



NEMESIS NEWS

ANU-AAMT NATIONAL MATHEMATICS SUMMER SCHOOL 2021

This year the NMSS newsletter takes a look at gender diversity and equity within mathematics. It is common knowledge that maths (and STEM more generally) is a male-dominated field, but few are intimately familiar with the actual numbers.

In Australian high schools in 2018, 12.2% of male students were studying higher mathematics, compared to 7.2% of female students. At universities in 2018, women constituted 38% of undergraduate maths students and 28% of honours maths students. In 2019, about 20% of the completions of honours and two-year masters degrees were made by women, while ~31% of PhD completions were. At the academic level across Australia in 2018, the proportions of female staff were: 29% for casuals, 30% at Level A, 31% at Level B, 27% at Level C, 18% at Level D and a whoppingly low 10% at Level E.^[1,2]

What steps are being taken to rectify this

breathtaking divide? What steps *ought* to be taken? What actions are effective, and which are actually harmful? Before being able to take any measures, it seems integral to first understand what is causing this stark discrepancy.

Not only does this data raise alarm at the disparity between men and women in maths, but it is also noticeably binary. These numbers do not reflect the rich diversity in the mathematical community. This edition of the NMSS newsletter gives voice to A/Prof Tracy Slatyer, who spoke with the newly appointed AAMT Program Manager Damien Hoban about her journey as a woman in maths and physics, and Mx Ell Baldwin, who shares their experience of undergraduate maths at the University of Queensland from their perspective outside the gender binary.

Ellena Moskovsky, Editor

¹AMSI. (2020). The State of Mathematical Sciences 2020. <https://amsi.org.au/wp-content/uploads/2020/05/amsi-discipline-profile-2020.pdf>.

²Johnston, P. (2020). Higher Degrees and Honours Bachelor Degrees in Mathematics and Statistics Completed in Australia in 2019. *AustMS Gazette* 47 (5), 221–227.

THE LIGHT AFTER A YEAR OF DARKNESS

A second-year Masters student in Bioinformatics at Sydney University, Andy has tutored at NMSS twice, in 2020 and 2021. Andy is passionate about mathematics/statistics education and communication.

2020 was a challenging year that started with widespread bushfires, leading to a promptly relocated and re-organised 2020 National Maths Summer School (NMSS). And this was followed swiftly by a global pandemic that saw the entire world brought to its knees. Lockdowns, travel restrictions and economic recession flipped society upside-down and interrupted all aspects of our lives. But NMSS must go on!

“ *NMSS 2021 will be remembered as the first time that the school was held virtually* ”

NMSS 2021 will be remembered as the first (and hopefully last!) time that the school was held virtually. It is no simple task to convert the NMSS experience to an online format, and it was thanks to the extensive planning and preparation from the Director and staff that NMSS 2021 could even happen.

Many of you would probably be wondering if an online NMSS can live up to a physical experience. Perhaps students missed out on sitting in a lecture theatre, hanging out in a common room and sharing meals in a dining hall. But Zoom became a lecture theatre,

Discord became a common room and students still found a way to stream their cooking and eating! Although this may sound underwhelming to the unenlightened reader, NMSS 2021 came with its own set of unforgettable memories.

“ *Communicating over Zoom certainly presented a new set of challenges* ”

The main goal of NMSS is to give the students an opportunity to think deeply about simple things. Communicating over Zoom certainly presented a new set of challenges, in fact I may have said “you’re still on mute” more times than “that’s a good question, you should think about it”! Nonetheless, the students tackled the lectures and tutorials with resilience and enthusiasm and ~~suffered~~ embraced the tutors’ open-ended questions.

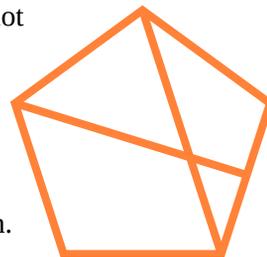
Another fundamental part of NMSS is the social side. Being able to meet enthusiastic like-minded students and making lifelong friends has always been an important corollary of NMSS. Here, the Experienced Group (13 students who attended NMSS the previous year and are invited back) did an overwhelmingly fantastic job in setting up the social scene. Within a day of the camp, the common room (aka Discord) was bustling with games of Mafia, Among Us, Chess and plenty more with a Puzzle Hunt, Assassins and memes in the background!

“ *NMSS 2021 came with its own set of unforgettable memories* ”

So, did these students get the full NMSS experience? I think so, yes. They learnt some interesting mathematics, they thought deeply of simple things, and they learned what it was like to share a passion with others their age. And they definitely made lifelong friends on their new discord community.

Let's hope nothing goes wrong in 2022...

I want to finish by commending the Experienced Group of 2021 for their passion and dedication to NMSS 2020 and 2021, two “abnormal” years in the history of NMSS. Although they would not have experienced a “typical” Canberra NMSS, they overcame great challenges to ensure that NMSS traditions are passed on.



Andy Tran, NMSS Tutor

THE GENDER GAP IN SCIENCE

The International Science Council has funded The Gender Gap Project: “A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences: How to Measure it, How to Reduce it?”

The project consists of three tasks:

A joint global survey

An international survey that will provide reliable data on the participation of women in the mathematical and natural sciences.

Joint data-backed study on publication patterns

A temporal analysis of the publication statistics of women in the sciences, as well as the rate at which they leave academia, at various stages of their careers.

Database of good practices for girls and young women, parents and organisations

A dissemination of the practices and initiatives aimed at closing the gender gap, with information on existing initiatives that have been found effective.

You can find more about The Gender Gap online at gender-gap-in-science.org.

THE (IN)FAMOUS WINDMILL PROBLEM

Let S be a finite set of at least two points in the plane. Assume that no three points of S are collinear. A windmill is a process that starts with a line l going through a single point P in S . The line rotates clockwise about the pivot P until the first time that the new line meets some other point belonging to S . This point, Q , takes over as the new pivot, and the line now rotates clockwise about Q , until it next meets a point of S . This process continues indefinitely.

Show that we can choose a point P in S and a line l going through P such that the resulting windmill uses each point of S as a pivot infinitely many times.

This problem was sourced from the 2011 International Mathematics Olympiad.

ASTRO-FIZZ AND FERMIBUBBLES

The mathematics of Tracy Slatyer

Just before students returned for the North American Spring semester, Associate Professor Tracy Slatyer had a brief chat with our National Mathematics Summer School Manager about her education in Australia, time at NMSS, and yes... dark matter.

Tracy Slatyer hit the headlines late in 2020 after winning the New Horizons \$100,000 Physics Prize from the Breakthrough Prize Foundation – funded by tech billionaires. She recently shared some of her experiences for the National Mathematics Summer School newsletter. It was, of course, a zoom call from Boston near the famed Massachusetts Institute of Technology where she achieved academic tenure in 2019.

This prize was awarded for pioneering methods of data analysis to find clues about dark matter. Her research began at Harvard University where she, along with co-researchers, discovered “the Fermi Bubbles” - giant plasma balloon structures extending tens of thousands of light years out from the centre of the Milky Way galaxy. “Most impressive discoveries are made by a combination of serendipity and years of hard work”, Tracy says, then adds, “you can’t predict serendipity – I’ve been very lucky”.

“ *Most impressive discoveries are made by ... serendipity and years of hard work*

But with so many years of hard work it would not be surprising should new discoveries



Tracy Slatyer (photo courtesy physics.mit.edu)

be close at hand for Tracy. Tracy’s research goals are genuinely altruistic. The real prize for “us”, she says, is to understand how 84% of the universe works and if she could have a role in that, “it would be amazing!”.

Tracy’s hard work began in her first year of high school when she was living in Fiji. “I was bullied, and it seemed the main trigger was simply being a girl and interested in Maths and Science”. Tracy can clearly remember the advice of the school counsellor, “that I was ‘abnormal’, and that I should solve the bullying by deliberately getting lower scores in maths”. Pervasive gendered stereotyping routinely diminishes the expectations of girls but not Tracy, who with her supportive family continued to strive.

“ *I was bullied simply for being a girl and interested in Maths and Science*

By the end of Year 7 Tracy had already worked through the Year 10 Maths curriculum. It was at this point the remarkable Lynda Chubb steps into the spotlight as Tracy's Year 8 Mathematics Teacher. Lynda is a first-in-family university graduate from regional New South Wales. Not only did Lynda complete a Science degree with honours in Chemistry, but went on to become a teacher with a double major in mathematics. Lynda clearly recalls their first class together. "Mrs Chubb, I'm good at maths, ... I'm really good at maths". Lynda was aware of the common mistake of advancing students upwards through curricula and knew it was unsustainable.

... and by the end of Year 8 Tracy was already a medallist in Australian maths competitions

Instead, Lynda helped Tracy focus on entirely new ways of thinking about mathematics, enrichment and problem solving. She ordered mathematics resources from Australia and led a small group of like-minded students through a range of appropriate learning goals. The mathematics classroom now became a welcome and productive refuge and by the end of Year 8 Tracy was already a medallist in Australian maths competitions. In her later high-school years she attended the Tournament of Towns, Maths Olympiad and the National Mathematics Summer School (NMSS). She had a great time at these programs and recalls her fondness for NMSS where she was able to relax, make friendships and focus on learning mathematics without the pressures of competition and selection.

“ They were not expected to understand [maths] ... because they were pretty, popular teenage girls

Tracy remains grateful for the help she received from teachers, but it was not always

the same for her female friends who were not as lucky in their school environments. She can remember unanswered questions and, "it's ok if you don't understand this honey - we don't expect you to". They were not expected to understand, Tracy says, "because they were pretty, popular teenage girls". Role models like Tracy are so important in countering gender stereotypes. Ensuring a constant pipeline of women's talent into scientific research requires an education system that explicitly encourages and supports it. Because becoming a researcher takes many years of post-secondary training, initiatives to achieve gender balance in Physics and Mathematics at the high school and undergraduate levels 20+ years ago are making a difference at faculty leadership levels only now.

Tracy's many years of hard work and dedication resulted in tenure at the Centre for Theoretical Physics at MIT. The CTP had not had a female faculty member for more than 10 years when Tracy was appointed in 2013, although there are now two other women CTP professors (Phiala Shanahan - who is also Australian - and Netta Engelhardt). Somewhat to her surprise, Tracy felt her arrival made some perceptible differences in the lecture theatres and research labs where she works.

"When I first walked into the room, I realized there was something unusual about the classroom", she says about teaching her first undergraduate Relativity class. "It was halfway through the lecture when I figured out the first two rows were absolutely full of women. One of my colleagues who was mentoring a student in the class told me the women students were excited to have a theoretical physics class at MIT taught by someone of their gender - it was the first time for many of them". Tracy adds, "having at least one woman in the faculty to talk to often seemed to provide a more approachable on-ramp to research for women who have frequently had the experience of being one of a minority in Maths and Physics classes". As a result, she has been fortunate enough to work with many undergraduate and postgraduate women who are superstars in physics.

What is she working on now? Tracy's research team is investigating dark matter in different ways and she explains that they are interested in understanding its behaviour in the very early stages of the universe.

“We have pretty good evidence that all the dark matter that is around today was already present when the universe was less than 100,000 years old.” Her research students are thinking about where the dark matter came from, whether or not the dark matter had interactions with other particles, and the effects of those interactions on the history of the universe. One line of inquiry for the team is the possibility of using microwave and radio telescopes to examine light from the very early universe, before galaxies formed, for evidence of energy released from dark matter collisions. “There's a big push in my field and

in related fields to improve our observations of the epoch when the universe was a few hundred million years old using radio telescopes. It turns out that during that epoch, any trickle of high energy radiation liberated from the dark matter could heat up the gas filling the universe, and you could potentially see the effects of the gas being hotter or colder in radio signals”.

There is no serendipity to this scenario. When a high performing student comes together with a motivated and resourced female mathematics teacher the sky is no longer the limit. Until we have gender parity in the STEM sector, we cannot underestimate the role of female mathematics and physics teachers in inspiring generations of young women who possess the grit and confidence to make a real difference.

Damien Hoban
AAMT Program Manager

THE NMSS PACKAGE



Even though #NMSS2021 is over, we have lots to remember it by! Every single staff member and student (that's 105 people!) received a parcel containing the academic material and a small gift for each of the 8 days.

Gifts (and those responsible for them) can be found below:

1. A NMSS t-shirt (Leanne Rylands)
2. A Rubik's cube (Norm Do)
3. Hexaflexagons (Leanne)
4. A 3D puzzle (Norm)
5. Modular origami (Yudhi Bunjamin)
6. NMSS-themed stickers (Ell Baldwin)
7. Maths-themed postcards (Norm)
8. A NMSS-themed deck of cards (Ellena Moskovsky)

The design for the playing cards was heavily influenced by a design by Francesca Pagani, so we would like to thank Francesca for the inspiration! If you'd like to see Francesca's other designs you can follow her at @francescapaganigraphics on Instagram.



THE UNIVERSE IS A WONDROUS PLACE

The universe is a wondrous place
Filled with burning stars and massive black holes
But mainly occupied with empty space
Seemingly hot yet outrageously cold.

Our planet sits in the midst of this plane
Or on the edge, for we do not yet know.
A question we ask again and again
A question that haunts our minds as we grow.

To be alone, or not to, we wonder
Where did it start, how did it and why?
A big bang we think, a roar of thunder
Building uncertainty up in the sky.

And yet here we are, living on this earth
Pieces of a puzzle larger than us
Governed by laws and axioms of worth
Are they arbitrary? Just worthless dust?

These patterns we continue to unlock
Never cease to spark curiosity
The ebb of each tide controlled by our rock
Breathing in and out, forever busy

Plants obeying the golden ratio
Numbers in a sequence describing sight
Trees dancing in wind, going with the flow
At sunset, life bathed in glorious light

Mathematics forever surrounds us
The universal language we say
Our home, despite unknowns, despite what's suss
It's beautiful at the end of the day.

"While maths might be the language of the universe, it's spoken by humans, with all their genius and all their faults"

Nadia De Fazio, NMSS 2021 Student

STUDENT REFLECTIONS

ADEN

TAYLOR

Is it possible to take final year secondary students, with all their grievances against online learning, and leave them in a state of utter enchantment? Doing so took nothing less than a trip down the NMSS rabbit hole.

ADEN

When all 72 students spotted that white rabbit of an offer to NMSS, they were much too curious. So, they followed the rabbit, down into NMSS Wonderland.

The rules in this wonderland are backward. Every problem is a sacred pilgrimage to the hallowed land of individual discovery. And with that comes one cardinal responsibility: spoiling the answers is a sacrilege and our peers' journeys must be protected at all cost.

TAYLOR

Every student had a different journey and took different roads to get to their final destination. Some students even took a side road and stopped off to make a new discovery, equipped with the support of their tutor and peers.

Throughout the intervening sojourns, all the students congregated via discord to talk, share, laugh and play - and at all hours: I'm assured that the other students, like me, are ordinarily perfectly studious but had been involuntarily transformed into nocturnal creatures by one of the enchantments of NMSS.

In the NMSS rabbit hole, social rules were inverted. Not only were forms of communication online instead of face-to-face, the games people played were cruel - figuratively and literally. It was considered normal to use people's weaknesses against them to win, and to use one's love for The Office as a bait for an incredibly clever trap (RIP Sophie).

While mathematical enthusiasm was a common trait among the inhabitants, we learnt that 'mathematical' could mean inspired, logical, analytical, creative, deductive, methodical. The people we met were not by any means "like-minded", but were incredibly diverse and completely united only by their drive to think deeply about simple things.

There wasn't a barrier between staff and students. Sure, they may have been more experienced than us, but they craved maths just like us. It was so odd to be able to talk to "teachers", who were usually considered as the strange figures at the front of a lecture theatre. In NMSS land, these teachers materialised out of nowhere in tutorials, helping us to improve our mathematics and share experiences.

Some combination of this attentive pedagogy and the arcane magic of the NMSS setting took the once disparate strands of ‘doing mathematics’ and unified them. To sit quietly and attempt a problem was to cement intuitions, to develop a recognition of mathematical beauty or to consider something in a way it hadn’t been considered for centuries.

ADEN

As our time in wonderland begins to blur, it’s the things we learnt, the things we felt: these memories are extremely acute: every conversation reminds me of an inside joke and revisiting any ordinary mathematics conjures an eerie sensation of déjà vu, and a knowing smile.

The closing of NMSS was marked by an outstanding final concert, because mathematicians pursue talents in multiple realms, consisting of carrot recorders, movie trailers, gaming and even a serenade from the director. It was truly extraordinary when everyone forgot about the countless days that they spent toiling away at maths problems and instead celebrated the talents of fellow students.

TAYLOR

*Aden Power and Taylor Heiniger,
NMSS 2021 Students*

“

‘It was a curious dream, dear, certainly: but now run in to your tea it’s getting late.’ So Alice got up and ran off, thinking while she ran, as well she might, what a wonderful dream it had been.

Charles Lutwidge Dodgson

“What is it like to be an EG at an online NMSS?”

“That’s a good question. You should think about it!”

Having hoped to come back since NMSS 2020 concluded, we could hardly contain our EGcitement (apologies in advance for all the puns) when we received our invites. We counted down the days to what was sure to be another unforgettable school, and wow, NMSS 2021 certainly delivered because it was everything we hoped for and more.

It was great to come back to Dr Norm Do’s number theory lectures again and watch him weave daily stories about some of history’s most EGceptional mathematicians. These tales were no less inspiring or magical than the first time and served as perfect segues into a course where ideas that had not made sense last year became clearer and problems that had once seemed impossible were now within reach.

After leaving the main group engrossed with Euclidean algorithms, we delved into the complex beauty of patterns and symmetry groups with Associate Professor Jonathan Kress not only as mathematics students but also as artists. EGuipped with paper, scissors, and mirrors, we had so much fun and acquired many insights from integrating our ‘classroom’ knowledge into designing handiwork such as paper snowflakes, kaleidoscopes, and frieze tapes. If you asked us our biggest gain from the course, we’d probably reply: “I will never forget to take my coffee cup next time when having my donut!”

“ If you asked us our biggest gain from the course, we’d probably reply: ‘I will never forget to take my coffee cup next time when having my donut!’

In the Counting with Algebra stream, we learnt about generating functions and recurrences among other fascinating maths. Associate Professor Leanne Ryland's obvious passion and love for the incredible ideas she was teaching us meant the lectures and problem sets were always intriguing, helping us to EGsplore the wonders of counting. The mind-stimulating discussions with Leanne and the constant lightbulb moments made the course truly mind-blowing and eye-opening for us all.

“ *If the maths is the core of NMSS, the people are the soul* ”

If the maths is the core of NMSS, the people are the soul. While we couldn't meet our old and new friends in person, distance did not stop us from building strong connections with each other and keeping up with our traditions on virtual platforms. The EG blackboards were now EG virtual whiteboards. Mafia conversations transformed into rigorous typing on keyboards. The lively dining hall chats with the staff were replaced by various discussion channels and a Zoom careers Q&A session. The alarms brought by talkative 'assassins' on the way to lectures got substituted with random pings on Discord when we least EGspected. We even took advantage of the virtual setting to introduce new activities such as the 'Scavenger Hunt at Home', an abundance of online board games and puzzles, and Leanne's enthralling talk on the maths behind Rubik's cubes.

The morning packages prepared by the staff were another new joy that we absolutely loved. We greatly appreciate the care that everyone involved put in these lovely and thoughtful gifts.

The Alumni lecture by Dr Alex Heath and the Blakers lecture by Professor Robyn Owens were also major highlights of the school. Both of the speakers inspired and captivated us with their stories and offered valuable insight into the connections between the type of values that embody NMSS - thinking deeply, passion for problem-solving, love of learning, and willingness to try new ideas among others - and careers in mathematics.

It seems like the days between the welcome session and the final concert flew by in a matter of seconds, and just like that, we were at the end of the NMSS. In retrospect, we are indeed a special carton of EGs, who went to two shortened NMSS and never took the walk from John XXIII College to the Martian Embassy, but never for a second did we feel the disappointment of missing out.

While NMSS 2021 may be over, all the amazing maths we EGsplored, the incredible people we met, the unforgettable memories we made, and the new mindsets we acquired are all things that we will carry into university and beyond. We would like to say a huge thank you to the EG tutors Sean and Brendan, the lecturers Norm, Leanne, Merryn and Jonathan, all the main group tutors and staff, the main group students, and our fellow EGs for their constant energy, guidance, hard work, and friendship. You all hold a special place in our hearts.

*Claire Huang and Cindy Liu,
NMSS 2021 Students*

MINESWEEPER

Can you place all mines on a 5x5 Minesweeper grid such that each number from 0 to 8 appear exactly once?

Warm up: Try the same problem on a 3x3 grid using the numbers 0 to 4!

This problem was supplied by NMSS alumnus, Dima Kamenetsky.

DIVERSITY WITHIN MATHEMATICS

A tutor in mathematics at the The University of Queensland, Ell Baldwin has tutored at NMSS twice in 2020 and 2021. Ell has a keen interest in discrete mathematics and is planning to begin an Honours in graph theory later this year.

When I began my (now-abandoned) engineering degree at UQ in 2013, my least favourite question by far was, “What’s it like being a woman in engineering?” Despite having more industry experience than most of my peers – I’d worked briefly with marine engineers before ever setting foot in a lecture hall – I couldn’t answer. I didn’t feel like a woman in engineering. I barely felt like an engineer.

In hindsight, my answer ought to have been, “Perhaps you should ask one.” But at its core, the question isn’t about being a woman, it’s about being anything other than the perceived “default”. This “default” has, among other things, a gender, a race and a sexuality, and explaining how each of these changes one’s experience takes more than a wry one-liner.

Women in mathematics

My third-year logic and model theory lectures took place on the second floor of the geology building. Lining the wall of the staircase were a series of staff photos of the geology department, and I would examine them before class, looking for names I recognised. The oldest photo, at the top of the stairs in black and white, is from 1963. In the front row sit the senior staff: ten white men, and Professor Dorothy Hill, the first female professor at an Australian university. In the middle, further back, is one other woman, easily visible against the sea of suits and ties.

These photos are recent history, but they show a time that is alien to me. Perhaps half of my lecturers at UQ were women, both in geography and in mathematics. And yet, even when female mathematicians were rarer, they have always been present. Cheryl Praeger, one of the first female maths professors in the country, recalls being taught by women in her undergraduate years. Throughout history, women have left their fingerprints on the field of mathematics, from the human computers at NASA to the code-breakers of Bletchley Park, to Cheryl Praeger’s lecturers, to Cheryl Praeger herself.

Despite the myths to the contrary, there has never been any question about women’s aptitude for mathematics, only about whether they have been sufficiently rewarded for it. Only one woman, Maryam Mirzakhani, has ever received the Field’s Medal, the most prestigious award in mathematics, and this only in 2014. The University of Sydney didn’t appoint its first female maths professor (Nalini Joshi) until 2001, and its second until 2015.

There are always other women in those photos in the geology building, but in the front row, amidst the professors and senior lecturers, there is only ever Dorothy Hill. In 1981, Dr. G. Khorasani joins her: two women to twelve men. By 1985, now-Emeritus Professor Hill is alone once again. By 1988, no women at all sit in that front row.

This so-called glass ceiling is a well-known phenomenon. Outreach programs to draw girls into STEM, scholarships for young women in those fields, student clubs and professional networks, all have their place in addressing gender equity in science and mathematics. However, the “glass ceiling” is something of a misnomer. Barriers exist at every level of

progression, from unconscious bias in hiring to hostile work environments. Recruiting girls and women to mathematics does nothing if policies are not in place to keep them there. Many of these policies would benefit everyone; for example, robust parental leave policies for all genders help new parents share both the labour and joy of child-rearing.

Universities are beginning to address some of the obstacles facing women. UQ, for example, reports the gender ratio of their annual academic promotions (although they don't break those promotions down by discipline). Populating staff rooms, especially senior staff rooms, with women is a decades-long process, but the changes are tangible. Perhaps one day, students will look at photos of my maths department and find them as alien as I find those in the geology building.

Racial diversity in mathematics

In the modern era, the ease of international travel has made both study and research in foreign universities prevalent, something which is beneficial both to the travelling academics and their host universities. There is no one right way to do mathematics, and trading academics is a good way to compare and combine different methods and paradigms to come up with something completely new. Universities are quick to encourage this.

However, it would be disingenuous to pretend there are no systems of racial oppression at work in academia and education. As recently as the 1980s, white mathematical historians falsely wrote that there was no word in any Aboriginal language for a number higher than four. Misconceptions like these, along with other vectors of oppression such as chronic underfunding for rural schools, have created a stark divide in the quality of education between Indigenous and non-Indigenous students.

There have been recent efforts to address this divide, including Closing The Gap, a partnership between state and federal

governments and the Coalition of Aboriginal and Torres Strait Islander Peak Organisations. Other organisations like the Aboriginal and Torres Strait Islander Mathematics Alliance (ATSIMA) provide conferences and workshops for educators, and camps for indigenous students.

Unfortunately, within Australian academia there's yet another "glass ceiling" (or series thereof) for people of colour, including both Indigenous peoples, and second- and third-generation Australians. Unlike women, there's less in the way of scholarships and professional networks to support these people.

Anecdotally, I've observed that higher level mathematics courses at UQ don't reflect the diversity of first year courses, and this disparity is even worse among the casual teaching staff. It's once again a question of unconscious bias: who gets told about open positions? Who gets promoted? How are the names on the assignments we mark and papers we peer review shaping our expectations of the content within?

Recently, I've seen promising changes in the history taught in university-level mathematics. Non-European mathematicians, especially Arabic, Indian and Chinese mathematicians, are finally being acknowledged as pioneers in mathematics, sometimes preceding their European peers by centuries. We owe much to Arabic mathematicians like Muhammad ibn Musa al-Khwarizmi, right down to the numeral system we use; it's only fitting to recognise their work. My hope is that this heralds similar recognition for the work and expertise of people of colour in mathematics today.

Being a queer

Women make up approximately half of the global population, and yet still hold few senior seats within mathematics. Given that, it's little wonder that I could find no evidence of an out transgender maths professor in Australia. Yet to me, this still seems remarkable, because at UQ, LGBTQ+ people are, if anything over-represented among the casual staff. This seems

to be true of Brisbane universities in general: I've repeatedly been asked if I know such-and-such from QUT or Griffith upon revealing myself as a trans mathematician.

Queer participation in mathematics is harder to gauge than other marginalised identities. It can be a less-visible identity, and can be difficult to discern even within oneself, to say nothing of the fluidity in which queerness is categorised and perceived by broader society. LGBTQ+ people have been not only excluded from mathematics, but from society in general for much of recent history, and this is still true in many places. WWII codebreaker Alan Turing was forced to stop work after being convicted for the "crime" of homosexuality in 1952. Homosexuality was only fully decriminalised in Australia as of 1997.

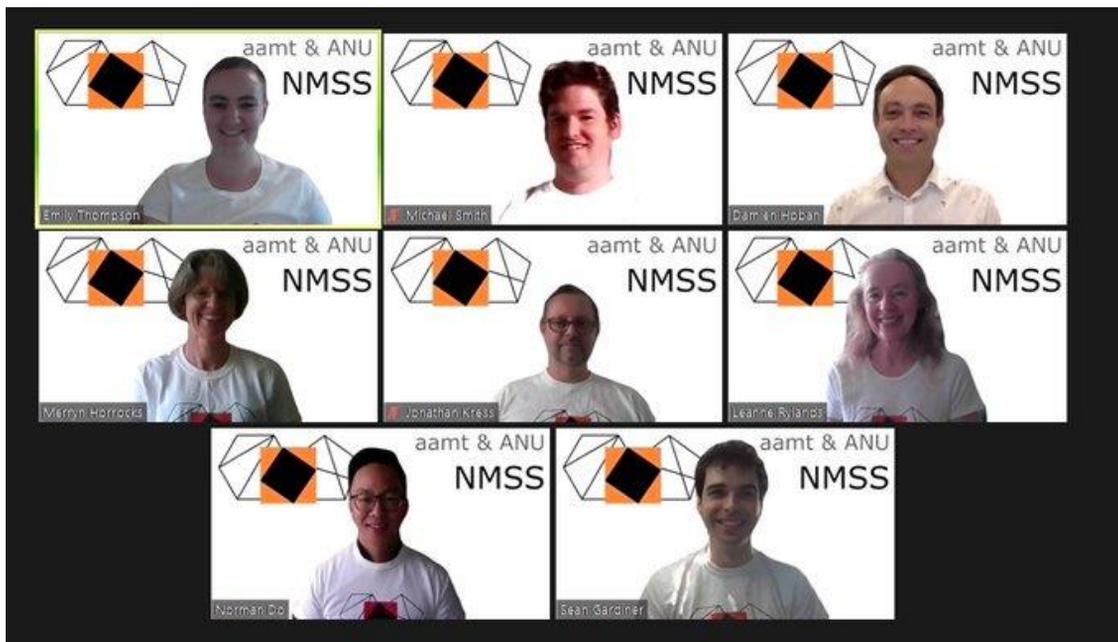
Despite this, acceptance is growing for LGBTQ+ people, particularly within academia. I have had students discuss with me Wear It Purple Day (a day for LGBTQ+ visibility); I have had students thank me for using the neutral "Mx" as my title. My cis gay peers also openly identify themselves as such,

marking themselves, and their departments as safe havens. Associations of LGBTQ+ mathematicians like Spectra do similar work on an international level, letting LGBTQ+ students know that there is a place for them in mathematics.

Conclusion

I often see "diversity" used to mean gender parity, which I think does a disservice to both concepts. The strength of diversity in academia and research comes from the introduction of new ways of thinking, which are born of different experiences, and these go beyond (binary) gender. It goes even beyond race and queerness; other sources of diversity come from class, disability, even the rural-urban divide. As a global community, we've been slow to recognise the advantages of seeing the world in many different ways, but the changes I've seen in my own university have been encouraging. It gives me hope that one day, there will be no "default" mathematician. One day, I'll never have to hear my least favourite question.

Ell Baldwin, NMSS Tutor



NMSS senior staff, left to right:
Top: Emily Thompson, Michael Smith, Damien Hoban; Middle: Merryn Horrocks, Jonathan Kress, Leanne Rylands; Bottom: Norman Do, Sean Gardiner

A WORD FROM THE DIRECTOR

NMSS goes virtual

For fifty-one consecutive years, the National Mathematics Summer School took place over two weeks at the Australian National University. Alas, mathematical induction ceased to hold in the early days of 2020, as NMSS staff quickly pivoted to reschedule the summer school as an eight-day program in Melbourne, to avoid the serious bushfire smoke enveloping Canberra. It was at this time that many of us first heard murmurs of a novel coronavirus emerging abroad, yet none of us could foresee the full extent of its eventual impact. Indeed, NMSS staff looked forward to the school returning to normality in 2021 --- how wrong we were!

An early decision was made to organise NMSS 2021 as a virtual school, with students participating online from their homes. Lectures, tutorials and study sessions were migrated to the Zoom web conferencing platform, with which I had far too much experience over the preceding year. Social activities were offered through the Discord instant messaging environment, with which I had no prior acquaintance. To give the online program a more tangible feel, each participant received a “NMSS advent calendar”, containing a mathematically-inspired gift to be opened each day, along with the relevant academic materials.

I was particularly impressed with the engagement and enthusiasm of the students, as well as their resilience and resourcefulness. To any of those who worried about how the experience could be transformed into the online environment, I would reassure them with the following words, which I truly believe: It felt like NMSS.

I hope that it isn't overly naive to say that I am looking forward to the school returning to normality in 2022!

(Re)connecting with alumni

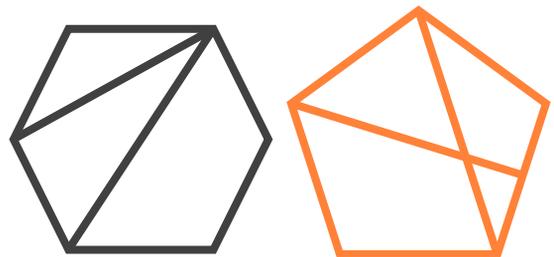
Over the years, we have lost contact with many of our more than three thousand alumni, most of whom graduated from the program without an email address! I hope that past students look back fondly on their time spent at the summer school, whether or not they have continued with mathematical thinking in their lives. So please do (re)connect with NMSS through one or more of the following platforms.

 [@ANUAAMTNationalMathematicsSummerSchool](#)
[Australian NMSS Alumni private group](#)

 [linkedin.com/showcase/nmss-au](https://www.linkedin.com/showcase/nmss-au)
[linkedin.com/school/nmss-au](https://www.linkedin.com/school/nmss-au)

 [@NMSS_Aus](#)

Norm Do, NMSS Director



To keep up with events, job opportunities and successes of women in mathematics in Australia, follow the Women in Maths Special Interest Group @WIMSIGAU on Twitter.