

Making Diversity 'Count': *empowering students through co-creation of inclusive mathematics curricula*

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Diversity in Mathematics (DiM): An Overview

- Why do we need it?
- How did I embed it in my modules?
- What did students say and what impact it did it have?
- Concluding remarks and next steps

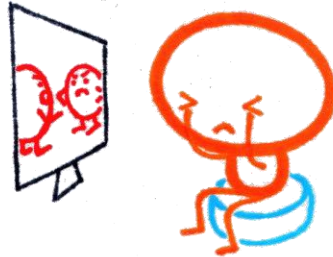
Attitude towards DiM: Not my problem!

This is M



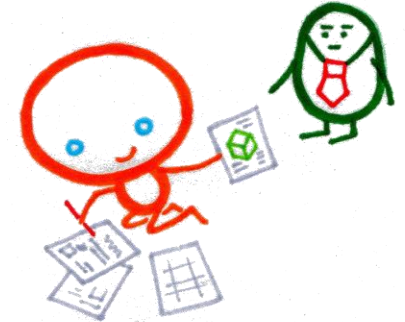
Mis very clever and likes solving fun puzzles and maths problems.

M doesn't like thinking about politics or society.



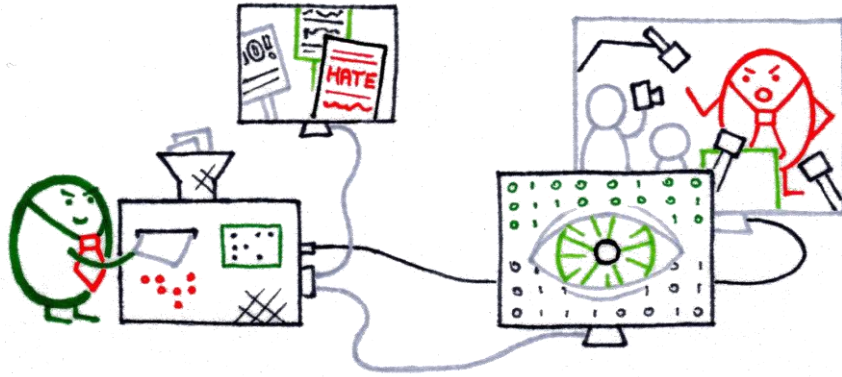
The outside world is scary.

At work, Mis given shiny new problems to work out every day.



Mis well looked after, and doesn't have to confront the outside world at all.

Attitude towards DiM: Not my problem!



And who would want to
anyway?

The news seemed to be
getting worse every day,
which made M feel
worried and scared.

Better far to ignore it all,
and get back to that
interesting problem...



Made by Phoebe Young
www.ethics.maths.cam.ac.uk

Need for Diversity in Mathematics (DiM)

- Mathematics usually taught through memorisation and repetitive application of formulae
- Often limited emphasis on historical aspects and contributions by diverse individuals
- If done, mostly confined to white, male, European mathematicians and scientists
- Consequently, very few students relate to these mathematical figures (no role models)
- Adds to the stigma that studying mathematics is esoteric, inaccessible and difficult

How did I embed it in my modules?

- Co-creation of teaching toolkit with **current undergraduate students**
- Teaching toolkit comprising short biographies and visual posters of **both historical and present-day 'STEM champions'** from diverse and under-represented backgrounds (e.g. African, Islamic, Asian, female, disabled, LGBTQ, those with non-traditional pathways)
- First pilot run implemented in two large (300-400 students each) **first and second-year** undergraduate **applied mathematics modules** for engineering students
- Embedded as **asynchronous non-assessed** resources alongside course content

✓ Making Diversity 'Count': Profiles of STEM Champions (RS)

Motivation

The profiles of past and present diverse individuals provided below form part of an ongoing scholarship research initiative to diversify STEM curricula being undertaken by Dr. Rehan Shah in SEMS with collaborators from the School of Mathematical Sciences at QMUL. These are designed to increase students' awareness of diverse representation and provide positive role models through exposure to mathematicians, scientists, and engineers from under-represented backgrounds (female, disabled, and queer) and non-traditional pathways in academia and industry.

If you are more interested in this area and would like to engage in it further, please get in touch with Dr. Shah.

STEM Champions

1. Mary Somerville (1780 - 1872)
2. Peter Landin (1930 - 2009)
3. Nira Chamberlain (1969 - present)
4. Gladys West (1930 - present)
5. Sofia Kovalevskaya (1850- 1891)
6. The ENIAC Six: Betty Holberton, Jean Jennings Bartik, Kay McNulty, Marlyn Wescoff and Ruth Lichterman and Frances Bilas Spencer

Task

Please engage and have a look through these materials and then provide your feedback by completing the survey below by the end of Week 10 (Friday 29 March 2024).

 Biographies of STEM Champions

 Completion ▾

 Feedback Survey

Opened: Saturday, 17 August 2024, 9:00 AM Closes: Wednesday, 30 October 2024, 4:00 PM

 Completion ▾

Mary Somerville (1780 - 1872)

Brought continental calculus to Britain, known as the 'Queen of Science'

"Whatever difficulty we might experience [...] in choosing a King of Science, there could be no question whatever as to the Queen of Science." - The Morning Post 1872



A Scottish writer and Polymath who is dubbed as the worlds 'first ever scientist' as well as one of the first female members of the Royal Astronomical Society. Awarded a silver medal in 1811 for solving the Diophantine problem, which included 'Fermat's Last Theorem', thought to have been unsolvable for 400 years. In addition to this, she can be credited with being one of the first people to suggest Neptune's existence and mentoring Ada Lovelace.

Somerville grew up as one of six children, and unlike her brothers, did not receive formal schooling as a young child, only being taught to read by her mother, but not to write. Her first interaction with science came from her art teacher who introduced her to 'Euclid's Elements'. In 1817 she was introduced to the works of Laplace, Poisson and Poinsoit whilst visiting Paris. Following this visit, Somerville used her connections in Paris to bring these concepts to Britain.

Scientist (noun):

First used in print in 1834 in William Whewell's anonymous review of Somerville's work, 'The Connexion of the Physical Sciences'

Somerville was the first person to be dubbed a 'scientist' in print, as her work was becoming so separate to the standard terminology at the time of 'philosopher'. She was a revolutionary in her field.



"Age has not abated my zeal for the emancipation of my sex from the unreasonable prejudice too prevalent in Great Britain against a literary and scientific education for women".

Somerville had to work hard to gain acceptance for her work, and at the start of her career, even publishing under the pseudonym, 'A Lady' to avoid scrutiny. She even described her husband as having 'a very low opinion of the capacity of [her] sex'

Always keen liberal, she was the first supporter of Mill's petition to Parliament to grant female suffrage as well as advocating for abolition of slavery.



Scan for a short video

Peter Landin (1930 - 2009)

CHANGED THE FACE OF COMPUTER PROGRAMMING

"Most papers in computer science describe how their author learned what someone else already knew."



Peter Landin was a pioneering British computer scientist whose work in the 1960s laid critical foundations for the development of programming languages. Known for his contributions to the theory of programming languages, Landin introduced key concepts such as the SECD machine, the first abstract machine for lambda calculus, and coined the term "syntactic sugar." His innovative ideas greatly influenced the design and implementation of many modern programming languages, cementing his legacy as a visionary in the field of computer science.

Aside from his work as a computer programmer, Landin was also an active campaigner for LGBT rights and was a member of the Gay Liberation Front during the 1970's, following the separation from his wife in 1973. Landin's distancing from computer science was triggered by his belief that computer science has become a capitalist idea focussed on profit taking and was ashamed by its move away from innovation.

"There's a good part of computer science that's like Magic"

Peter Landin aimed to create a programming language that was not limited to a single machine but could be used across various machines and manufacturers. To achieve this, he employed lambda calculus as the foundation for a new language. By utilizing lambda calculus, he integrated it into his own language, ISWIM, which featured higher-order functions, automatic storage management, and abstract syntax notation. ISWIM influenced the development of languages like LISP, ML, and Haskell. Landin's work also led to the introduction of 'Landin's Off-side Rule', an indentation rule commonly used in Python. This rule was detailed in his paper, 'The Next 700 Programming Languages', and is crucial for maintaining code structure and scope.

Landin's legacy is left by the archives in the Bodleian Library in Oxford containing an archive of all of Landin's work. There is also an annual seminar entitled the 'Annual Peter Landin Semantics Seminar' as well as the Peter Landin building at Queen Mary University of London which is home to the computer science department of the university.



Scan for additional information!

Dr Gladys West (1930 - Present)

COMPUTER PROGRAMMER CREDITED WITH THE INVENTION OF THE GPS

"I had to be the best that I could be, [...] Always doing things just right, to set an example for other people who were coming behind me."

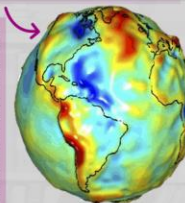


The work of Gladys West enabled the creation of the GPS. This was done through her analysis of satellite altimeter data from the NASA Geodetic Earth Orbiting Programme. This was the foundation of her work to programme an accurate geopotential model of the earth, a Geoid. This model then served as the basis of the GPS. Her complex algorithms were able to account for all factors impacting the shape of the Earth and its irregularities.

Born in 1930's Virginia, West felt certain she would follow in the footsteps of her parents, a work in the farms and tobacco plants, however her determination and aptitude for maths allowed for her to pursue a career in computer programming and modelling.

Graduating from Virginia State in 1955, following a stint as a teacher in segregated schools, West was hired by the U.S Navy, where she was one of four black employees. Her work here involved: determining the movements of Pluto in relation to Neptune, project manager of SESAT (a satellite used to provide data on oceanographic conditions, and then eventually the development of the mapping of the Geoid.

West did not receive recognition for her work until the early 2000's and receiving her first award for her work in 2018. In more recent times being known as a 'Hidden Figure' in history. However, she did not aim for recognition only for academic excellence. Notably earning her PhD in public administration and policy affairs at the age of 70, 2 years after her retirement.



Awards:

2018 - Inducted into the United States Air Force Hall of Fame

2018 - Female Alumna of the Year at the Historically Black Colleges and Universities Awards

2018 - One the BBC's 100 Women

2021 - The first female to be awarded the Prince Philip Medal by the Royal Academy of Engineering (the highest individual honour)

"I have realised my dreams and reached a height beyond what I anticipated. I encourage young women to believe in yourself, find your passion, work hard and apply yourself [...] and most of all - follow your dreams"



Scan for additional information!

Student Feedback Survey Responses

(1) Were you aware of any diverse mathematicians before coming across these biographies?

*"Before reading these biographies, I was **not aware** of any diverse individuals within the STEM sector. The large **majority** of mathematicians/scientists/engineers that I knew **were of white-European origin.**"*

*"I was **not aware** of the diversity in the STEM industry. As a person of ethnic minority studying engineering, I was **pleased to see representation in this industry.**"*

*"I was surprised that I **never heard about Gladys West** (African American mathematician) **or the six ENIAC** (Electronic Numerical Integrator And Computer) **women programmers**".*

(2) What did you find most enjoyable or interesting about these resources?

*"I like that it **shed light on people who deserved as much recognition** as their more famous counterparts. It is **heartening to see their stories being actively searched for** despite falling towards obscurity for decades."*

*"I found it **interesting to learn about the challenges women faced** in the academic world and **how much harder they had to work than their male counterparts** in order to be recognised for their achievements. It also gave me some insight into how much society has progressed."*

*"I like how they are **concise** but still provide a pretty good insight into what they developed; some of the mathematicians' **Wikipedia pages can be hard to navigate**, so it's nice to have a background on the person in one place."*

Student Feedback Survey Responses

(3) Have these biographies made you want to learn about the contributions of diverse mathematicians?

*“Yes - these biographies **highlight the rich and varied contributions of individuals from diverse backgrounds** in STEM, underscoring the **importance of inclusivity** in science and mathematics. Each story brings a unique perspective, **showing how overcoming personal and societal challenges can lead to significant advancements** in their fields. These stories certainly **spark a desire to learn more** about other equally important figures in STEM history.”*

*“Yes, it **makes women motivated** as we rarely hear about their contributions in STEM, so reading these biographies **made me very proud.**”*

*“**I do not particularly want to learn more about people only based on their diversity**, I would rather learn about individuals that are committed to their field and passionate about their jobs and life regardless of their ethnic background.”*

(4) Would you like such material to be introduced in a classroom setting e.g. in lectures or tutorials?

*“Yes, in class nearly **every time an equation or theory etc. is introduced, it is named after a white man**. It would be nice in lectures to then **mention the contributions from individuals not recognised in history**. As a woman in engineering, it **would be very inspiring and motivating to see this in lectures.**”*

*“Incorporating these narratives into academic discussions not only **gives a variety of viewpoints and role models**, but also helps **promote an inclusive learning atmosphere.**”*

*“**No**, as it will just **confuse us even more with the content** and we **do not have much time** to cover all content.”*

Analysis of Student Feedback

- Most students **had not previously heard** of these mathematicians (if at all, only in a secondary school setting, **not at university** – usually also **through films and books**)
- **Minority and female students resonated more** strongly and motivated by materials
- Suggestions to include **YouTube videos, newspaper articles, examples of actual work**
- Most students **highlighted strong need** for such resources, respite from technical content
- Would like to **embedded in modules if relevant** (possibly introduce as separate session)

Impact Highlights of Project

- **Increase in module student satisfaction results** (from 67% to 82%)
- Student-staff joint presentation and panel at the QMUL *Inclusive Scholarship* workshop
- Student-led poster presented at *Posters in Parliament* event at the House of Commons
- Co-created poster **received 'Best Innovation Poster Award'** at the *QMUL Festival of Education*
- Creation of repository to share resources with staff to embed in their own modules
- Student co-creator successfully awarded QMUL *Student Enhanced Engagement and Development Award* for contributions to curriculum and educational development
- Dr. Shah nominated for **QMUL Education Excellence Award**

Concluding Remarks and Next Steps

- **Faculty support is critical** for integrating DiM into courses, but this can be hard (responses such as “*we’re a mathematics/engineering department or this is a technical mechanics module, how can we teach diversity in our course?*”)
- As educators, we have a **duty to teach our students about the wider historical context** of the discipline through the **lens of diversity and inclusivity** (in accordance with the varied set of students we teach and the society they will become part of)
- Next steps for project: **joint student focus group interviews led by Dr. Shah (QMUL) and Dr. Stenhouse (OU)** featuring both QMUL and OU current undergraduate students
- [QMUL Diversity in Mathematics Project](#) and [Diversity in Mathematics Teaching Toolkit](#)

Prompts for Further Discussion

- **How can we organically and seamlessly introduce diversity resources within technical mathematics-based modules (not specifically dedicated to History of Mathematics)?**
 - Should these be within large lectures/small tutorial groups? By lecturers or TAs?
- **Should such materials be assessed and if so, how? Formative/summative?**
 - How might this align and be standardised alongside departmental assessment regulations?
- **How can we inspire other academic staff colleagues in our department/university to incorporate this within their own teaching?**
 - Will created toolkits help to address time/capacity issues? Is there a need for a mindset shift?

Thank you for your time!



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