where did mathematical ideas come from?
  - What is left to invent?
  - An inspiring tale of a remarkable female mathematician
- PART 3: A personal reflection on my career and the inspiring influence of a maths teacher
  - Why I chose to become a mathematician
  - Things I wish my maths teachers had told me

PART 1: Busting 5 popular myths

1. You can only be a mathematician if you are a genius
2. Girls aren't as good at maths as boys
3. Maths is just about adding up numbers
4. Maths isn't relevant to the world or my future
5. There is no new maths to invent

Search YouTube for "Kate Smith-Miles" and/or "myth-busting maths"

Where do these myths come from?

- Student attitudes towards mathematics are formed early
  - It's challenging to undo deeply engrained perceptions that maths is too hard, boring, and irrelevant
  - Often reflects attitudes and experiences of parents
- But these perception issues *must* be challenged
  - Every student deserves equal opportunity for a strong career in a future workforce where high level numerical skills and analytical thinking will be essential and assumed
- These myths seem to stem from two main causes:
  1. Lack of understanding of what mathematics really is, and therefore what it is good for, and why they should study it
  2. A belief that some people have a "maths brain" and others do not

What is maths to most people?

- Most people think they know what mathematics is about
  - They've been studying "maths" since they learned to count
  - After more than a decade of studying a subject, you would be entitled to think you have a clear idea of what it is all about!
- The mathematics studied at school leads to common beliefs that:
  - mathematics is dry and boring, and all about procedures that need to be drilled
  - mathematics is mostly useful for trivial "everyday" applications
    - making recipes using ratios, laying brick patterns using geometry, or figuring out how to place a ladder against a wall!
  - Mathematics is irrelevant to their future

Not even close to the 10,000 hour rule!

Parent counter-argument: "I hated maths at school, dropped it as soon as I could, and have never needed it since!"

Foundations for beauty and power

- Musical scales and exercises are preparation for playing great musical works
- Grammar provides the foundations for literature
- The kind of *mathematics learned at school is foundational* and mere preparation for something more powerful that most students do not ever see
- How do we expose students to the real *power* and *beauty* of more significant mathematics, and inspire them to want to learn more, beyond the basic foundations of numeracy?

Foundations for future jobs

- The future (well-paid) jobs for the current generation of students will demand greater numeracy skills, problem-solving and critical, analytical and logical thinking taught only by studying higher levels of mathematics.
- There is a depth and breadth of the field of mathematics that the school curriculum simply can’t explore.
- We need students to realise that more *advanced mathematics is important for tackling truly significant problems*
- Just like mathematics has done for centuries, it responds to challenges of our time

The challenge for curriculum and pedagogy

- How to ensure a balance between:
  - strengthening the foundations for all students (everyday numeracy)
  - motivating a greater number of students to explore the more creative side of mathematics required for careers that build upon advanced mathematics training?
- How to ensure students see how basic concepts explored at school can be extended to solve real-world problems of great importance?
- https://mathigon.org/applications

“Why do I need to know this?”

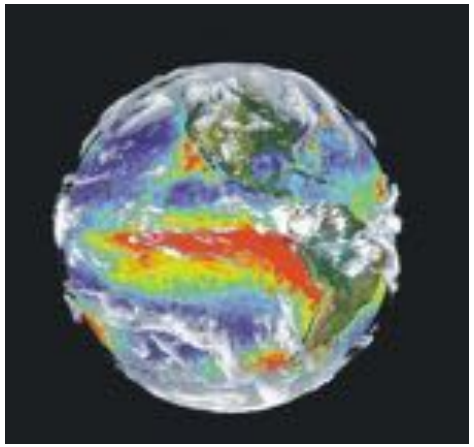
- A simple answer: *Mathematics is a language; we use it to describe our world*
- With mathematics we can:
  - prove facts and estimate uncertainties
  - model a system
  - predict what would happen if we make changes
  - improve the system
- The opportunities for positive impact are endless for those who speak this powerful language
  - Impact in the corporate world and for social good
- Everybody needs to learn to speak it fluently!

traffic networks, the human brain, stem cells, stock markets, etc.

The hidden work of mathematicians

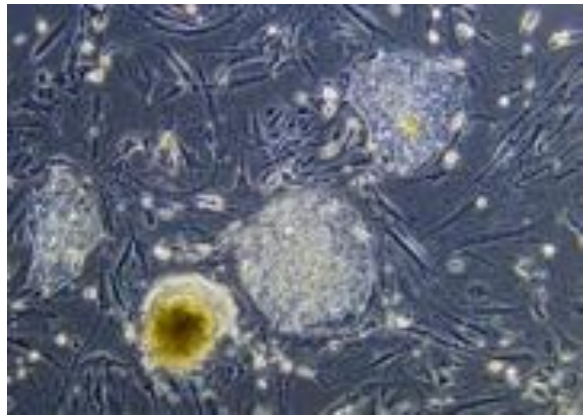
- Who works out the traffic light sequences?
- Who works out which trains we need on which lines at which times?
- Who works out when airplanes should take-off and land?
- Who works out what the weather forecast will be?
- Who works out which stocks investment funds should buy?
- Who works out the best premium to charge insurance customers?
- Who works out how much radiation cancer patients need in various parts of a tumour?
- Who works out if a credit card application is fraudulent?
- Who works out which frequency your mobile phone should be assigned so your call doesn’t interfere with others?

Mathematics underpins many of the grand challenges of our time



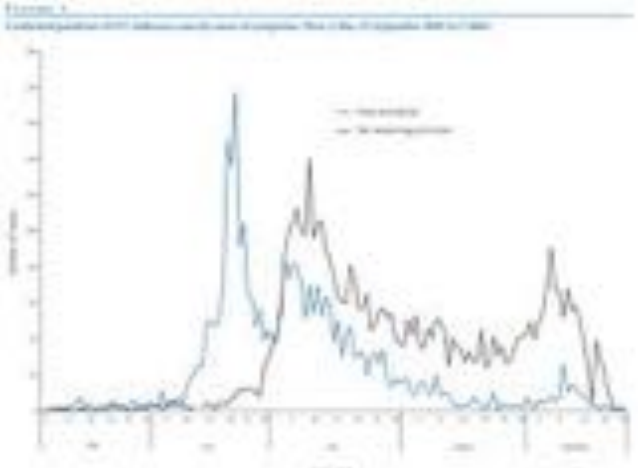
Climate modelling

Traffic modelling

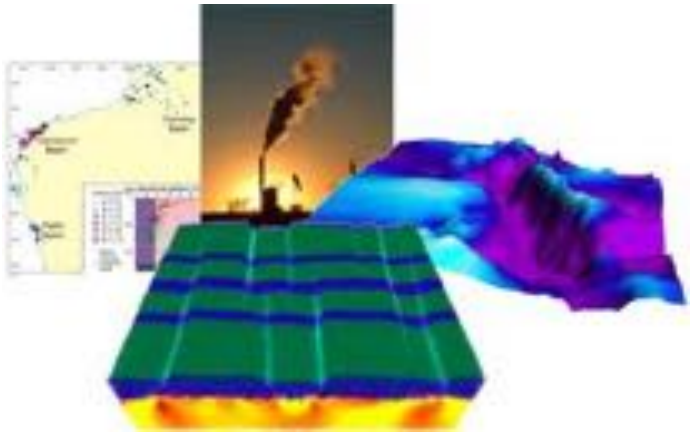


Stem cell modelling

Outbreak detection



Fluid flow analysis



Biosecurity

THE WALL STREET JOURNAL.
WSJ.com

CAREERS | JANUARY 26, 2006, 11:20 A.M. ET

Doing the Math to Find the Good Jobs

Mathematicians Land Top Spot in New Ranking of Best and Worst Occupations in the U.S.

By SARAH E. NEEDLEMAN

Nineteen years ago, Jennifer Courter set out on a career path that has since provided her with a steady stream of lucrative, low-stress jobs. Now, her occupation -- mathematician -- has landed at the top spot on a new study ranking the best and worst jobs in the U.S.

"It's a lot more than just some boring subject that everybody has to take in school," says Ms. Courter, a research mathematician at mental images Inc., a maker of 3D-visualization software in San Francisco. "It's the science of problem-solving."

The study, released Tuesday from CareerCast.com, a new job site, evaluates 200 professions to determine the best and worst according to five criteria inherent to every job: environment, income, employment outlook, physical demands and stress.

Wish I did a maths degree!

Top 5 jobs are:

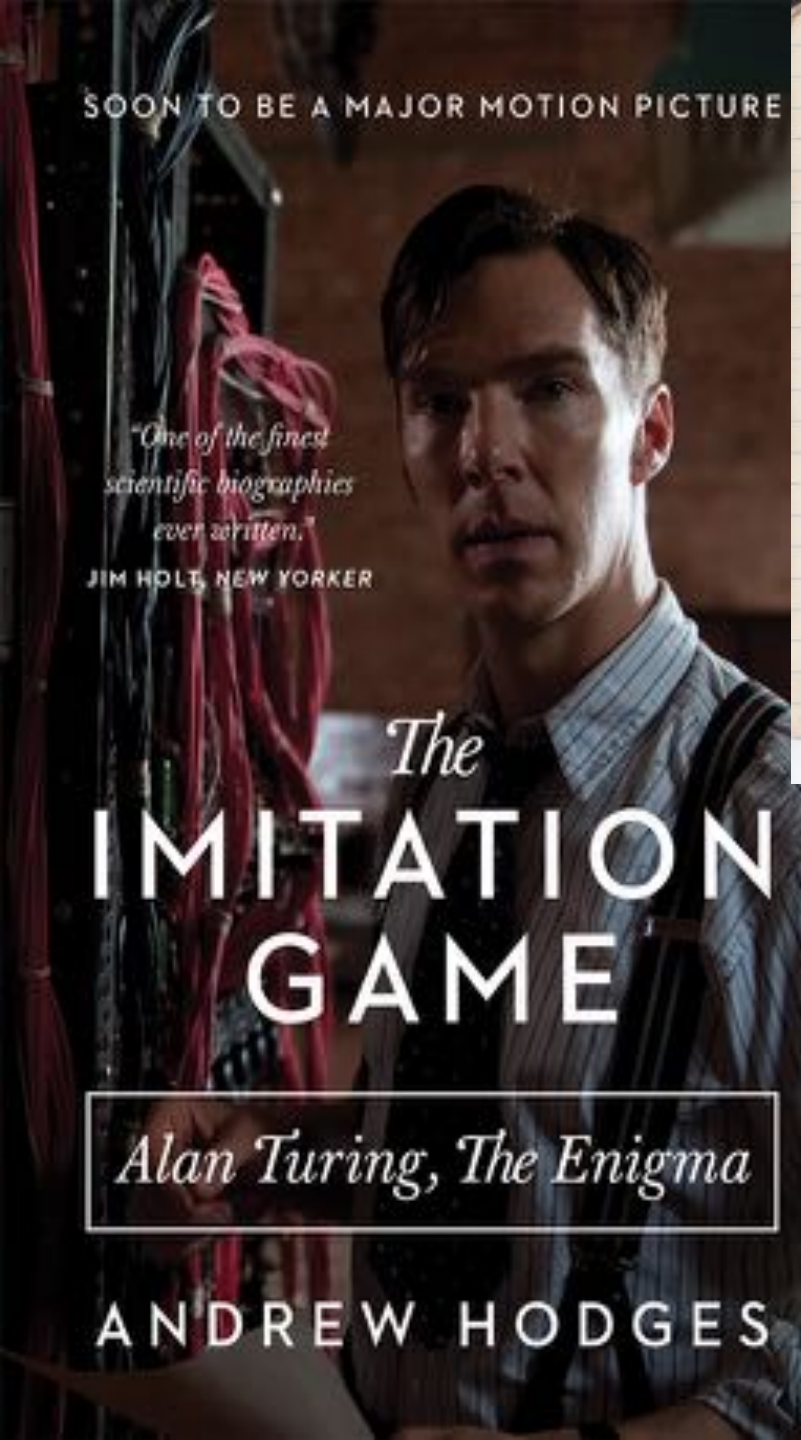
1. Mathematician
2. Actuary
3. Statistician
4. Biologist
5. Software Engineer

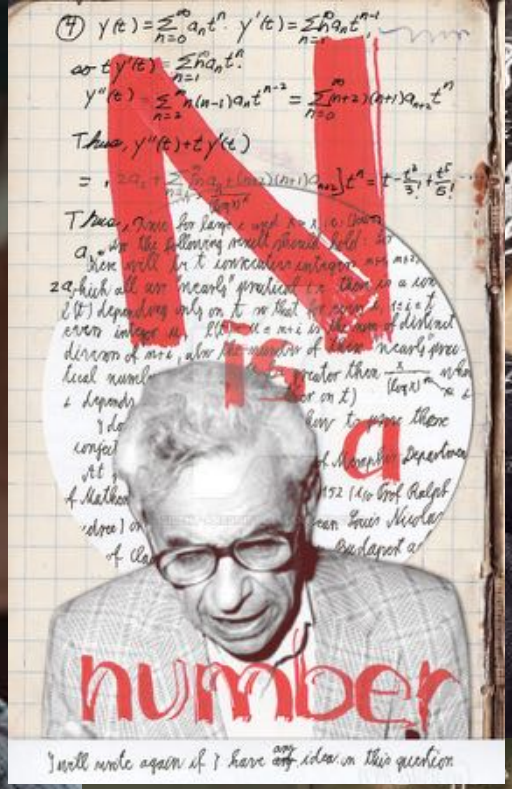
“OK, so maths is important … but I don’t have a maths brain”

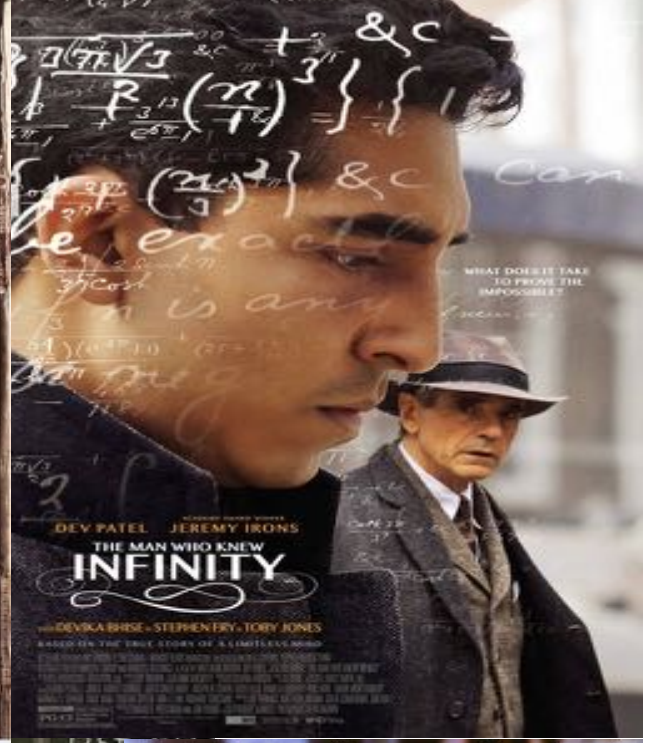
- Early negative experiences can be detrimental to student perception of ability
- Gender differences?
  - Evidence that girls *disengage* in maths earlier and in greater numbers than boys
  - *No* evidence that girls *perform* more poorly than boys in mathematics
  - Evidence that girls are less *confident* than boys in their mathematics ability
- AMSI ChooseMaths has shown confidence (∀) can be changed with simple intervention exercises (the power of “yet”)
- The impact of “maths anxiety” and use of mind-shift thinking to increase confidence should inform strategies around teacher training and influencing parental attitudes

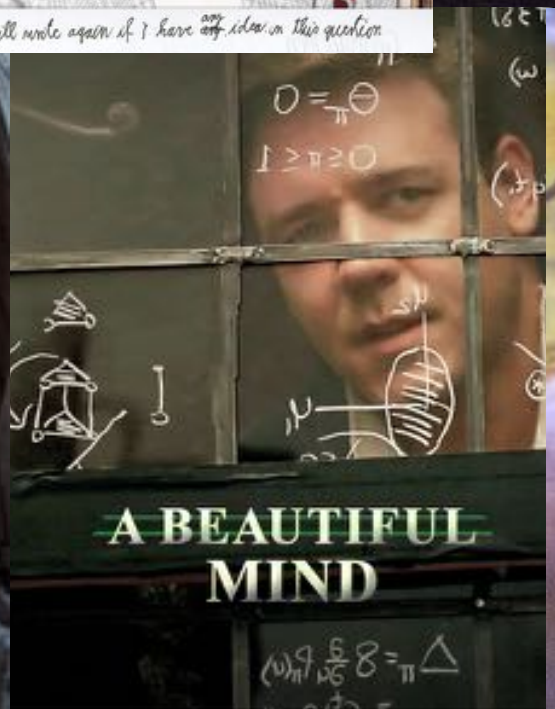
“OK, I can do maths, but I’m not a genius …”

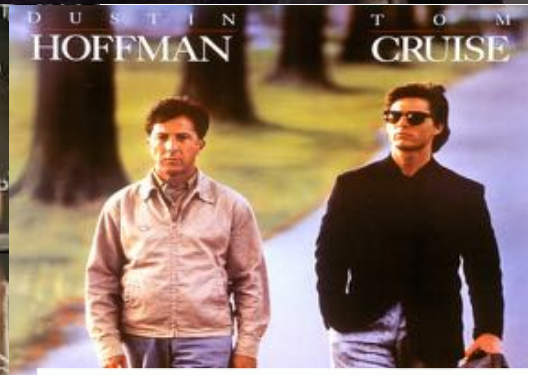
- *All* students can be taught to thinking mathematically and problem solve
  - just as all students can be taught to read and decipher and understand concepts and messages discussed in literature
- You don’t need to be a genius to become a mathematician!
- There is an urgent need to communicate more effectively in order to change student perceptions and attitudes towards mathematics
  - what mathematics really is
  - its significance for the real world
  - showcase role models who are relatable
- Back to myth-busting …











What can you do?

- Find relatable role models to visit school
- contact maths outreach officer at local university
- find math-trained parents
- find alumni to visit school

Literature Review

242 Studies (1990-2007) of 1,286,350 people

Lindberg, S. M.; Hyde, J. S.; Petersen, J.L.; Linn, M. C. (2010). "New Trends in Gender and Mathematics Performance: A Meta-Analysis". *Psychological Bulletin*. Vol. 136 , no. 6, pp. 1123–1135.

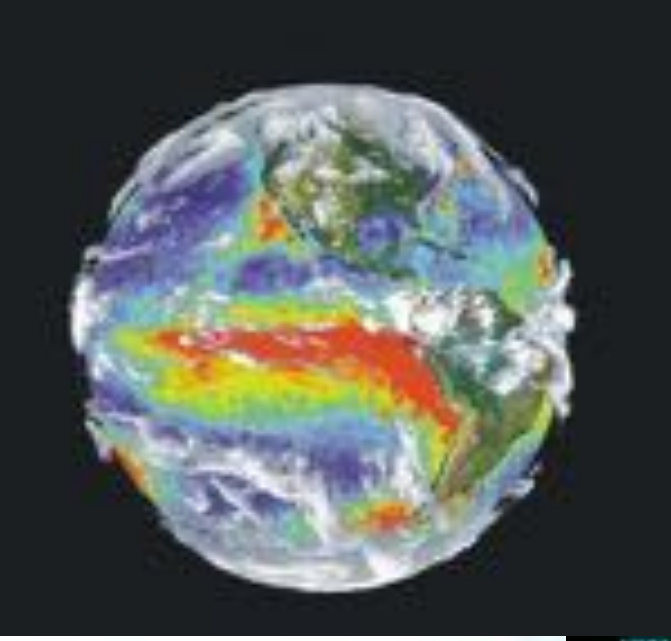
- Share study findings
- AMSI Choose Maths mentors
- growth mindset

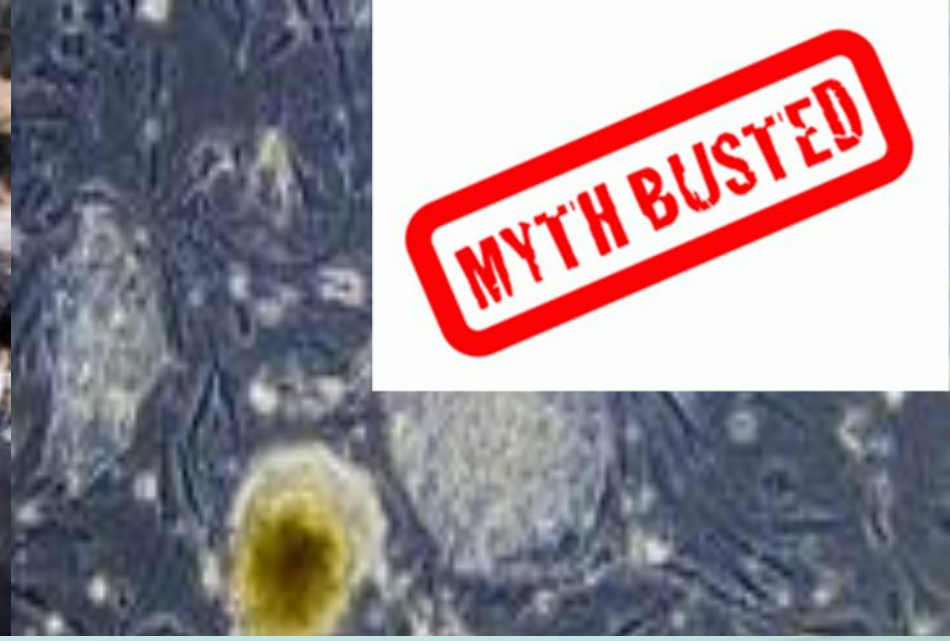
Conclusion:

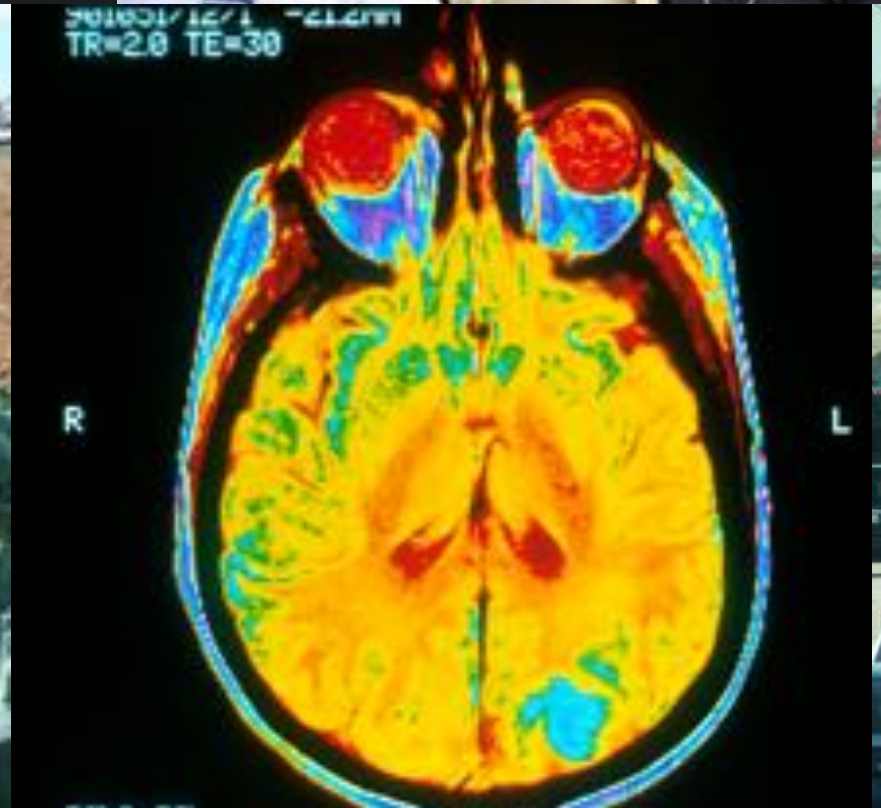
No overall difference in performance in mathematics based on gender

Speed Maths
...how quick are you?

- Reinforce foundational message (hang in there!)
- focus on problem solving rather than procedural drilling
- creativity, elegance, proof, logic.




MYTH BUSTED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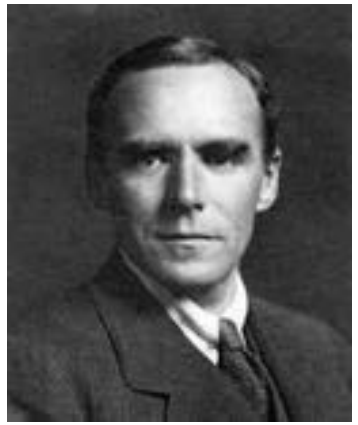
Dr Martin Luther
King Jr Blvd
EXIT ONLY
TARGET

THE ELEMENTS
HISTORY OF MATHEMATICS
INTRODUCTORY AND INTERMEDIATE ALGEBRA
MYTH BUSTED
CALCULUS
Calculus
USED

PART 2: Classroom ideas to inspire curiosity

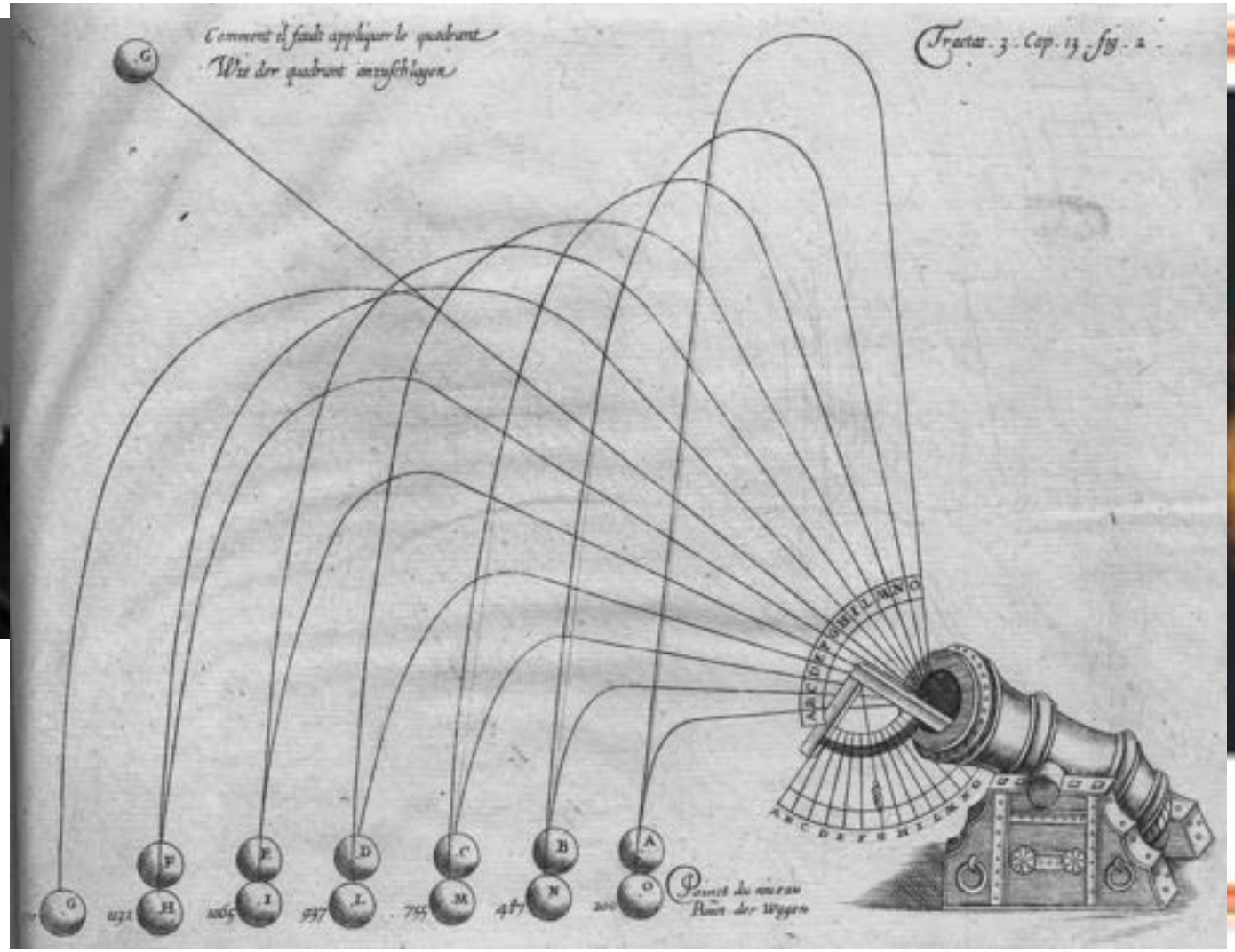
- Where does new maths come from?
- New maths is often created in response to society's challenges
- WW1 mathematics?

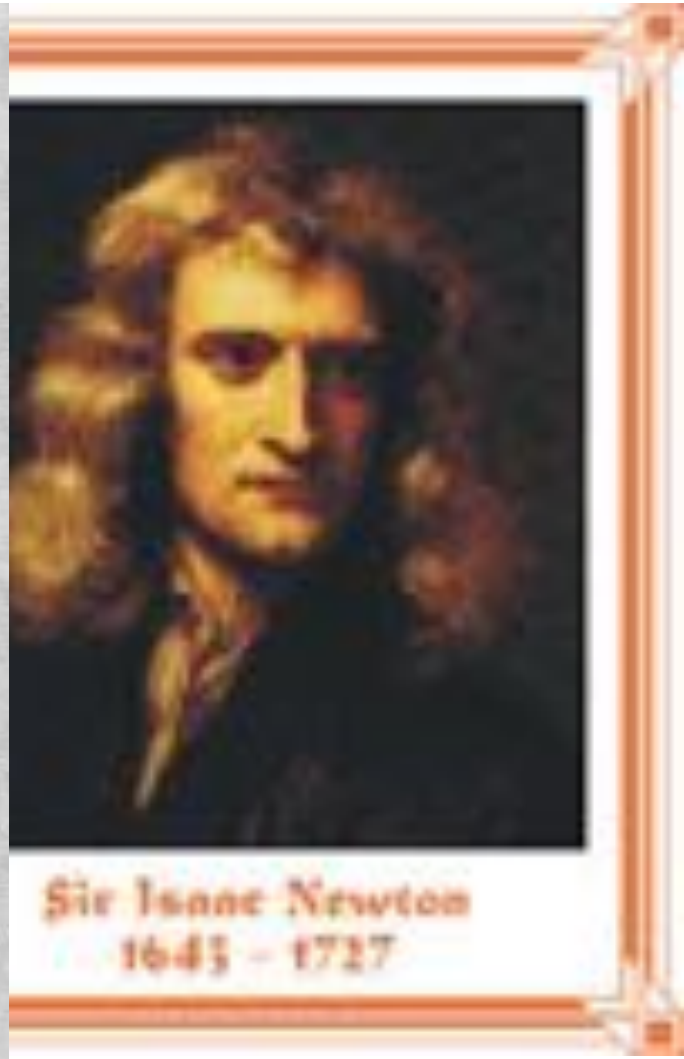


Geoffrey Taylor (pilot and mathematician) studied the maths involved in parachute dynamics, enabling troops to land at targets

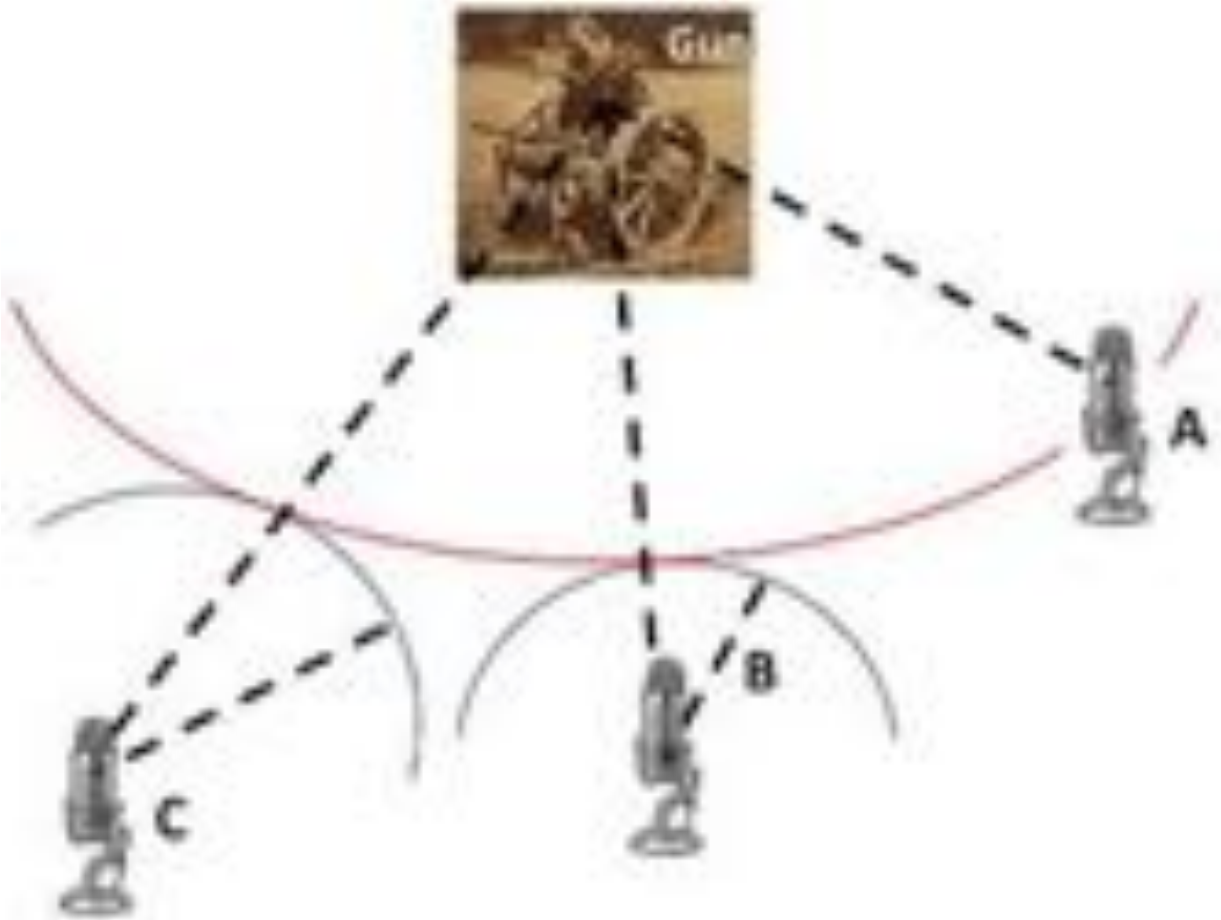
Edward Busk (pilot and mathematician) was able to unravel the mysteries of airplane stability, leading in 1913 to the production the first stable aircraft used in WW1

Ballistics … where will the cannon balls land?





WW1 and sound-ranging …
where are the guns hiding?



Similar modern inverse problems (non-war)

- Where are the ants going?
- Where are the ant nests hiding?

Optimisation – a new branch of maths from WW2

- A whole field of mathematics emerged from war-time decision making
  - Which troops should be sent to which battles?
  - How should weapons be allocated across the army?
  - When should maintenance be done on war planes and ships?
- All of these questions involve making decisions:
    - Maximise or minimise something while satisfying some limits or constraints

What if decisions have to be whole numbers?

- Famous “Branch and Bound Algorithm” pioneered by Melbourne woman Alison Harcourt in 1960!
- Victorian Senior Australian of the Year, 2019

ABC 7:30 TV story

Maths: For women as well

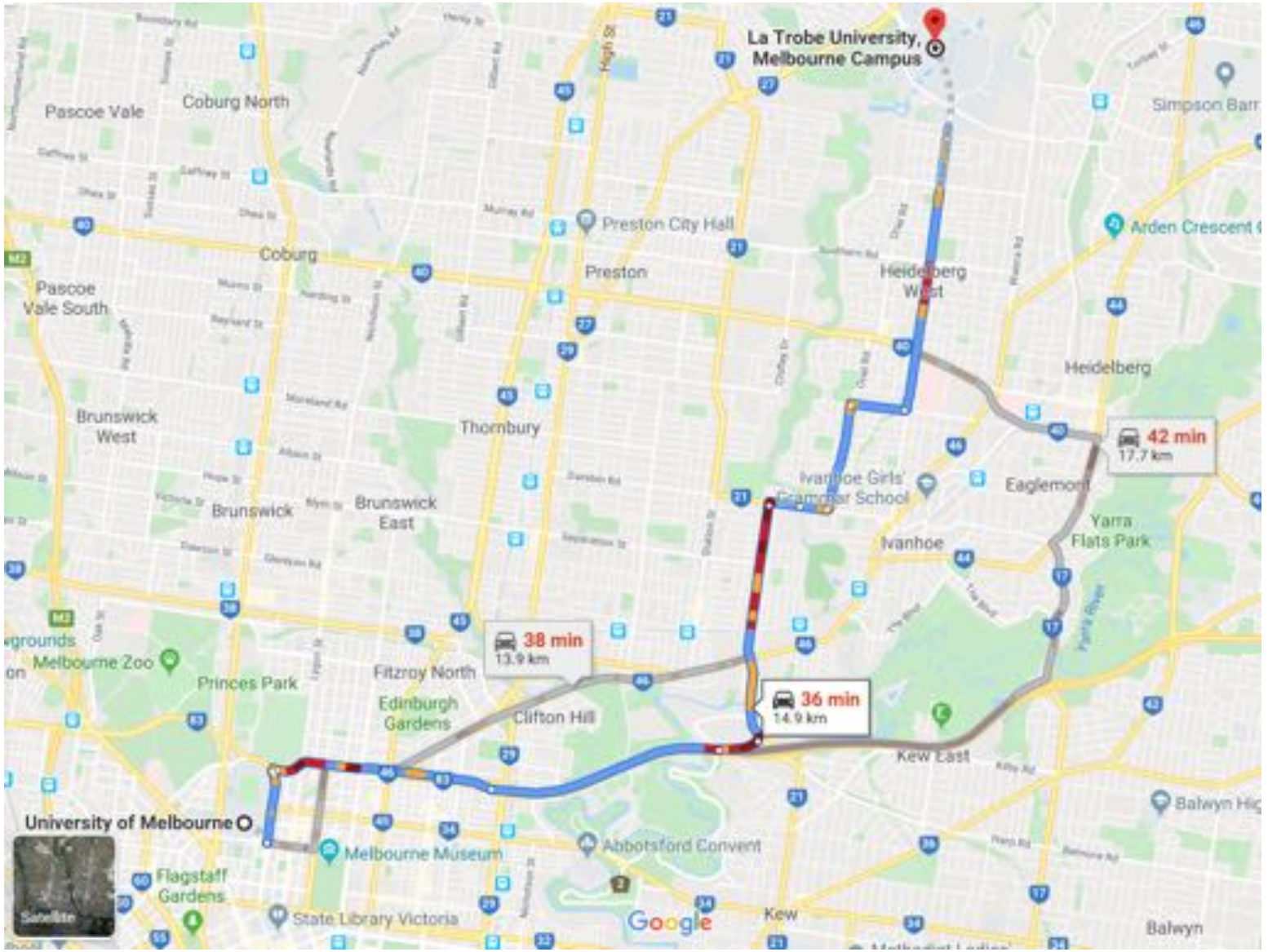
Housework? No! Hobbies? No! but

Computing pioneer gets her PhD

Almost six decades on, the University of Melbourne will recognised at last the unsung achievement of one of its pioneering female graduates. It will award an honorary doctorate to mathematician Alison Harcourt, 88, whose work helped found a field of

Everyday (non-war) optimisation problems

- Same methods used in Google Maps to plan your trip
- Minimise travel time getting from A to B while avoiding tolls, using roads, avoiding traffic jams, etc.



McDonald's Diet Problem Formulation

Data for the McDonald's Diet Problem

McDonald's Food: the Facts

Menu Item	Price* ($)	Calories	Protein (g)	Fat	Sodium (mg)	Vit. A % U.S. RDA	Vit. C	Calcium	Iron
Hamburger	0.69	260	13	9	530	2	2	15	15
Big Mac	1.99	560	25	30	1010	8	2	25	25
Chicken McNuggets (6pcs)	1.99	250	15	15	670	2	2	2	4
Garden Salad	2.05	35	2	0	20	120	40	4	6
Baked Apple Pie	0.79	260	3	13	200	0	40	2	6

* Prices recorded Jan. 12, 2000 in St. Louis, Missouri

1. What must be decided?

Diet Plan

x1 = # of hamburgers
x2 = # of Big Macs
x3 = # of Chicken McNuggets
x4 = # of Garden Salads
x5 = # of Baked Apple Pies

2. What measure should we use to compare alternative sets of decisions?

Money Spent on McDonald's Diet

3. What restrictions limit our choices?

Calories obtained ≤ 2000
Protein obtained ≥ 55 gram
Vitamin C obtained ≥ 100% of U.S. RDA
Calcium obtained ≥ 100% of U.S. RDA

PART 3: A personal reflection on my career and the inspiring influence of a maths teacher

KATE SMITH

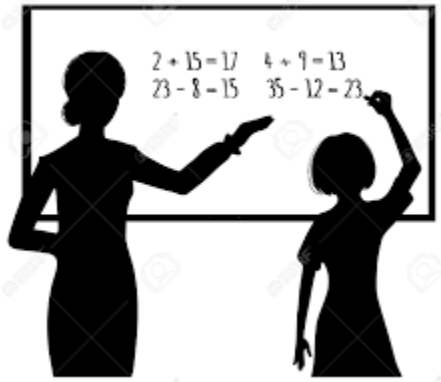
The straight 'A' student with the intriguing and mysterious background.

Likes: Pink pencils, No. 5 Trams, Twisties, rhythmic 'Laudates' rain, Christopher Cross, 'Sailing'.

Dislikes: Light rail trams, digital watches, 40°C heat, and a few other things not worth mentioning.

Ambition: To get 369 in these exams, to work out 'Kate's Theorem,' for someone else to use it, and to find a career and a way of life that I would be happy in.

Where did this ambition come from?



- From ballet to journalism to …?
  - … am I good enough, will I enjoy it?
- Prior to year 12, mathematician wasn't on my radar
  - … Was I good at maths? Yes, but no genius
  - … Did I enjoy it? Yes, but really passionate about it yet
  - … confidence? procedural? couldn't see relevance …
- Then an inspiring Year 12 maths teacher changed my view
  - … maths is creative, elegant, beautiful … curiosity sparked!
- She tried to dissuade me!
  - …medicine, law, architecture, "where will studying maths at uni lead you? Becoming a maths teacher like me? You can aim higher!"
- But I'd made up my mind to learn more maths and see where it took me …

My Journey Begins: Melbourne University

- Bachelor of Arts (lots of maths, and music history and psychology)
- Day 1, Monday 9am, decided to become a maths lecturer!
- PhD became next goal, transferred first into Bachelor of Science
- 3rd year: “these equations can be used to model traffic flow”
- Drawn to practical applications, operations research, mathematical modelling, improving the world, rather than abstract (pure) maths
- Summer vacation research work at CSIRO
- PhD with CSIRO, good exposure to industry work, but decided I still wanted to be a lecturer

Finally the job I wanted (sort of)!

- Lecturer in Information Technology at age 25 (Monash University)
  - Teaching computer programming and artificial intelligence
- Professor of Information Technology at age 35
- Professor of Engineering at age 36 (Deakin University)
  - Head of the School of Engineering, IT, and maths; research in robotics and AI
  - Teaching maths to future primary school teachers
- Professor of Mathematics at age 38 (Monash University)
  - Head of the School of Mathematical Sciences
  - Teaching maths to engineering students and maths students
  - Research in mathematical modelling and optimisation

So what's Kate's Theorem?

- Alas no "Kate's Theorem" per se, but lots of research with ≈ 10000 citations
- Professor of Applied Mathematics at The University of Melbourne
  - Teaching, research, collaboration
  - Intellectual freedom
- A focus on having impact in society with my mathematics
  - Collaborations
  - Industry
  - Outreach
  - Mentoring

MENTORING THE NEXT GENERATION OF MATHEMATICIANS

Professor Smith-Miles loves teaching and training the next generation. She encourages students and academics to follow their passions first and highlights the importance of keeping everything in balance while striving for the satisfaction that comes from creating a positive impact on the world

The hidden work of mathematicians

- Who works out the traffic light sequences?
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- Who works out which frequency your mobile phone should be assigned so your call doesn’t interfere with others?

What my maths teachers should have told me …

1. There is a growing skills shortage of mathematically qualified people
2. The world needs mathematical scientists to help
   - Understand our world and beyond
   - Model and improve systems
   - Fill the world with people who can think clearly and rationally!

"Do as much mathematics and statistics as you can in your degrees – these skills will empower your professional life."

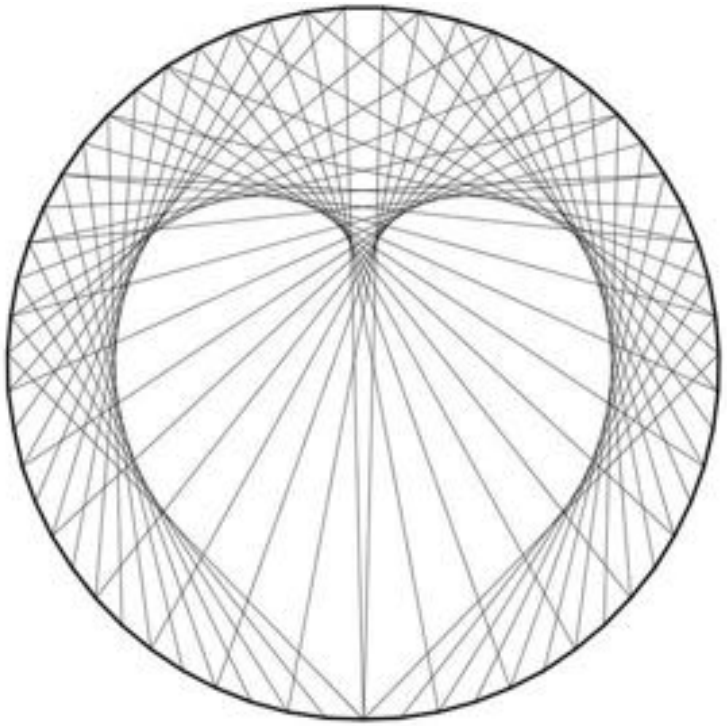
Sir Gustav Nossal
Australian of the Year, 2000
Distinguished Scientist

Other (maths) things I wish I knew when I was 17 …

- Maths is a language (of logic, truth, to describe the world, and improve it)
- Maths is the key to tackling many significant challenges for society
- Maths is creative, elegant, beautiful and satisfying
- There are many ways to be a good mathematician (collaboration not just competitions)
- There are many ways to have an impact in society through maths
- The maths you have seen at school is foundational and preparation for the good stuff at university!
- Maths is a foundation for many careers (always has been, always will be)
- An inspiring maths teacher can change your life!

This talk is dedicated to the inspiration of Ms Elizabeth Kerr (1953-2003)

Wishing you all a wonderful MAV2019



Thank you!

THE MATHEMATICAL ASSOCIATION OF VICTORIA

Learn more at
www.mav.vic.edu.au

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- Matrix newsletter
- Advocacy
- News page
- Public events

CONFERENCES
- Annual conference
- Primary conference

PUBLICATIONS
- Prime Number (Primary journal)
- Vinculum (Secondary journal)
- Common Denominator (Magazine)

RESOURCES
- MAVshop
- Teaching resources
- Professional resources
- VCE trial exams, SACs, VCE solutions

PROFESSIONAL LEARNING
- Contracted in-school
- Network days
- VCE
- Professional learning events
- Virtual learning sessions

STUDENT ACTIVITIES
- Maths Talent Quest
- STEM events
- Maths camp
- Games days
- Family maths activities
- VCE revision lectures
- Made by Maths app

MEMBERSHIP
- Become a member
- Mathematics Active Schools