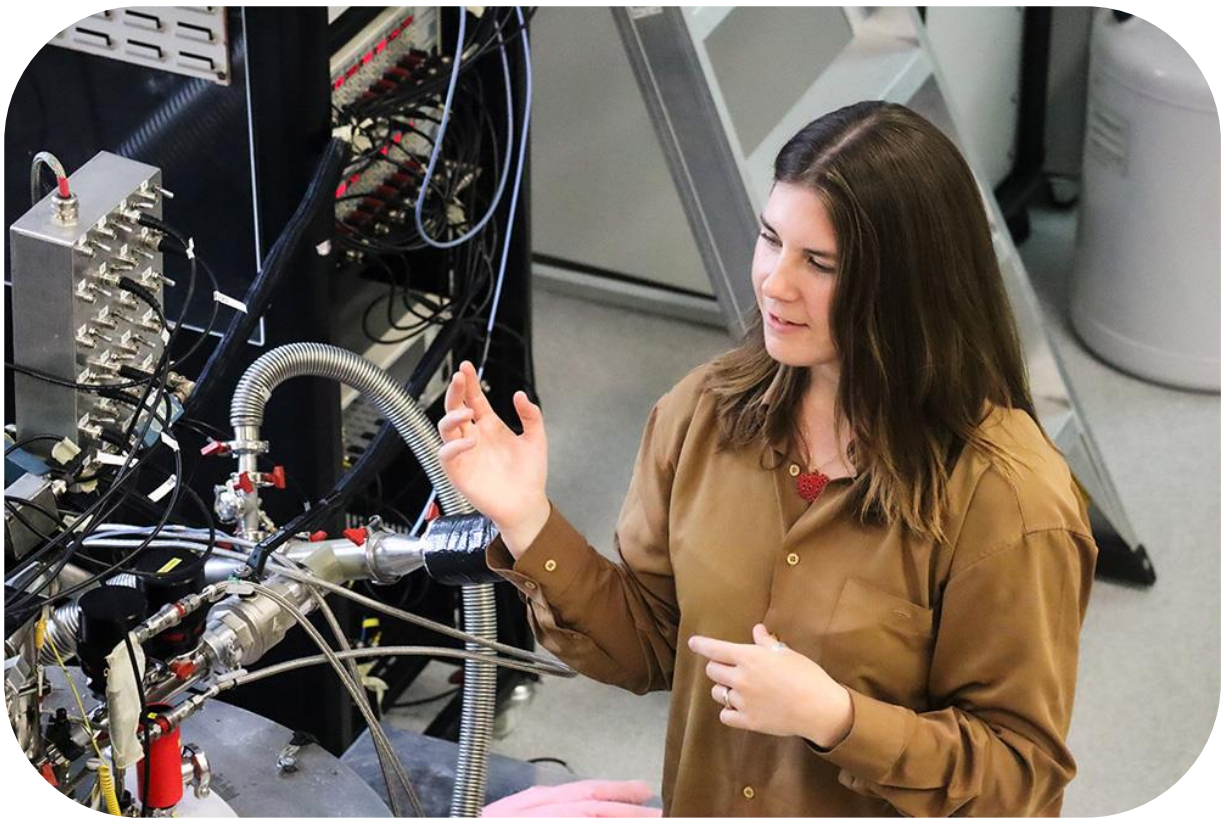
Australian Government

Pathway to Diversity in STEM Review

Final Recommendations

| **industry**.gov.au/diversityinstemreport



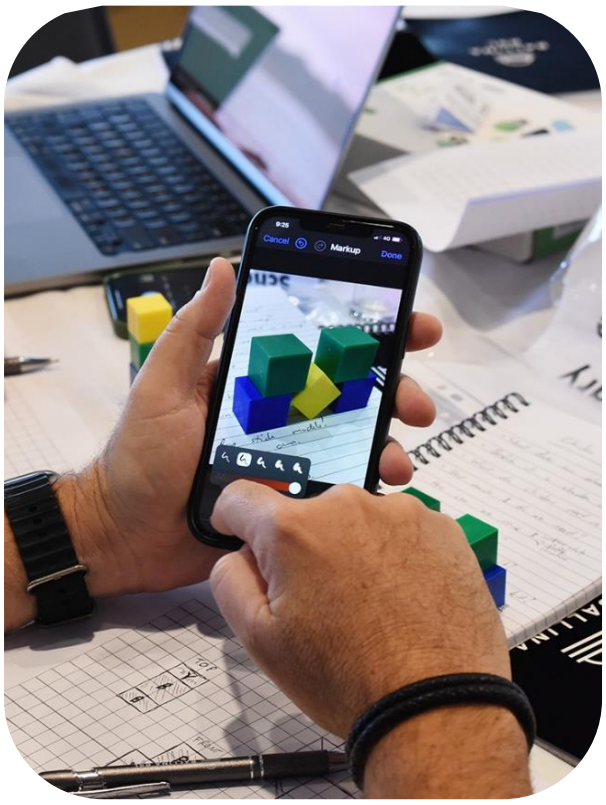


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Photo credits, front page: (left) Sydney Quantum Academy; (middle) Engineers Australia; (right) Engineers Australia.

Contents

Acknowledgement of Country

This report was developed across many lands that have provided a foundation for learning and connection, during this review and for countless generations before. These connections have allowed us to build relationships all over what we now call Australia and to engage in open conversations with First Nations peoples, scientists, and knowledge holders, who have generously shared their stories with us.

We acknowledge that this review is another step on a journey that began long ago. First Nations peoples, as the Traditional Custodians of the oldest continuing culture of scientists and technologists, have been passing on the lessons of the lands and waterways for more than 65,000 years. We pay our respects to Elders past and present for the preservation and continuity of this knowledge. We extend that respect to all First Nations people.

It is with gratitude that we recognise the important role of First Nations people to this review. Their insights and wisdom are woven throughout the pages of this report. Their sustainable practices, environmental stewardship and cultural perspectives that care for our Country have helped shape our understanding of STEM as a diverse set of knowledge systems.

Country is land, waters, seas and skies.
Country is people, relationships and mutual respect.
Country is knowledge, culture and wellbeing.
If you care about these things, this report is for you.

Message from the Panel

We present this final report of the **Pathway to Diversity in STEM Review** with pride. We express deep appreciation for the generosity of everyone who shared their time, expertise and personal stories with us along the way.

We have drawn on submissions and conversations, from research and other important work underway across Australia and overseas, to develop the recommendations in this report.

We've heard (and experienced) that learning about and working in STEM (science, technology, engineering and mathematics) can be as rewarding as it is challenging.

People from diverse cohorts face additional and often intersecting barriers. These might include where they live or their socioeconomic status, their gender or sexual orientation, their race or culture, or their physical or cognitive ability.

As a result, they cannot pursue their aspirations and interests in STEM in the same way as peers who do not face these challenges. We also recognise the existing systemic and structural barriers that exclude or place additional burdens on people pursuing and working in STEM careers.

People underrepresented in STEM too often carry the weight of advocating for change. Drawing on these people's lived experience is critical to knowing how to remove barriers to their participation. The work of fixing it should not only fall on their shoulders.

More importantly, these individuals should not have to change to belong and thrive in learning and work environments not designed to support them. We have heard from so many people and organisations: the system must change, not the people.

Industry and academia will benefit from a more diverse STEM workforce, so they must play a role alongside governments. This is why we have included actions targeted at non-government organisations.

The recommendations in this report reflect the urgency of supporting and retaining diverse people in our existing STEM workforce. We cannot afford to lose anyone. We must harness the potential of all people with a curious mind, a spark for problem-solving and a keenness to build up and change our world.

We acknowledge that much needs to be done to improve the education system. We must ensure equity and diversity across the pathway from early childhood to tertiary education, and in and out of STEM jobs. We must give specific attention to improving STEM learning as part of national education and skills reforms currently underway.

We must also work to shift pervasive perceptions and stereotypes about who can, and should, work in STEM jobs.

However, these efforts will be wasted if people endure bullying, sexual harassment, racism and discrimination in their workplace.

We heard directly from people in the sector who have voiced dismay and exhaustion by continued, unchecked harmful behaviours. Many stories were shared in confidence for fear of retribution. This is unacceptable.

Organisations and government must take urgent action to eliminate behaviours that cause people to leave STEM occupations because they feel, and are, unsafe. Accountability for change is critical.

Government and non-government organisations are already doing incredible work to increase diversity in STEM. We've shown this through case studies in this report. These initiatives are important, but cannot, and will not, result in sustainable and meaningful change on their own. We must increase accountability and drive a long-term strategic approach to ensure cultural and systemic change. The Australian Government has a clear opportunity to coordinate and lead these efforts.

We developed the recommendations in this report collaboratively. We built them with evidence and shaped them from personal stories. We did this to drive empathy, accountability and cultural transformation essential for ongoing advancements in STEM diversity and inclusion. The recommendations respect an important message conveyed throughout many of our conversations: 'Tell my story, but do not tell it without me'.

We look forward to a future where all people are welcome and supported to pursue their aspirations for a career in STEM.

Sally-Ann Williams

Chair, Pathway to Diversity in STEM Review | Chief Executive Officer at Cicada Innovations

Mikaela Jade

Member, Pathway to Diversity in STEM Review | Chief Executive Officer and Founder at Indigital

Dr Parwinder Kaur

Member, Pathway to Diversity in STEM Review | Associate Professor and Director, DNA Zoo Australia at the University of Western Australia

An ancient connection: STEM and story-telling

The following artwork depicts an ancient story communicated by Neville Namarnyilk, a Traditional Knowledge holder. The story reflects on the importance of technology and innovation, and their connection with life and culture.

The techniques Neville used to create these paintings are both traditional, with this style existing for tens of thousands of years, and continuing to evolve and grow. You can see this in the below photo where Neville is painting fire for the first time.

About the artist, Neville Namarnyilk

Born: 29-1-1966
Clan: Burlardjah
Languages: Kunwinjku, Kune, Gunderjngemih, Mayali, Gunjeimih, Kuninj.
Country: Yayminyi
Djang (dreaming): Namarrkon, Bandicoot, Cycad

Neville was one of the last babies of his clan to be born on country. His mother birthed him by a billabong in Kakadu. His father cut his umbilical cord with a fresh-water mussel shell and wrapped him in paperbark. 'This boy is going to grow up to speak the language of the colonisers' said Spider Namirrki, Neville's father. Neville grew up to be educated in a traditional way, living on country and experiencing ceremony. He was also educated in a colonial way via government schooling in Gunbalanya and Jabiru. He was a founding artist of Injalak arts and crafts. Neville also qualified as a plumber and fathered 6 children. Today Neville is a sought-after tour guide on the Guluyambi Cultural Cruise on the East Alligator River in Kakadu National Park. He is also an actor, teacher, artist, elder and musician who promotes his ancient cultural perspective through modern technology.

Photo credits (left to right): Bindi Isis; Satya Jack.

Mojarrki and Bered Bered

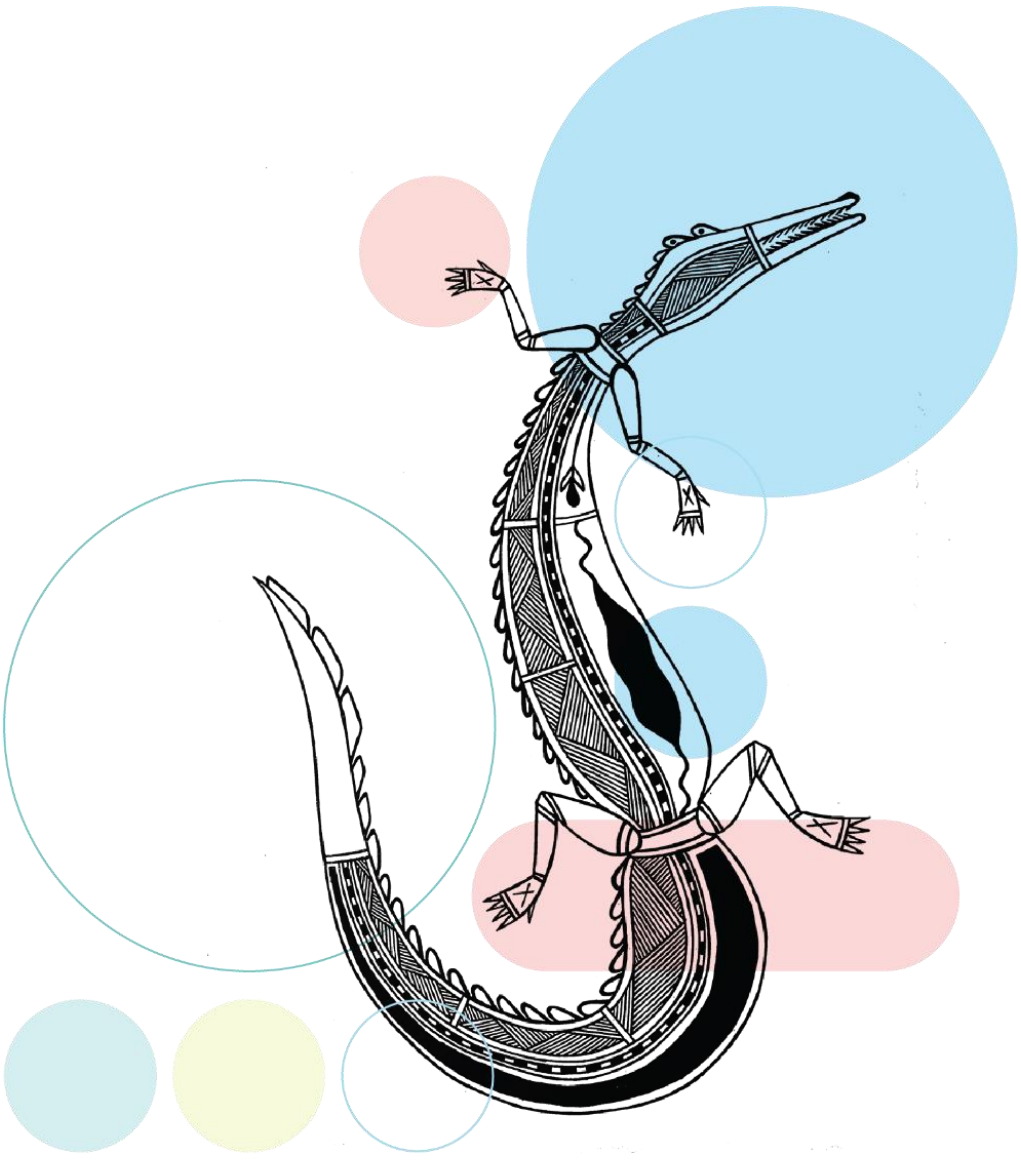
An Ancient Story describing how Kunwinjku people obtained the use of Fire

This is Mojarrki, the freshwater crocodile.

Throughout Arnhem Land, it is widely recognised that fire was brought to earth by crocodiles. Fire is sacred to all plants and animals in the Kunwinjku environment. Even today, you can see the pattern of a log on fire, burnt into the skin of a crocodile.

Mojarrki was clever with his fire, he knew it was a tool that he could use to cook his food, manage his country and keep his lore strong. He was not prepared to share this power. But how did Mojarrki know how to make fire with two sticks?

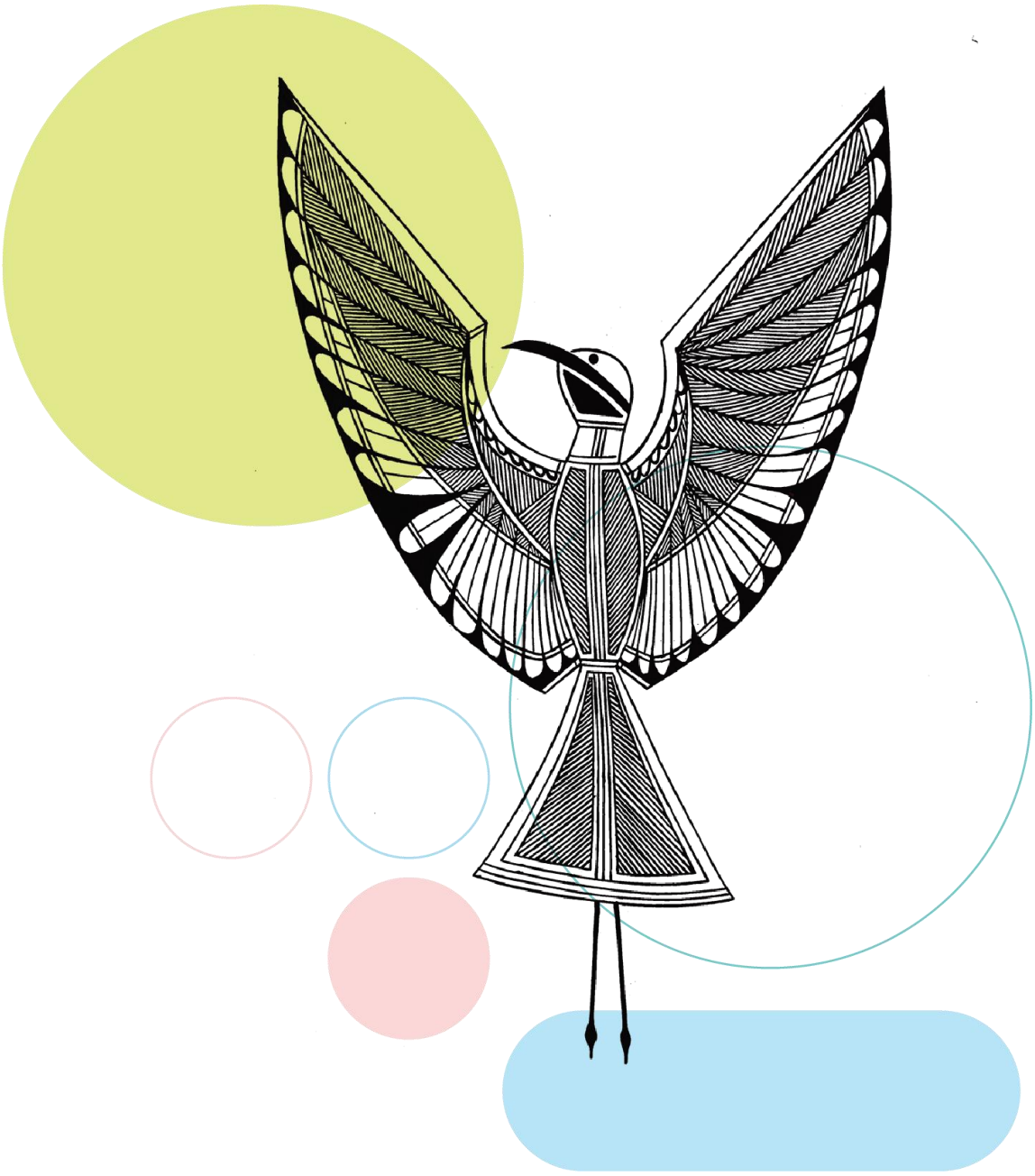
Well, Mojarrki was a victim of the fire himself. He was on earth when a meteorite struck. His body was burnt and he ran back into the water to save himself.



This is Bered Bered, the Rainbow Bee-eater.

Bered Bered was a very busy and industrious ancestral being who made his nest in a burrow by the bank of the river. One day as he was delivering some materials to soften his burrow, he spied Mojarrki making a fire. Bered Bered was very impressed and he wanted that skill and the technology of the fire sticks for himself.

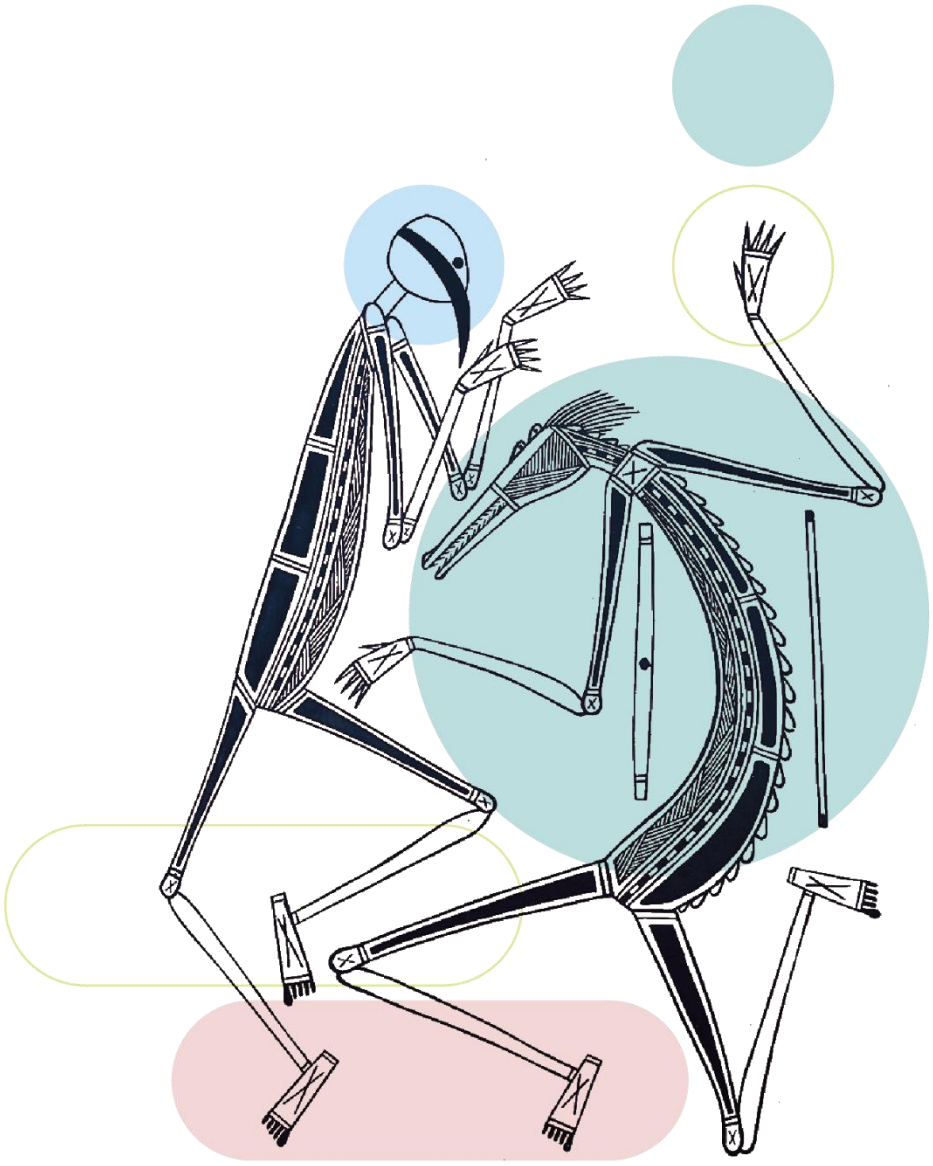
Mojarrki and Bered Bered struck up a conversation and in time they became good friends. This whole time, Bered Bered had his eyes on the firesticks. He wanted to use them to make fire, so he could cook food for his children. One day he mustered the courage to ask Mojarrki, if he could borrow the firesticks but Mojarrki said 'No Bered Bered, I am the keeper of fire, you must not use my firesticks, it is sacred to me'.



Mojarrki came to Bered Bered one day.

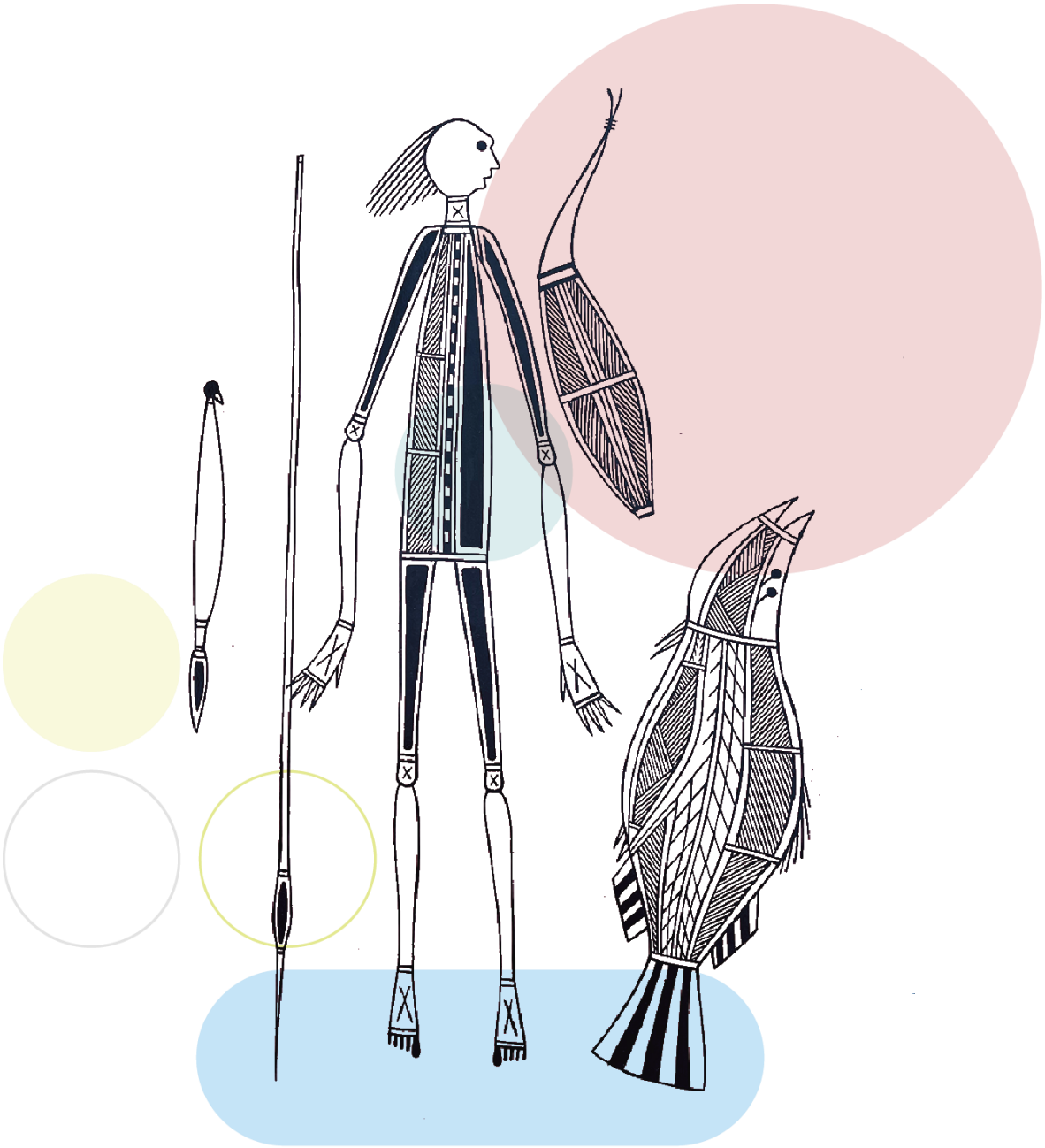
‘Bered Bered, I have a terrible case of headlice, I love to eat fish and I know how you love to eat insects. Can you help me with these insects?’ He lay his firesticks to one side and put his head in Bered Bered’s lap and Bered Bered carefully picked the insects from his hair.

It is so relaxing to have someone tenderly ruffle your hair, especially when that person is a friend. Very soon, Mojarrki was sound asleep. Bered Bered saw his opportunity, he stood up and grabbed those firesticks for himself. Bered Bered carries those firesticks today. You can see them poking from his tail, two long black feathers with a dot on the end of each, these are the kundjakol (fire sticks) of Bered Bered, that once belonged to Mojarrki.



Mojarrki was devastated to lose his firesticks. But he lives in the waterways and fires don't burn so well there. Instead Mojarrki learned to make spear and borndok (woomera) to catch fish. Mojarrki had to eat his fish raw.

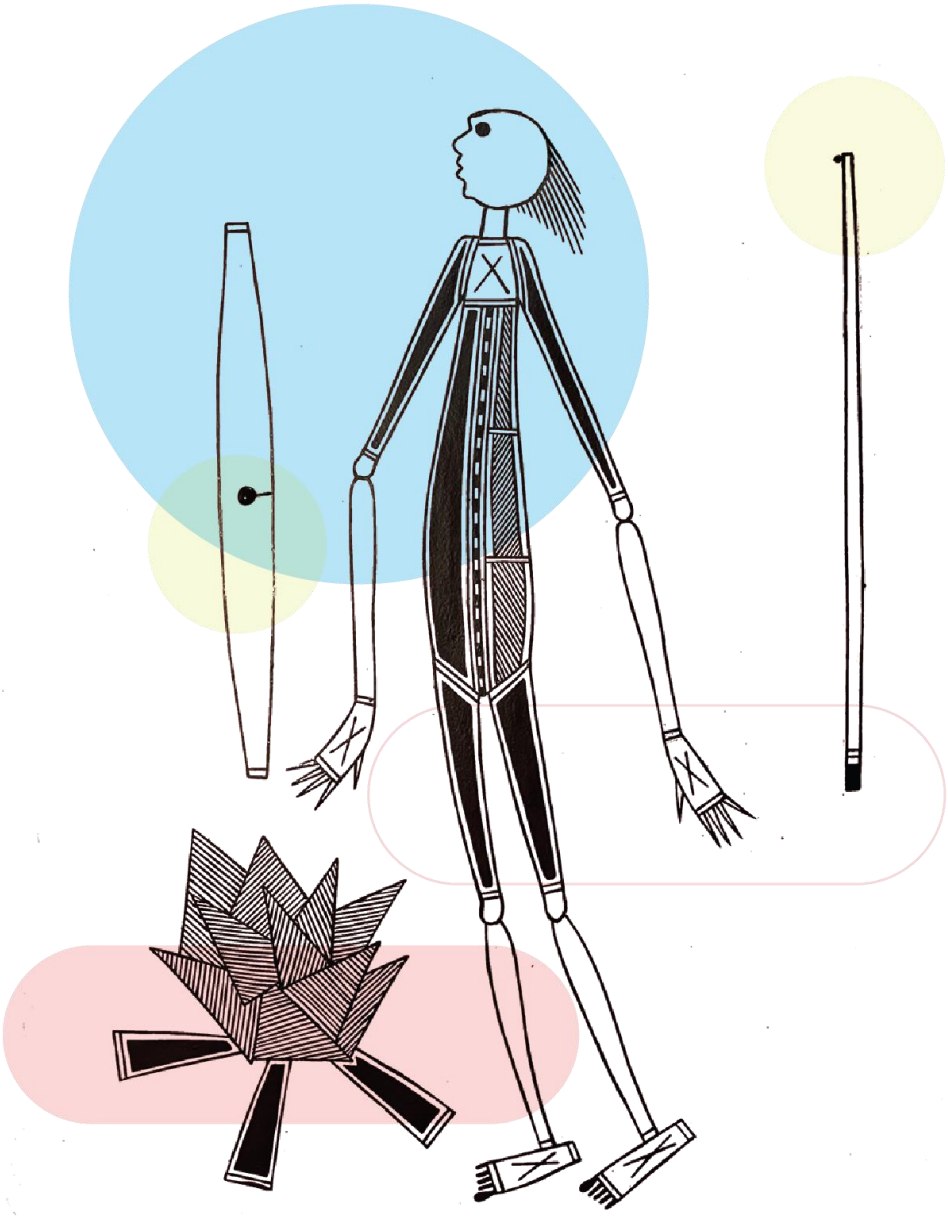
Mojarrki, like many of the ancestral creation beings is always shifting between human and animal form. There is no difference between the human and the animal because each has memory of the other. This way they are changing and carrying their technologies and understandings with them. Here Mojarrki, has also learned the art of weaving, he has a dilly bag to carry food home to his family.



Bered Bered carries the Kundjakol (firesticks).

These need to be made of mangundalk (black plum). One stick has a hole in it, the other stick rubs into the hole to create friction, heat, smoke and then flame. Kunwinjku use charcoal to get the initial flame going. Fire was made in 5 minutes this way.

Fire is the best way to ensure crocodiles stay clear of a riverside or billabong camp. Kunwinjku people often lit 3 or 4 fires between themselves and the water to keep ginga (saltwater crocodile) away. Only humans can manage the landscape with fire. For this reason, Kunwinjku people thank Bered Bered and Mojarrki.



Story Painting and Storytelling Neville Namarnyilk December 2023

Oral Story Dictation and Production Bindi Isis December 2023

Summary: The pathway to diversity in STEM

This review has highlighted the need for more ambitious and strategic action to increase diversity in STEM. Industry, governments, the education sector, not-for-profits and individuals all have a role to play.

This report contains 11 detailed recommendations to create structural and cultural change to increase the diversity of Australia's STEM system. In summary, these are:

1. **The Australian Government** committing to a whole-of-government, long-term strategy to increase diversity and inclusion in STEM. This includes establishing a dedicated advisory council supported by dedicated government resources.
2. **The Australian Government** establishing a suite of diversity in STEM programs, as detailed in the Diversity in STEM Program Strategy in the final section of this report. This includes embedding best-practice program design elements across programs, making changes to the current Women in STEM program suite, and establishing new programs that address barriers for underrepresented cohorts.
3. **Every Australian organisation employing STEM workers** committing to the elimination of bullying, harassment and discrimination, including racism.
4. **Every Australian organisation employing STEM workers** adopting, making public and implementing a plan to increase attraction, retention and promotion of underrepresented cohorts.
5. **The Australian Government** making Australian STEM workplaces safer, more diverse and inclusive by changing grant and procurement processes for STEM-related programs. This includes providing guidance to help organisations implement the recommendations in this report, and examining the need for further changes, such as legislation or changes to other financial arrangements.
6. **The Australian Government** including a focus on STEM in implementing any strategies in response to the *2023 Review of the Migration System*.
7. **The Australian Government** working with states and territories to improve participation and achievement in STEM skills and subjects in schools.
8. **The Australian Government** preparing and supporting educators to teach STEM in a way that is responsive to the needs of diverse cohorts.
9. **The Australian Government** working with states and territories to ensure that national tertiary education reforms increase access, participation and attainment of underrepresented cohorts in STEM education.
10. **The Australian Government** preferencing First Nations scientists and researchers applying for government funding for projects that affect or draw from First Nations Knowledges and knowledge systems, and working with First Nations communities to develop further ways to elevate First Nations Knowledges. **The Learned Academies** working with the academic

community and Traditional Knowledge holders to build respect, awareness and better practices to weave First Nations Knowledges into science and research systems.

11. **The Australian Government** developing a communication and outreach strategy to increase awareness, visibility and importance of diversity in STEM to emphasise the opportunities and potential for careers in STEM.

A long-term strategy, based on the recommendations in this report, will drive coordinated and impactful actions to increase diversity and inclusion of all people currently underrepresented in STEM education and jobs. A dedicated advisory council should guide implementation of this strategy, providing expert advice from people with lived experience of being underrepresented in STEM.

The review found that stronger leadership and coordination is essential to drive faster and more ambitious progress. There are many initiatives to increase diversity in STEM, but no central point to bring these together, identify gaps, and measure and share what works.

This report includes an approach to develop a strategic suite of programs that go beyond gender equity. This includes changes to the current suite of Women in STEM programs in the Australian Government's Department of Industry, Science and Resources. The advisory council should have a role in designing, implementing and evolving these programs. It will ensure that programs are effective, fill genuine gaps and do not duplicate existing initiatives.

Advice on ways to improve education and employment outcomes for underrepresented people in STEM must come from those with lived experience. The recommendations in this report align with and support findings of other recent reports that are helping to guide broader education and employment policy development, including:

- advice of the Women's Economic Equality Taskforce
- the *Australian Universities Accord interim report*
- *Working future: The Australian Government's white paper on jobs and opportunities*.

Urgent action is needed to create safe and inclusive workplaces that value diverse skills and experiences. This is critical to attract and retain diverse people in STEM jobs. Submissions to the review, and findings of the evaluation of Women in STEM programs, revealed that industry can – and should – do more.[1]

Organisations need to be accountable for their actions to eliminate bullying, harassment and discrimination, including racism. The government should require this accountability from organisations that receive public funding.

Creating safe and inclusive workplaces should be a priority in all organisations, not just those focused on STEM. Action in these areas is critical to grow the STEM workforce in occupations that are traditionally male-dominated and lacking in diversity. Taking action will ensure people from diverse cohorts do not leave or avoid STEM occupations because they feel unsafe, unwelcome or insecure.

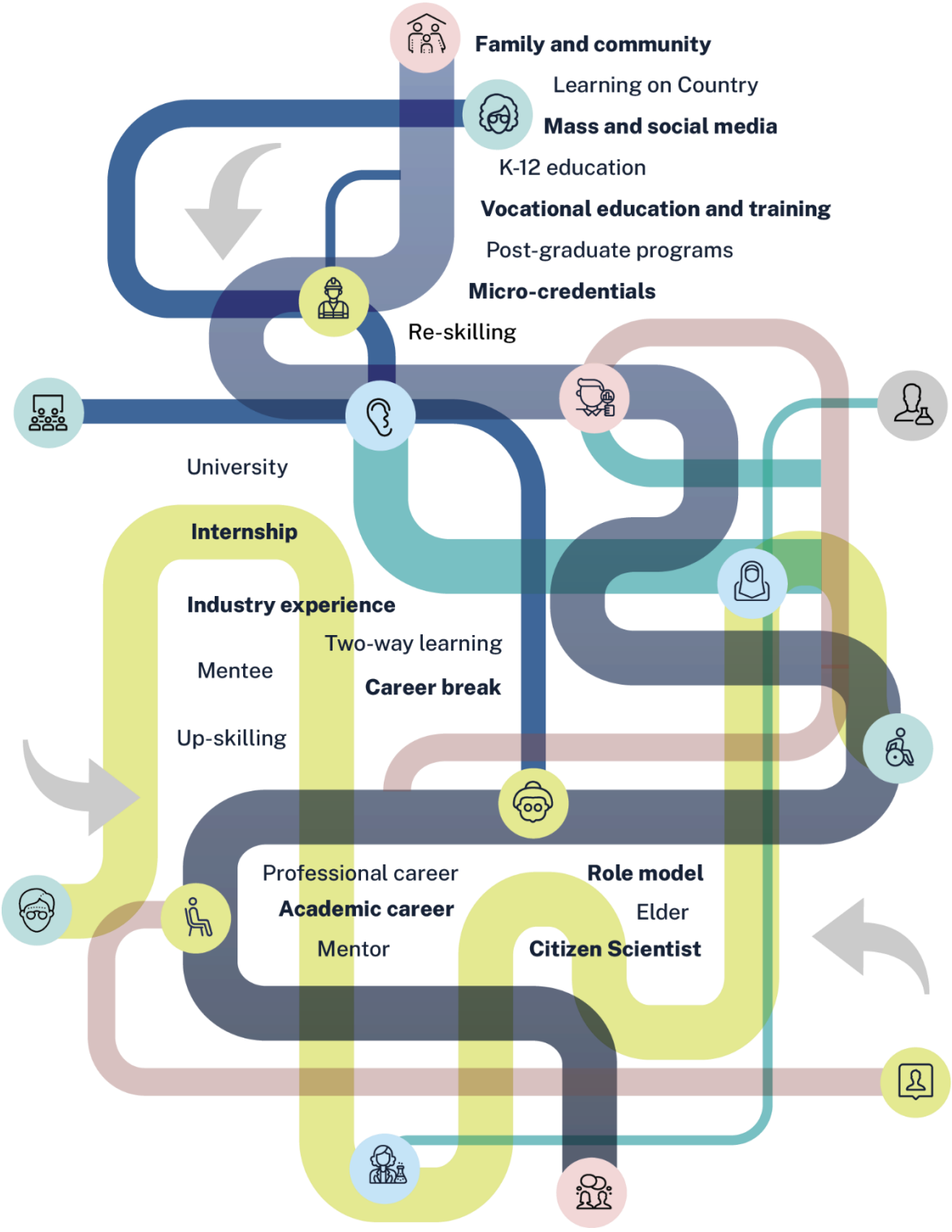
Organisations can fill immediate STEM workforce needs by drawing on people with diverse and valuable STEM skills and experience.

[1] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

This includes migrants with overseas STEM qualifications, people who are VET qualified, and First Nations people with STEM knowledge and experience. Industry also has a role to play in widening pathways to STEM opportunities and re-skilling their existing workforce with STEM competencies.

Different pathways through STEM

Creating flexible, accessible pathways to learn and enhance STEM skills and knowledge can attract more diverse people.



The pathway begins by supporting educators to inspire young people in STEM education. Positive engagement in STEM education, with opportunities to solve real world problems, can influence subject and career choice. More diverse STEM teachers in the education system can be positive role models for diverse students.

Good work is underway by universities to improve access and inclusivity in higher education. While there is room for improvement, this pathway might not be right for everyone at all stages of their lives. This means taking a lifelong learning approach to STEM education.

There should be a clear pathway for non-school leavers to easily find and access high-quality STEM learning opportunities. Pathways should be available to people regardless of their age or career stage, where they live, or how they identify. Flexible learning pathways could help people from underrepresented cohorts enter a STEM career for the first time or gain new skills that meet industry needs. This includes improving STEM vocational and education options, and high-quality short courses to help people upskill or re-skill.

Stereotypes and perceptions influence the choices people make about their study and careers. Workplaces should be safer, and pathways to get there more flexible and accessible. However, these efforts will be limited if people from diverse cohorts don't believe they can, or should, do STEM because of society's views about STEM and who does it. Essential to addressing this is a dedicated, First Nations-led effort to value First Nations Knowledges in STEM education, research and practice.

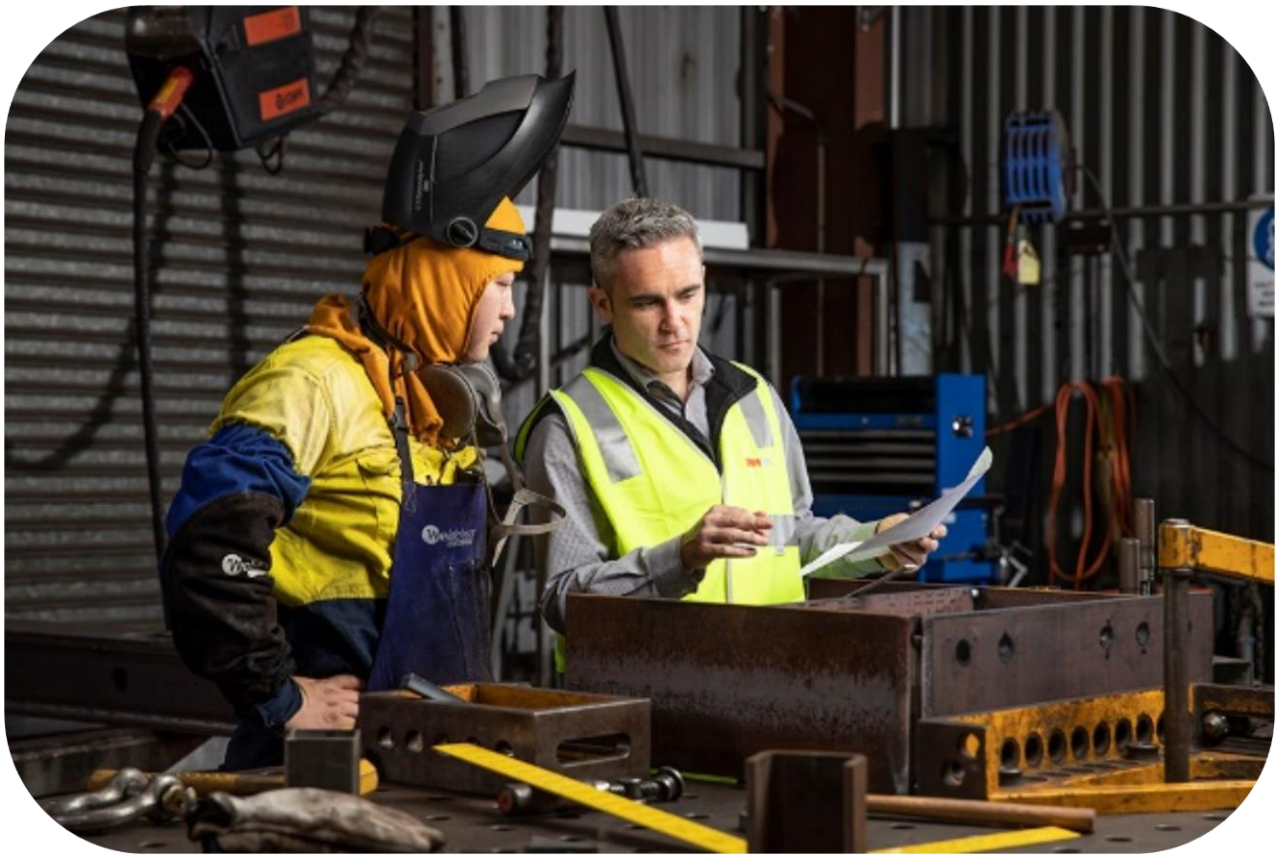


Photo credit: Engineers Australia.

Overview of recommendations

Government coordination and leadership

- commit to a whole-of-government long-term strategy to increase diversity and inclusion in STEM
- establish a dedicated advisory council, and commit dedicated government resources, to implement the strategy
- establish a suite of impactful diversity in STEM programs, based on best-practice program design

Creating safe and inclusive workplaces

- commit to eliminate workplace bullying, harassment and discrimination, including racism
- increase attraction, retention and promotion of diverse workers
- change Australian Government grants and procurement processes
- address barriers faced by skilled STEM migrants

Lifelong learning

- improve participation and achievement in STEM skills and subjects in schools
- prepare and support educators to teach STEM in a way that is responsive to the needs of diverse cohorts
- work with state and territory governments to ensure national tertiary education reforms include a focus on underrepresented cohorts in STEM education

Changing perceptions and valuing diverse knowledge

- preference First Nations scientists and researchers applying for government funding for projects that affect or focus on First Nations engagement in STEM
- develop better practices to elevate First Nations Knowledges.
- develop a strategy to increase visibility and importance of diversity in STEM and STEM careers

An open letter to the unconvinced

We heard you too.

During the review we heard from hundreds of people and organisations about Australia's STEM landscape. We heard inspiring and confronting stories, and exciting ideas. Along the way we also heard concerns from a few people that pursuing greater diversity and inclusion is the wrong approach.

Most people recognise that pursuing more diversity will directly help individuals from underrepresented groups. But is it good for everyone? Is there even a real problem to address? And importantly, is it fair?

Let's look at these concerns, and we'll share some findings from the review that give context for the rest of the report.

Why make STEM more diverse?

One concern we heard is that the effort to increase diversity isn't worthwhile. While we've heard about many ways diversity directly improves lives, there are significant positive economic implications at play too.

A key reason the Australian Government established this review was to help meet Australia's future skills needs. Our current STEM pipeline won't meet the forecast demand for STEM skills to drive productivity and meet tomorrow's challenges. Looking to groups currently underrepresented in STEM to take up the call is an obvious solution.

The review quickly discovered this isn't just a matter for governments – diversity benefits organisations too. The *Australian IP report 2023* highlights diversity is good for innovation and productivity in organisations, ultimately asserting that 'gender and cultural diversity underpins innovation in Australia'.[2]

Considering gender as an example, recently published research has linked women's representation in the workforce to corporate financial performance and to enhanced investment decisions.[3] This research found that companies with the most diverse workforces outperformed country and industry group peers with the least-diverse workforces. The most diverse companies had, on average, a 29% greater return on assets over the 2013-2022 period.

To understand how else diversity in our places of STEM learning and work improves lives, it's worth delving into the current situation to understand what needs addressing.

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[2] Intellectual Property Australia. (2023). *Australian IP report 2023.* Australian Government. https://www.ipaustralia.gov.au/tools-and-research/professional-resources/data-research-and-reports/australian-ip-report

[3] Blackrock (November 2023). *Lifting financial performance by investing in women*. https://www.blackrock.com/corporate/literature/whitepaper/lifting-financial-performance-by-investing-in-women.pdf

Is there a real problem?

Another concern we heard is that there isn't a real problem to address.

A good place to start is to consider the diversity in STEM education and jobs. Evidence shows it's a long way from reflecting the diversity of Australia's population. In 2021, only 36% of STEM university students identified as female.[4] Among other underrepresented cohorts, around 5% of people studying university STEM subjects in 2021 were living with a disability.[5] In the same year, less than 1% of First Nations people held a university STEM qualification.[6]

Resources such as the STEM Equity Monitor, *Australia's STEM workforce report*, the *Women staying in the STEM workforce report*, the Australian Human Rights Commission's *Willing to work report* and a recently published peer-reviewed article by Adamovic and Leibbrandt support this evidence.

More concerning though is *why* Australian STEM is less diverse than Australian society. This is what we heard frequently throughout the review. We heard that living in remote locations can restrict learning opportunities. Coming from low socioeconomic circumstances can make it hard to take on full-time study. People with disabilities have difficulties accessing places of learning and work. We heard many examples and we include them in this report.

We also heard the current make-up of STEM fields reinforces this lack of diversity. For example, engineering has very low female representation. Females represent only around 16% of Australian engineering graduates, and approximately 14% of people in the Australian engineering workforce.[7] This low representation makes it hard to attract more women into engineering.

The evidence shows that familiarity is one of the biggest barriers to girls and women choosing engineering as a profession.[8,9] A lack of visibility, resources, support and role models all contribute. As a result, many girls don't know what an engineering career looks like and don't consider it a realistic option. Similarly, the *Willing to work* report found that many people face work barriers because of attitudes about age and disability.[10] We heard repeatedly that it is very difficult to address these barriers when the people affected are cut off from the system they need changed.

Considering the combined effect of the barriers and biased thinking that discourage people from pursuing STEM, it becomes very difficult to put the current landscape down to individual decision making. The recommendations in this report intend to address this, so more people can find their way into STEM education and careers.

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[4] Submission to the Pathway to Diversity in STEM Review from Universities Australia.

[5] Ibid.

[6] Australian Bureau of Statistics. (2021). *TableBuilder*. Australian Government. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

[7] Submission to the Pathway to Diversity in STEM Review from Engineers Australia.

[8] Ibid.

[9] Engineers Australia. (June 2022). *Women in Engineering: Identifying avenues for increasing female participation in engineering, by understanding the motivators and barriers around entry and progression.* https://www.engineersaustralia.org.au/publications/women-engineering

[10] Australian Human Rights Commission. (May 2016). *Willing to work: National inquiry into employment discrimination against older Australians and Australians with disability.* https://humanrights.gov.au/our-work/disability-rights/publications/willing-work-national-inquiry-employment-discrimination

Is pursuing more diversity fair?

This leads us to the third concern we would like to address – that a focus on diversity is not a focus on merit, and that striving for greater diversity will not result in the best people for the job.

We absolutely agree that jobs should be filled by the people that have the most to contribute. This means considering what the candidates can contribute to the position, and the culture, productivity and reputation of the organisation.

It also means considering what merit looks like in a situation where our brightest minds at all ages can be held back by their circumstances. Even during recruitment, the evidence is clear that unconscious bias can have an enormous impact. Recent research found that ethnic discrimination is especially pronounced for leadership positions.[11] It included over 12,000 applications sent in response to job advertisements in Melbourne, Sydney and Brisbane. They found applications with names common in ethnic minorities received 57% fewer positive responses for leadership positions than applicants with English names and 45% fewer positive responses for non-leadership positions. This is despite identical resumes.

This should be addressed like any other bias, such as conflicts of interest – to remove the unfairness and create a merit-based outcome.

Ultimately fairness is at the heart of this report and all our recommendations. It is in pursuit of truly merit based outcomes – where people succeed based on what they can contribute rather than as a flow on from their circumstances.

The opportunity

We have an opportunity to work together to make Australian STEM a stronger, more productive and fairer system. It will require us to join in removing barriers and supporting each other to succeed. We would love you by our side in championing for a brighter future for Australian STEM.

[11] Adamovic, M., & Leibbrandt, A. (2023). Is there a glass ceiling for ethnic minorities to enter leadership positions? Evidence from a field experiment with over 12,000 job applications. *The Leadership Quarterly*, 34(2), 101655. https://doi.org/10.1016/j.leaqua.2022.101655

About the review

Why we needed this review

We cannot overstate the importance of increasing diversity and inclusion in Australian STEM. Diverse and inclusive STEM sectors are critical to meeting the increasing demand for STEM-skilled employees in emerging industries. This includes helping Australia reach its target of 1.2 million tech-related jobs by 2030.

The Australian Government's 2023 *Intergenerational report on Australia's future to 2063* states that we require STEM skills to respond to the forces shaping Australia's economy. This is from the expanded use of digital technologies to the rising demand for care and support services, climate change, and the net zero transformation.[12]

These skills can diversify and transform Australia's economy, in areas such as renewables and low emissions technologies, medical science and defence capability. Investment in people and growth in Australia's STEM capability will require new approaches to diversity, to expand opportunity and address disadvantage.[13]

Jobs and Skills Australia's 2023 *Jobs and skills report* revealed that future skill needs concentrate around STEM-related occupations. Jobs in professional, scientific and technical services have growth expectations of 233,600 people by 2033.[14]

Not enough people are pursuing education pathways to provide these skills. There are persistent imbalances in STEM education and workforce participation. For example:

- women still only represent 15% of the STEM workforce despite participation increasing by 68% since 2012.[15] One in 5 female scientists have indicated they plan to leave their profession.[16]
- women make up 47% of Year 12 STEM enrolments, but these are notably lower in engineering (23%) and technology (24%).[17]
- less than 1% of First Nations people held a university STEM qualification, and less than 5% held a VET STEM qualification in 2021.[18]

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[12] Department of the Treasury. (2003). *Intergenerational report 2023: Australia's future to 2063*. Australian Government. https://treasury.gov.au/publication/2023-intergenerational-report

[13] Ibid.

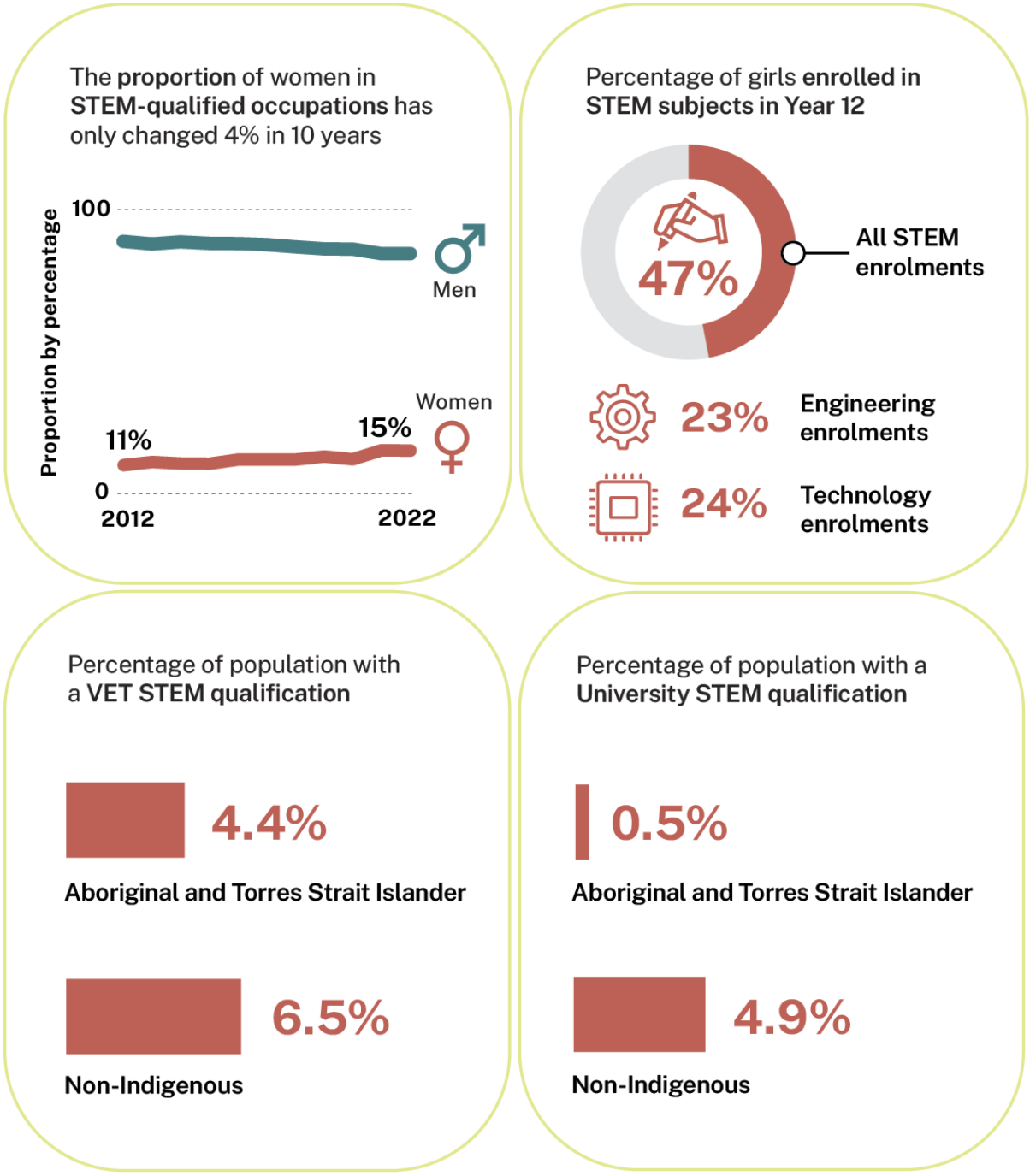
[14] Jobs and Skills Australia. (4 October 2023). *Towards a national jobs and skills roadmap: Annual jobs and skills report 2023*. Australian Government. https://www.jobsandskills.gov.au/publications/towards-national-jobs-and-skills-roadmap

[15] Department of Industry, Science and Resources. (2023). *STEM Equity Monitor.* Australian Government. https://www.industry.gov.au/publications/stem-equity-monitor

[16] Professional Scientists Australia. (2022). *Professional scientists employment and remuneration report.* https://scientists.professionalsaustralia.org.au/Scientists/News/Professional_Scientists_Employment_and_Remuneration_Survey_Report.aspx

[17] Department of Industry, Science and Resources. (2023). *STEM Equity Monitor.* Australian Government. https://www.industry.gov.au/publications/stem-equity-monitor

[18] Australian Bureau of Statistics. (2021). *TableBuilder*. Australian Government. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder



This data helps to understand some of the gaps, but better data would help understand participation of other underrepresented cohorts in STEM education and jobs.

STEM workforce shortages are not exclusive to Australia. For example, in 2022, Germany had a shortfall of around 320,000 STEM specialists.[19] By 2025, the US predicts to have a shortfall of 3.5 million STEM skilled workers.[20] The UK forecast is to have a shortfall of 1.8 million engineers and

[19] Bundesvereinigung der Deutschen Arbeitgeberverbände. (24 May 2022). *Germany lacks 320,6000 MINT workers*. https://arbeitgeber.de/en/mint-fruehjahrsreport-2022-deutschland-fehlen-320-600-mint-arbeitskraefte

[20] Emerson. (2018). *Emerson survey: 2 in 5 Americans believe the STEM worker shortage is at crisis levels.* https://www.emerson.com/en-us/news/corporate/2018-stem-survey

technicians by the same year.[21] By 2030, Japan expects to have a shortage of 450,000 IT workers.[22] Work underway internationally reinforces the importance of increasing diversity in STEM to address workforce shortages. The review draws on approaches overseas to inform the recommendations in this report.

Australia must accelerate its efforts not just to address skill needs. A diverse STEM sector brings new perspectives, better problem solving, increased creativity and improved productivity.[23] Research shows that diverse teams achieve greater success than non-diverse teams.[24]

Getting STEM-skilled people into these jobs is not enough. Diverse STEM-literate people on boards and in leadership positions across all sectors is critical to ensure good decision-making in an increasingly technologically advanced economy. Retaining these people in these positions is also critical for ensuring that improved decision-making capability builds over the long-term.

> ‘Greater workforce diversity can boost economic output by tapping into underutilized talents and bringing different experiences and perspectives to the table.’[25] – Blackrock

In announcing the review, the Minister for Industry and Science noted that ‘it is vital that Australians from all parts of the community have a chance to contribute to our ambitious scientific and technological agenda’.[26]

[21] Scrimgeour, H. (27 June 2019). How changing attitudes are closing the gender gap in engineering. *The Guardian*. https://www.theguardian.com/careers/2019/jun/26/how-changing-attitudes-are-closing-the-gender-gap-in-engineering

[22] Foster, M. (2021). Japan needs a lot more tech workers. Can it find a place for women? *The New York Times*. https://www.nytimes.com/2021/09/01/business/japan-tech-workers-women.html

[23] Commonwealth Scientific and Industrial Research Organisation. (17 May 2023). *Breaking stereotypes and championing diversity in STEM.* https://research.csiro.au/WithSTEMYouCan/breaking-stereotypes-and-championing-diversity-in-stem

[24] Jõgi, A. (10 May 2022). *Diverse teams achieve greater success: How business can champion diversity as good sense*. Forbes. https://www.forbes.com/sites/forbestechcouncil/2022/05/10/diverse-teams-achieve-greater-success-how-business-can-champion-diversity-as-good-sense

[25] Blackrock. (November 2023). *Lifting financial performance by investing in women*. https://www.blackrock.com/corporate/literature/whitepaper/lifting-financial-performance-by-investing-in-women.pdf

[26] Australian Government. (24 November 2022). *Diversity in STEM expert panel announced.* https://www.minister.industry.gov.au/ministers/husic/media-releases/diversity-stem-expert-panel-announced

Our approach to the review

The review has valued lived experience alongside data and evidence-based research and inputs. Public engagement was a key part of the review, in addition to research and program evaluation. The review prioritised engagement with communities underrepresented in STEM, including:

- First Nations peoples
- people living with disabilities
- women and girls
- people facing age-based discrimination
- culturally and linguistically diverse people
- people with low socioeconomic status
- LGBTQIA+ people
- neurodivergent people
- people living in regional and remote areas.

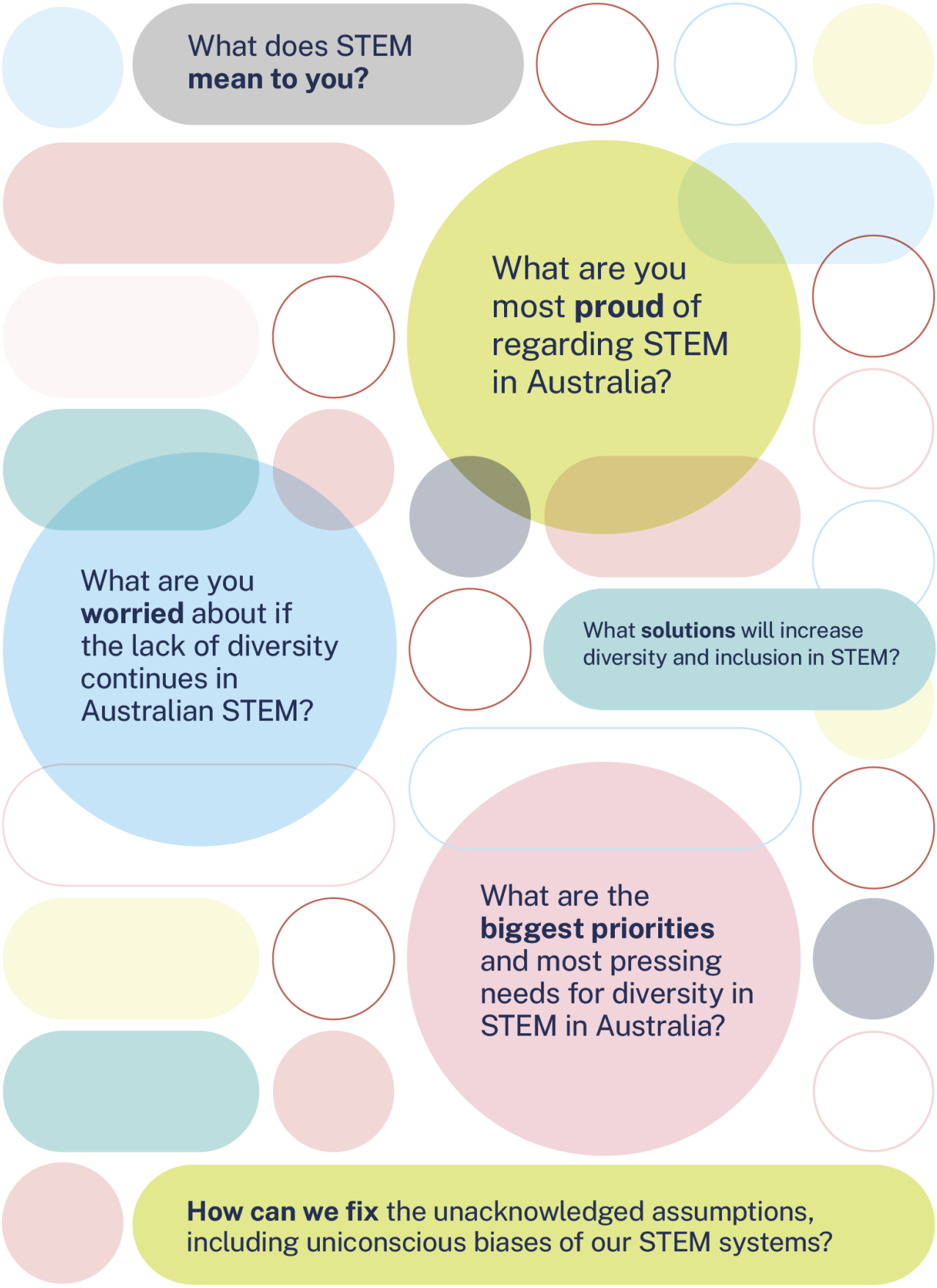
This report refers to intersectionality, where people identify as belonging to more than one cohort. This is when their identities and experiences overlap multiple intersecting factors.

The approach to gathering evidence and perspectives did not intend to diminish the expertise or reduce the focus on gender diversity of people already represented in STEM. The intent was to capture a broad range of voices and perspectives. Listening to all underrepresented communities increases understanding of the challenges faced in increasing diversity in STEM.

Virtual and face-to-face workshops were culturally sensitive and strengths-based to support genuine collaboration. Instead of asking questions standard of a government review process, the panel used questions inspired by First Nations ways of building relationships and partnerships. Some of these questions are in the graphic on the following page.

Instead of a traditional public submission process, the review invited a public conversation over 3 months. The panel asked questions, considered the answers and asked further questions. If people in underrepresented communities did not feel comfortable providing a submission, panel members spoke to them. A summary of the conversation was then submitted. Key stakeholders in the STEM sector engaged using the traditional submission process and, in several cases, also interviewed individually.

Some questions we asked



Snapshot of our engagement

The review also engaged Australia's Women in STEM Ambassador to produce 2 research reports. These have been a key source of evidence for this review.

The Office of Australia's Women in STEM Ambassador synthesised peer-reviewed evidence on evaluated workplace equity initiatives. The final report is called *Initiatives for workplace equity and inclusion: A series of rapid systemic reviews of the peer-reviewed literature*. This research focused on evidence-based initiatives that can help address the challenges of gender equity, bullying and harassment, the gender pay gap, and disability in the workplace. The report highlights initiatives that are implementable by organisations, peak bodies, and/or government entities.

Associate Professor Marnee Shay, of the University of Queensland, was also commissioned to lead a research project called Big Mob: STEM it Up. This project focused on Aboriginal and Torres Strait Islander participation in STEM education and careers. It involved a systematic literature review, community survey, a podcast series and international research. The findings and recommended actions provide a valuable addition to the evidence base of what works for First Nations people. It highlights the importance of valuing First Nations STEM Knowledges alongside Western knowledge paradigms. It also outlines a clear need to support Indigenous-led research and researchers to fill the gaps in evidence on participation of First Nations people in STEM.

Research recently commissioned by the Office of the Chief Scientist has also been a source of evidence. This includes:

- the *STEM career pathways* report, produced by Science and Technology Australia for the National Science and Technology Council. This report identifies barriers to STEM careers and ways to build the workforce
- the *Research assessment in Australia: Evidence for modernisation* report, produced by the Australian Council of Learned Academies. This report provides evidence of how research metrics impact Australia's STEM research workforce.

Links to this research is provided as an appendix to this report, and at industry.gov.au/diversityinstemreport.

Photo credit: CSIRO.

How we understand STEM

The review's terms of reference included exploring what is needed to improve diversity and inclusion in science, technology, engineering and mathematics (STEM). The review revealed that people have different understandings of what STEM is, based on their individual experiences and values. Consultation also highlighted these perceptions of STEM are a clear barrier for diverse cohorts in accessing and belonging within STEM.

STEM has shaped the everyday lives of most people living in Australia. But this is not always reflected in the structures of STEM in Australia. For STEM skills and engagement to continue growing, more people need to see themselves as a part of the STEM system. This is true whether they are studying, practising, working or using STEM skills.[27] These skills include curiously and rigorously questioning our world, seeing ways to do things differently, and noticing the patterns and features our world relies on. Getting this right will set up STEM to keep growing the Australian economy.

Information and statistics used throughout this report are from a range of sources that have varying definitions of STEM. This review takes an inclusive view of STEM as a collection of knowledge practices and systems that support:

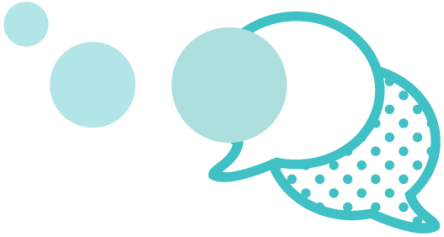
- the ways people learn about the world around them in increasingly accurate ways
- the act of developing, sharing and applying knowledge
- the tools people create and use
- what people can make and will make in the future
- the patterns people see
- the stories people tell about how these all fit together.

Photo credit: DeadlyScience.

[27] Science and Technology Australia. (2023). *STEM career pathways major research report*. https://www.chiefscientist.gov.au/STEM-CareerPathways

the ways people learn about the world around them in increasingly accurate ways

the act of developing, sharing and applying knowledge



the stories people tell

the patterns people see

the tools people create and use

what people can make and will make in the future

This approach reflects that STEM can inform many ways of thinking that contribute to community and society. For example, First Nations Knowledges contains huge amounts of STEM practices, systems and ways of thinking. These are seen throughout First Nations perspectives, laws and lore about Country.

One of the major perceptions we must change is that there is only one pathway to a career in STEM. There are many ways people can develop STEM skills. Engagement with STEM can look like a student who takes higher level mathematics in senior schooling. It can also look like learning on Country or pursuing a TAFE course in a STEM-related field. It can look like re-skilling as an adult or engaging in citizen science.

Inclusive definitions and understandings of STEM are central to increasing diversity and inclusion in STEM, and therefore building the STEM-skilled workforce needed for a strong economy and inclusive society.

Photo credit: The STEM Teacher Enrichment Academy (University of Sydney).

An example of how understandings of STEM can work for or against the inclusion of people was provided to the review by Queers in Science:

‘A common inquiry arises: “What relevance do gender and sexuality have in the realm of science?” This question assumes that science is objective and impartial, detached from external factors such as societal, environmental, economic, and political influences. This view promotes the compartmentalisation of science, separating it from identities like LGBTQIA+ identities. However, science operates within a larger context. Scientists excel at isolating specific aspects of the world for analysis, yet contextualising findings and understanding the bigger picture presents a greater challenge. Data may seem unequivocal, but its interpretation—particularly in discussion sections of scholarly articles—is profoundly influenced by existing knowledge, personal experiences, worldviews, values, beliefs, prejudices, and biases. Even the process of data collection and the assumptions that underlie the creation of distinct categories for qualitative analysis are often flawed, disregarding, or oversimplifying intricate complexities. These flaws in data collection can be seen in, for example, the 2021 Census, which omitted the collection of data on LGBTQIA+ people living in Australia. While science strives for logic and rationality, scientists are innately human, and humans are inherently intricate.

“Mathematics is a human creation that cannot be removed from its social and historical context. In fact, positioning mathematics as neutral and objective has enabled its exploitation as a tool of oppression, perpetuating unequal outcomes for marginalised students.” (Hughes, B.E., 2018. Coming out in STEM: Factors affecting retention of sexual minority STEM students). This statement underscores that the query, “What relevance do gender or sexuality hold in science?" essentially assumes cisgender heteronormativity as the default. This stance reflects a lack of awareness regarding the challenges faced by LGBTQIA+ individuals and the detrimental consequences of disregarding these challenges.’[28]

[28] Submission to the Pathway to Diversity in STEM Review from Queers in Science.

Recommendations

Government coordination and leadership

The Australian Government must take strategic and coordinated action to accelerate progress on diversity and inclusion in STEM.

Recommendation 1

The panel recommends that the Australian Government:

- commit to a whole-of-government, long-term strategy to increase diversity and inclusion in STEM, based on the recommendations in this report
- establish a dedicated advisory council with representation from different sectors and diversity cohorts to advise the government on implementing the strategy
- commit dedicated government resources to:
    - support the work of the council
    - contribute to and coordinate efforts across government to increase diversity, including the design and delivery of programs
    - provide a point of coordination and access to government for non-government efforts to increase diversity in STEM.
- report on progress of the strategy.

Why we recommend this

Increasing diversity in STEM is the responsibility of all governments, industry, academia, education providers and the broader community. Good work is underway, but the review highlighted a need for a centralised approach to drive ambitious progress on diversity in STEM across all sectors.

Multiple problems are arising from a lack of leadership and coordination, including:

- duplication and lack of connection in initiatives across governments, industry, education providers and not-for-profit organisations that support people along the STEM education and employment pathway

- gaps in programs to increase representation of diverse cohorts beyond gender
- inadequate evaluation and monitoring of long-term impacts of initiatives
- individuals and organisations finding it difficult to find the right information and initiatives
- missed opportunities to influence and align broader policy reforms and settings.

The review's consultation, and research by Australia's Women in STEM Ambassador, highlights the importance of centralised approaches.[29] In particular, the need for a centralised effort to support and hold STEM organisations to account for creating safe, diverse and inclusive workplaces. This is outlined in Recommendation 4 of this report.[30]

'Long-term policy objectives will only be as effective as the resources that support them, and the sanctions or accountability for failures to deliver against policy.' [31] – RMIT Respectful Research and Women in STEMM Research Team.

The *Women in STEM Decadal Plan* set a direction for change to attract and retain more women in STEM careers. However, driving real progress under national strategies cannot be fully realised without leadership and a holistic effort to connect, implement, evaluate and refine them.[32]

Australia can learn from other countries that are taking a similar approach. For example, the Republic of Korea's government has a centralised, long-term approach to setting and implementing plans to increase support for women in STEM. A cross-sector advisory committee oversees development of new plans and actions every 5 years (since 2003), informed by progress and changing workforce needs.[33] A government-funded agency for women in STEM (WISET) oversees policies and program implementation.[34]

The Government of Finland published the *Finnish National STEM Strategy 2030 and Action Plan*.[35] The strategy and action plan (2023) aim to ensure there is a focus on science and mathematics

[29] Submissions to the Pathway to Diversity in STEM Review supporting this recommendation include those from Investment NSW, Tech Council, National Youth Science Forum, Science in Australia Gender Equity, Science and Technology Australia, Engineers Australia, Regional Universities Network, Advancing Women in Healthcare Leadership, Australian Academy of Technological Sciences and Engineering.

[30] Submission to the Pathway to Diversity in STEM Review from Professors Denise Cuthbert, Kay Latham and Nicola Henry, Associate Professors Robyn Barnacle and Ceridwen Spark, and Dr Leul Sidelil.

[31] Ibid.

[32] Submission to the Pathway to Diversity in STEM Review from the Monash Centre for Health Research and Implementation.

[33] Lee, K. (2010*). Effective policies for supporting education and employment of women in science and technology*. https://www.un.org/womenwatch/daw/egm/gst_2010

[34] Ahn, H. Center for Women in Science, Engineering and Technology. (26 May 2021). *Gender equality in STEM: Korea's policy for women in STEM.* https://www.unescap.org/events/2021/expert-group-meeting-gender-equality-technology-industry

[35] Ministry of Education and Culture, Finland. (16 May 2023). *Finnish National STEM Strategy and Action Plan*. https://julkaisut.valtioneuvosto.fi/handle/10024/164953

competence and understanding in society. The emphasis of these initiatives is to increase gender equality, equity and diversity across STEM sectors and promote wellbeing.

The Australian Government is well positioned to set the environment, ambition and direction for change, and connect and coordinate initiatives to maximise impact.[36]

Establishing a dedicated diversity in STEM advisory council

A dedicated advisory council can provide the expertise to advance and evolve the strategic approach to increasing diversity in STEM outlined in this report. It should build on the foundation created by Australia's Women in STEM Ambassador to ensure future efforts support all diverse cohorts.

It is critical to draw on lived experience of underrepresented cohorts in different STEM sectors. This will ensure policies and programs support and meet the needs of those they are designed to support. This can be achieved by requiring the council to have diverse representation. The advisory council can also undertake targeted engagement with community and organisations to maximise representative advice. This approach aligns with commitments of all governments under the National Agreement on Closing the Gap to work in partnership and share decision-making with First Nations peoples on policies and programs that impact them.[37]

Systemic change will require mobilising efforts across community, industry, academia and education. An advisory council with a deep understanding of these groups' needs and barriers, and relationships, can do this.

The advisory council needs a clear mandate and accountability to advise government on ways to improve diversity in STEM and avoid duplicating other work across government.[38] It should regularly report to the government on impact and progress, to support government reporting to the public.

The advisory council should work closely with other advisory bodies with a remit to advance diversity and inclusion. For example, working with the independent national women's economic equality advisory body recommended by the Women's Economic Equality Taskforce, if agreed by the Australian Government.[39]

Providing dedicated resources to support the council through an existing Australian Government department would allow for greater visibility and coordination of policies and programs. It would provide assurance that they are evidence-based, not duplicative, and targeted where they are most needed.

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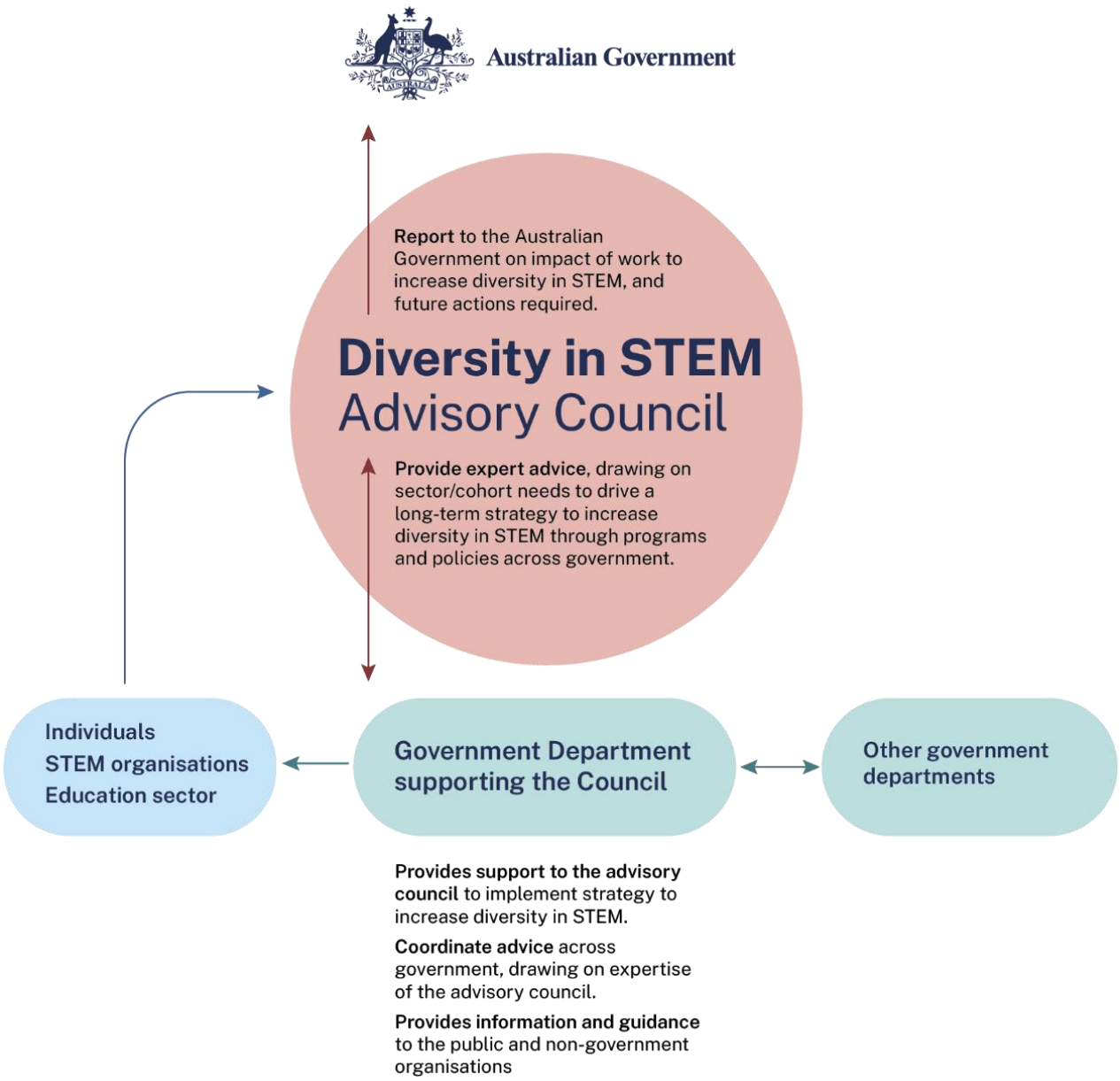
[36] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

[37] Australia, & Australian Capital Territory, & Australian Local Government Association, & New South Wales, & Northern Territory, & Queensland, & South Australia, & Tasmania, & Victoria, & Western Australia, & Coalition of Aboriginal and Torres Strait Islander Organisations. (July 2020). *National Agreement on Closing the Gap.* https://www.closingthegap.gov.au/national-agreement/national-agreement-closing-the-gap

[38] Submission to the Pathway to Diversity in STEM Review from the Australian Academy of Science.

[39] Women's Economic Equality Taskforce. (2023). *A 10-year plan to unleash the full capacity and contribution of women to the Australian economy*. https://www.pmc.gov.au/resources/10-year-plan


Australian Government
Report to the Australian Government on impact of work to increase diversity in STEM, and future actions required.
Diversity in STEM Advisory Council
Provide expert advice, drawing on sector/cohort needs to drive a long-term strategy to increase diversity in STEM through programs and policies across government.
Individuals
STEM organisations
Education sector
Government Department supporting the Council
Other government departments
Provides support to the advisory council to implement strategy to increase diversity in STEM.
Coordinate advice across government, drawing on expertise of the advisory council.
Provides information and guidance to the public and non-government organisations

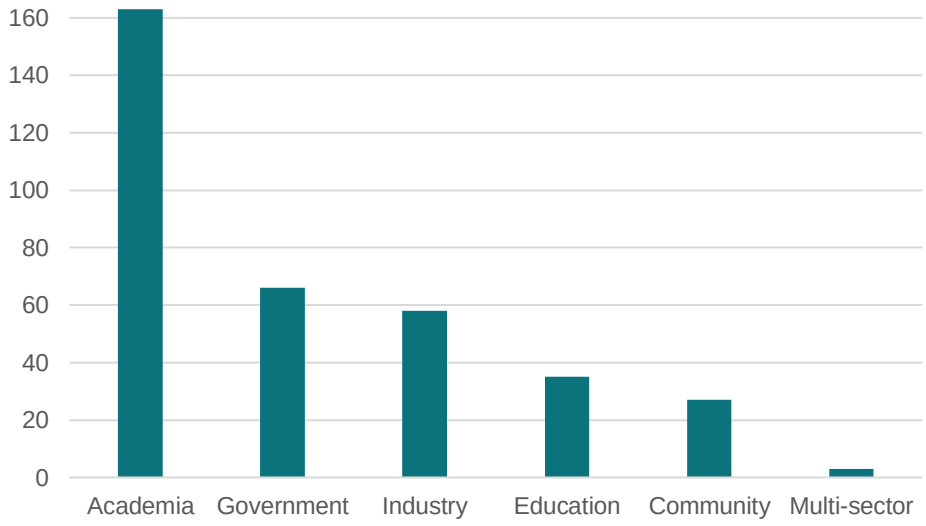
‘The council and office could have a key coordinating role – and act as a champion across the breadth of government and beyond – to accelerate diversity gains.’[40] – Science and Technology Australia

Reducing duplication, filling gaps and sharing information

Governments, academia, industry, community and education sectors are supporting hundreds of initiatives to increase diversity in STEM in different sectors or stages of the pathway.

In 2022, the Department of Industry, Science and Resources conducted an environmental scan of programs to support women in STEM. The scan found more than 350 programs aimed at supporting women in STEM alone.[41]

Figure 1: Number of programs supporting women in STEM. Source: *Women in STEM programs: Environmental scan and gap analysis* (2022).[42]



There were also more than 500 registered STEM activities on the STARportal website in March 2018. These activities connect parents, students and teachers with learning opportunities.[43]

These programs are worthwhile and important. However, they are not always well coordinated or integrated.

There are examples of coordination at the sector, program or cohort level. For example, Australia’s Women in STEM Ambassador provides advocacy, outreach and leadership for women and girls in

[40] Science and Technology Australia. (14 September 2023). *Response to the Pathways to Diversity in STEM Draft Recommendations.* https://scienceandtechnologyaustralia.org.au/reports-and-publications

[41] Byrne, N., Dance, J., Flannery, G., Leeson, J., McCarron, L., Ovington, L., & Pratt, E. (October 2022). *Women in STEM programs: Environmental scan and gap analysis*. Internal report produced by the Department of Industry, Science and Resources.

[42] Ibid.

[43] Education Council. (12 April 2018). *Optimising STEM industry-school partnerships: Inspiring Australia’s next generation*. https://www.chiefscientist.gov.au/2018/05/optimising-stem-industry-school-partnerships-report-released

STEM. The Australian Government's Defence STEM Council is playing a role in coordinating activities across the STEM ecosystem to support defence industry.[44] The Australian Academy of Technology and Engineering's Elevate program uses its advisory group to avoid duplication. It shares lessons across organisations and governments leading similar initiatives.

However, a central point of coordination will help to connect and provide information about the breadth of programs across different sectors, and those supporting different underrepresented cohorts.

A fragmented approach also makes it difficult for governments and other organisations to identify where and how their funding and efforts will have the greatest impact. This can create competition among organisations seeking funding, disincentivising them from co-sponsoring or collaborating with other delivery partners.

It is equally difficult for people to find the programs, initiatives or information they need to support themselves or others through the pathway to a STEM career. Making it easier for people to find and access quality resources and initiatives can encourage individuals to pursue STEM education or careers.

High-quality information and guidance for organisations employing STEM-qualified people (particularly small and medium businesses) can help them better address diversity and accelerate change. More information on workplace initiatives is in Recommendation 4.

Other countries are also taking action to centralise resources and information. For example, Canada has developed the Government of Canada and STEM website. This provides information and links to several programs that encourage growth in the STEM sector.[45] The programs include InSTEM for Indigenous Canadians, ChooseScience for women in STEM, Citizen Science Portal for the general community. It also provides financial support for Canadian youth and underrepresented cohorts to participate in upskilling and further studies through CanCode. Canada is proactive in highlighting the role of Indigenous Canadians in STEM and providing support to increase their participation in all STEM sectors.[46]

Influencing national education and employment reforms

No single initiative or stakeholder can drive the systemic and cultural change needed to ensure people from diverse cohorts can thrive in STEM education and jobs.[47]

Policies and reform efforts to increase diversity in education and employment cut across multiple Australian Government portfolios. A dedicated advisory council can provide guidance and advice to ensure these reforms focus on education and employment in STEM fields.

Several national reforms present opportunities to progress findings of this review to influence diversity in STEM education and careers specifically, including:

[44] Submission to the Pathway to Diversity in STEM Review from Department of Defence, Defence Science and Technology Group.

[45] Government of Canada. (13 August 2021). *The Government of Canada and STEM.* https://ised-isde.canada.ca/site/choose-science/en/government-canada-and-stem

[46] Actua. (2023). *National Indigenous Youth in STEM Program*. https://actua.ca/edi

[47] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

- implementation of the National Strategy to Achieve Gender Equality, expected to be released in 2024
- implementation of recommendations of the Australian Universities Accord Panel, expected to be provided to government by the end of 2023
- negotiation and implementation of a new National Schools Reform Agreement
- implementation of the new National Skills Agreement, which was signed by all Australian Governments in October 2023.

Photo credit: Sydney Quantum Academy.

Recommendation 2

The panel recommends that the Australian Government establish a suite of diversity in STEM programs with proven impact by:

- embedding best-practice program design elements across all its diversity in STEM programs
- building on and making targeted changes to the current Women in STEM program suite
- establishing new programs to address identified barriers for underrepresented cohorts.

The panel's detailed advice on this recommendation is in the Diversity in STEM Program Strategy in the final section of this report, which the government should implement in full.

Why we recommend this

Programs to increase diversity in STEM cannot solve the problem alone. However, they play an important role in supporting individuals and organisations while systemic change is underway. They can facilitate cultural change and help underrepresented people overcome the barriers they face.

Many programs exist to increase diversity in STEM, but the majority focus on gender diversity. Further, they do not connect in a way that helps to mitigate attrition at key transitions along the pathway from education to the workforce. For example, the current Australian Government Women in STEM program suite was not designed to support all underrepresented people in STEM. It does not provide a holistic picture of what is needed. This includes the need for an increased focus on supporting participants who face multiple barriers because they belong to more than one underrepresented cohort.

Programs in this suite, and programs to support women in STEM more broadly, mostly focus on supporting people to engage in STEM education.[48] There are gaps in support for underrepresented cohorts in the different STEM disciplines. For example, the *Big Mob: STEM it Up research report* identified a need for more support for First Nations people to engage in technology, engineering and mathematics.[49]

A different, more strategic, approach is needed to adjust these Women in STEM programs and fill program gaps. The dedicated advisory council proposed in Recommendation 1 can inform design of a strategic program suite that supports underrepresented cohorts from education to work.

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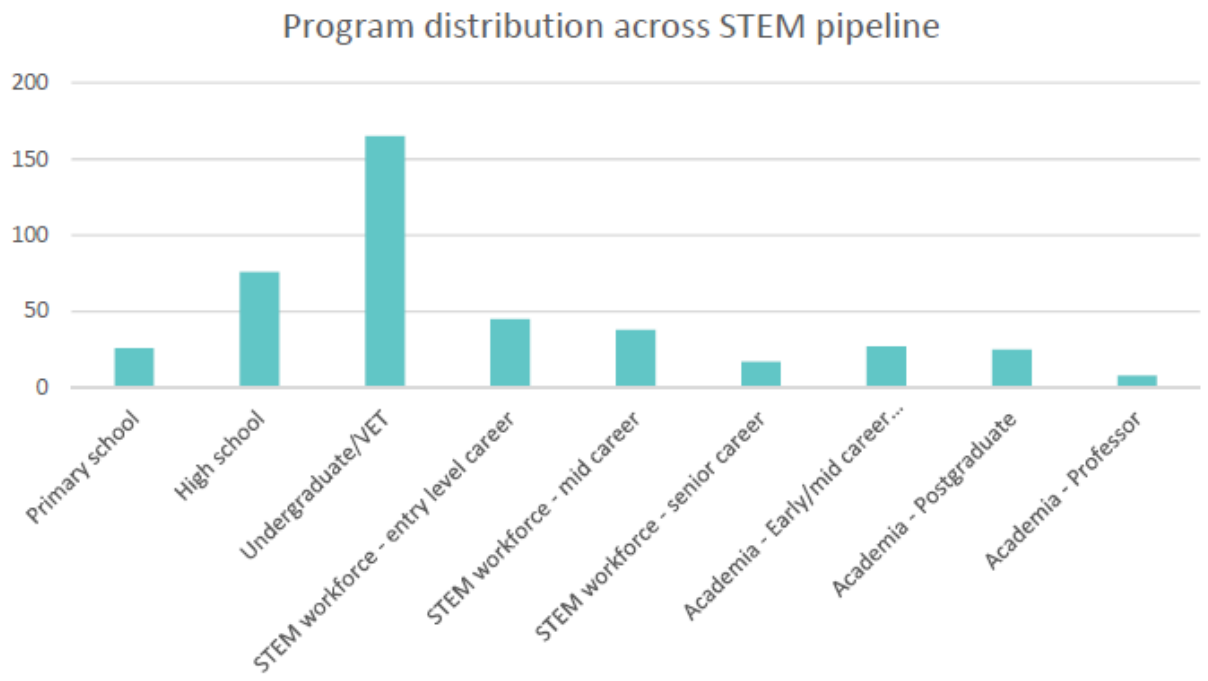
[48] Byrne, N., Dance, J., Flannery, G., Leeson, J., McCarron, L., Ovington, L., & Pratt, E. (October 2022). *Women in STEM programs: Environmental scan and gap analysis*. Internal report produced by the Department of Industry, Science and Resources.

[49] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z, Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

Figure 2: Program distribution across the STEM pathways. Source: *Women in STEM programs: Environmental scan and gap analysis* (2022)[50]



Filling gaps in support by drawing on lived experience

Future programs must be designed:

- to genuinely fill gaps in need
- in partnership with the people that the program aims to help
- to ensure grant processes encourage diversity in funded organisations and accessibility to diverse applicants, to increase the likelihood of programs meeting the needs of these applicants.

An example of a program that draws on the perspectives of participants to improve program design for people living with a disability is the Wallara Program.

[50] Byrne, N., Dance, J., Flannery, G., Leeson, J., McCarron, L., Ovington, L., & Pratt, E. (October 2022). *Women in STEM programs: Environmental scan and gap analysis*. Internal report produced by the Department of Industry, Science and Resources.

Wallara eMaking program and the MakerVan

Associate Professor Kirsten Ellis, inventor of TapeBlocks, has been working to create accessible STEM engagement activities through Monash University.

Associate Professor Ellis has a long-standing passion for STEM engagement for people with a disability. She developed TapeBlocks after realising there was a lack of resources for people living with a disability to learn about electronics. TapeBlocks are colourful, easy to connect blocks that can build circuits to run lights, fans and buzzers.

Her team is collaborating with Wallara Australia, a Victorian-based disability support organisation, to develop an evidence-based eMaking program for people with a disability. Associate Professor Ellis is committed to listening to participants to improve engagement and access to the program.

Associate Professor Ellis and her team found there wasn't as much engagement with the Inclusive Maker Space at Monash University as expected. After talking to participants, they found transport to the venue was a significant barrier. To address this, the team developed a 'MakerVan' that brings the program to the participants.

Since making its first journey in July 2023, the MakerVan now operates 5 days a week across 6 different Wallara sites and welcomes between one and 8 participants at each session.

Kirsten's experiences with TapeBlock and the Wallara eMaking program highlight the importance of listening and codesigning initiatives that go beyond a gender lens.

Her work challenges perceptions of STEM and how people living with a disability can engage with STEM when it is made accessible. Kirsten's work in this space was recognised with the 2022 Eureka Prize for STEM Inclusion.

Photo credit: Wallara Productions.

Making a long-term commitment based on evidence

Cultural and systemic change does not happen overnight. Governments and other program funders need to commit to evidence-based programs that support people throughout the STEM pathway.[51] Building in evaluation and flexibility to pivot the approach over time can ensure programs can work towards systemic and cultural change.

A commitment to long-term funding must be both informed by, and generate, evidence of impact. The review found a lack of evidence for which programs or initiatives attract and retain diverse people in STEM over the long term.[52,53] This can cause missed opportunities to scale successful initiatives or change unsuccessful ones.

‘To achieve increased inclusion and diversity in STEM, solutions must be evidence-based. Programs and initiatives must be backed by ongoing evaluation, and investments should be made to scale up effective programs.’[54] – Australian Academy of Science.

‘Better monitoring and evaluation of STEM diversity initiatives can ensure we identify and scale the interventions that are working and having the greatest impact, to ensure limited resources are being used as effectively as possible.’[55] – Tech Council of Australia.

[51] Submission to the Pathway to Diversity in STEM Review from Science and Technology Australia.

[52] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

[53] Submission to the Pathway to Diversity in STEM Review from the Australian Academy of Technological Sciences.

[54] Submission to the Pathway to Diversity in STEM Review from the Australian Academy of Science.

[55] Submission to the Pathway to Diversity in STEM Review from the Tech Council of Australia.

The below is an international example of how longer-term funding can impact cultural and organisational change.

National Science Foundation – ADVANCE program and Cultural Change in the Geoscience Community Program

In the United States, the National Science Foundation (NSF) takes a centralised approach to expanding opportunities in STEM to people of all racial, ethnic, geographic and socioeconomic backgrounds, sexual orientations, gender identities and people living with a disability. The NSF funds a range of programs to support diverse cohorts in different areas of STEM research and education, including through longer-term grants to drive a commitment to cultural and systemic change. The NSF also provides the infrastructure to collect, disaggregate, analyse and share data and information to support policy development and practice – including building connections across STEM institutions. [56,57]

One of the NSF programs is ADVANCE. It provides US$270 million to fund systemic change initiatives that create equitable and inclusive academic workplaces for all genders. ADVANCE has contributed to cultural change at more than 170 U.S. academic institutions.[58] It has also produced a body of knowledge on evidence-based practices to create institutional change. Two examples of success are below.

- The University of Washington received a grant to implement a number of effective practices to increase the representation and advancement of women in academic science and engineering careers. For example, through best practice equitable recruitment, retention and promotion practices. Over the course of a 5-year grant, the university reported a 28% increase in the number of women achieving tenure or tenure-track positions and an 18% increase in the number of women achieving the rank of professor. The University of Washington has sustained this effort to achieve the highest percentage of female faculty representation in 2015.[59]
- The University of Michigan implemented hiring practices that led to an increase in the proportion of women hired from 13% in 2003 to 31% in 2016. The University also developed best practices that could be translated to other settings.[60]

The NSF Cultural Change in the Geoscience Community (CCGC) program builds on the ADVANCE model to drive cultural change in the academic geoscience community, one of the

[56] National Center for Science and Engineering Statistics. (30 January 2023). *Diversity and STEM: Women, minorities and persons with disabilities*. https://ncses.nsf.gov/pubs/nsf23315/

[57] National Science Foundation. (July 2020). *Special report to the nation II: Building connections*. https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf20099

[58] Bell, R. (June 2023). Tackling sexism in science needs money, leadership and time. *Nature, 618, 435*. https://doi.org/10.1038/d41586-023-01925-x

[59] National Academy of Sciences, Engineering and Medicine. (2020). *Promising practices for addressing the underrepresentation of women in science engineering and medicine.* https://nap.nationalacademies.org/catalog/25585/promising-practices-for-addressing-the-underrepresentation-of-women-in-science-engineering-and-medicine

[60] Ibid.

least diverse STEM fields in the U.S., and support career advancement of underrepresented cohorts.[61]

Projects are funded for up to 5 years to increase scholarship, mentorship, equity, accessibility, and anti-racist and anti-harassment practices. Organisations can apply for a further 5 years of funding if they demonstrate effectiveness of the current project and can identify how a gap in support would be addressed with additional resources.[62]

One example of a program funded through CCGC funding is INSPIRE.[63] INSPIRE, funded for an initial 5 years in 2022, includes multiple approaches to transform culture, shift power and engage underserved communities in earth and environmental sciences. It provides mentoring, training and professional development activities, and uses storytelling to highlight diverse career pathways. The program focuses on retaining future leaders at transition points where they are often lost – before graduate school, and before tenure.

The program, while early in its implementation, demonstrates a dedicated effort to prioritise engagement and employment of historically underrepresented people and communities to ensure research is inclusive and representative of society's diverse needs and perspectives.

There are some encouraging examples of evaluation that can inform a common approach. Subscribers to Science in Australia Gender Equity's (SAGE) Pathway to Athena Swan program must collect quantitative data to inform their diversity and inclusion interventions. They use this data to monitor, evaluate and publicly report on progress and impact.[64] SAGE's multiple award system also encourages a longitudinal view for evaluating impact.

In another example, the ARC Centre of Excellence ASTRO 3D achieved 50% women representation over 5 years by using evidence-based measures. Drawing from sociology and psychology, ASTRO 3D designed a new evidence-based program aimed at increasing the number of women in astronomy. It found, among other factors, that designing equity into the program from the start, with regular progress monitoring, contributed to success in recruiting and retaining women in the field.[65] It also found the percentage of women in teams strongly correlated with having female team leaders, highlighting the importance of gender diversity in leadership.[66]

Best practice evaluation is not currently standard. Long-term impact evaluation must be built into program design, with findings centralised and shared across governments and sectors. This should include developing a monitoring and evaluation framework for diversity in STEM programs that will enable tracking of outcomes across the whole suite of programs against clearly defined outcomes.

The below case study shows how supporting people along the STEM pathway can generate impact.

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[61] Bernard, R.E. & Cooperdock, E.H.G. (30 April 2018). No progress on diversity in 40 years. *Nature Geoscience*, 11. https://doi.org/10.1038/s41561-018-0116-6

[62] National Science Foundation. (23 December 2022). *Cultural transformation in the geoscience community*. https://new.nsf.gov/funding/opportunities/cultural-transformation-geoscience-community-ctgc

[63] INSPIRE-Geoscience. (2023). *Inspire*. INSPIRE-geoscience https://inspire-geoscience.org

[64] Science in Australia Gender Equality (SAGE). (2022). *Sage Pathway to Athena Swan*. https://sciencegenderequity.org.au/sage-accreditation-and-awards/sage-pathway-to-athena-swan

[65] Submission to the Pathway to Diversity in STEM Review from ARC Centre of Excellence ASTRO 3D. Further information can be found here: https://www.scienceinpublic.com.au/media-releases/astro3d-kewley-natureastronomy

[66] Kewley, L.J., Wyithe, J.S.B., Tran, KV. & McCarthy, I. (2023). The achievement of gender parity in a large astrophysics research centre. *Nature Astronomy.* https://doi.org/10.1038/s41550-023-02079-6

The Young Indigenous Women's STEM Academy

The Young Indigenous Women's STEM Academy is an example of a program that supports First Nations women to engage in STEM education, from Year 8 through to tertiary education and into the workforce.

The National Indigenous Australians Agency has provided $20 million of funding through the *Indigenous Advancement Strategy* from 2018 to 2028. CSIRO delivers the program in consortium with CareerTrackers.

Participants are provided a culturally safe and inclusive environment with targeted, long-term mentoring and support. Support can include a dedicated Academic Coordinator (9 out of 10 are First Nations women), individual learning plans, STEM experience (such as camps and work placements), and in some instances financial assistance.

Halfway through Year 12, participants transition to the tertiary element of the program. They receive ongoing mentoring and support to navigate the tertiary environment. They are also linked to employers through paid multi-year internships.

In October 2023, 599 women were participating in the academy. Some key outcomes include:

- participants from the first Year 8 cohort of the Young Indigenous Women's STEM Academy are now in Year 12. Of these participants, 73 are considering tertiary pathway options in STEM. This translates to a 95% school retention rate, compared to the national retention rate of 63% for female First Nations students
- 16 participants have graduated from university and are either undertaking further tertiary education or working in their chosen STEM field
- over 80 individual STEM experiences have been delivered
- a network of female First Nations STEM professionals has been created.

Some successful elements of the program design include:

- co-designing the program with First Nations people
- employing predominantly First Nations people to lead and deliver the initiative
- fostering collaborative partnerships with other organisations to provide more holistic and targeted support
- providing individualised support, including monthly check-ins, national assemblies and virtual STEM experiences.

ARTD is currently evaluating the academy to assess the impact of the initiative and how it could be refined.

Improving data collection to improve decision-making

In Australia, the STEM Equity Monitor provides a strong foundation to improve data collection and track progress over time. The STEM Equity Monitor is an annual national data resource of girls' and women's participation in STEM. First released in 2020, it addresses the need to collate various data sources to understand how girls and women engage in STEM. The monitor is in its fourth year. The aim is to provide an evidence base over 10 years to ensure policies and programs are designed to support women engaging in the STEM pathway.

The monitor should be continued and expanded to inform future policy and program design, under the guidance of the advisory council. It should track long-term progress and provide insights on engagement beyond gender and First Nations status. This includes capturing more data on the unique barriers and opportunities for different underrepresented cohorts in STEM education and careers.

A consistent and centralised approach to evaluation, data collection and information sharing can:

- drive investments in programs that are evidence-based and impactful
- identify where additional efforts are needed.

> ‘Data coordination and sharing via a central body could provide data driven insights for program funders, designers and evaluators to understand the evidence of problems and solution needs to inform effective interventions.’[67] – CSIRO

Photo credit: CSIRO.

[67] Submission to the Pathway to Diversity in STEM Review from Commonwealth Scientific and industrial Research Organisation (CSIRO).

Creating safe and inclusive workplaces

Every Australian organisation employing STEM workers must eliminate bullying, harassment and discrimination.

Recommendation 3

The panel recommends that every Australian organisation employing STEM workers, including the Australian Government, commit to eliminating bullying, harassment and discrimination, including racism, as the foundation of a safe and inclusive workplace.

This will require governance, transparency and accountability measures, including obligations for senior leaders, that go beyond existing work health and safety requirements.

Organisational governance, transparency and accountability measures to eliminate bullying, harassment and discrimination should be implemented as part of broader workplace diversity and inclusion measures. This is outlined at Recommendation 4.

A further role for the Australian Government in supporting this recommendation is outlined at Recommendation 5.

Key considerations for this recommendation

Implementing this commitment will demonstrate leadership in safety and inclusion for employees, funding bodies and the public. Successfully implementing this commitment means:

- adopting a 'positive duty' through preventative and proactive action
- there is a culture of reporting, respect and safety
- there are consequences for perpetrators and documented processes for managing allegations and findings
- mismanaging allegations carries consequences for senior leaders and the organisation that reflect the harm that bullying, harassment and discrimination causes.

Why we recommend this

Safe and inclusive workplaces are critical for attracting and retaining people in STEM jobs. It is unacceptable for people to feel unsafe because they are being bullied, harassed or discriminated against.

The terms 'bullying', 'harassment' and 'discrimination' broadly follow definitions of the Australian Human Rights Commission.[68] In this report, these terms include any behaviours or conduct that creates hostile work environments, particularly sexual harassment and assault. Discrimination and harassment on the grounds of gender, race, sexual orientation, disability status or age is unacceptable.

Creating safe and inclusive workplaces is not exclusive to organisations employing STEM workers. However, less diverse and inclusive workplaces, such as those in STEM sectors, can perpetuate bullying, harassment and discrimination. For example, the Human Rights Commissions' *Respect@Work* report identifies gender inequality as the key power disparity that drives sexual harassment.[69]

Workplace sexual harassment continues to be unacceptably high, with 41% of women experiencing sexual harassment at work between 2017 and 2022.[70]

Organisations, including government, industry and academia, must take immediate and deliberate action to eliminate bullying, harassment and discrimination. These actions must be consistent, reasonable and proportionate to the conduct.

Future actions and initiatives developed by the Australian Government, including by the dedicated advisory council proposed in Recommendation 1, will need to align with work underway to eliminate bullying, harassment and discrimination. This work includes the *Respect@Work* report and platform, which provides resources for government and the private sector to fulfil their obligations to prevent and address workplace sexual harassment.[71] This work also includes implementation of Priority Reform Three of the National Agreement on Closing the Gap, which commits all Australian governments to identify and eliminate racism.[72,73]

Bullying, harassment and discrimination in STEM workplaces

Bullying, harassment and discrimination are significant and pervasive barriers which deter individuals from pursuing higher education and careers within STEM sectors. People who are

[68] Australian Human Rights Commission. (2014). *Workplace discrimination, harassment and bullying*. https://humanrights.gov.au/our-work/employers/workplace-discrimination-harassment-and-bullying

[69] Australian Human Rights Commission. (2020). *Respect@Work: Sexual harassment national inquiry report.* https://humanrights.gov.au/our-work/sex-discrimination/publications/respectwork-sexual-harassment-national-inquiry-report-2020

[70] Department of the Treasury. (2023). *Working future: The Australian Government's white paper on jobs and opportunities.* Australian Government. https://treasury.gov.au/employment-whitepaper/final-report

[71] Australian Public Service Commission. (10 February 2023). *Preventing and responding to sexual harassment in the APS.* Australian Government. https://www.apsc.gov.au/working-aps/diversity-and-inclusion/resources/preventing-sexual-harassment

[72] Australia, & Australian Capital Territory, & Australian Local Government Association, & New South Wales, & Northern Territory, & Queensland, & South Australia, & Tasmania, & Victoria, & Western Australia, & Coalition of Aboriginal and Torres Strait Islander Organisations. (2020). *National Agreement on Closing the Gap.* https://www.closingthegap.gov.au/national-agreement

[73] Department of the Treasury. (2023). *Working future: The Australian Government's white paper on jobs and opportunities.* Australian Government. https://treasury.gov.au/employment-whitepaper/final-report

subject to bullying, harassment and discrimination often experience serious mental, economic and physical harm.[74]

A recent survey of researchers indicated 25% of respondents were considering leaving research for these reasons.[75,76] Engagement undertaken by the review has consistently shown this, as has research by Australia's Women in STEM Ambassador.[77]

A recent report, which collected results from a survey of 130 engineering industry respondents, found that:

- more than 1 in 5 respondents had experienced physical sexual harassment or assault. Even more women had experienced verbal, online or intimidating forms of sexual harassment
- regardless of gender, people experienced bullying and aggressive cultures, including verbal abuse, belittling, physical harassment and threats
- there are gaps in the execution of existing policies against harassment and discrimination.[78]

Research has also found that people identifying as LGBTQIA+ are disproportionately affected by informal forms of workplace discrimination, exclusion and harassment.[79] A submission to the review from Queers in Science notes that:

- 1 in 3 LGBTQIA+ individuals experiences discrimination or harassment in STEM workplaces
- in academic settings, LGBTQIA+ students are more likely to withdraw from STEM fields.[80]

Further research identified systemic discrimination during workplace recruitment processes. A large-scale field experiment conducted by Adamovic and Leibbrandt investigated discrimination during hiring.[81] The researchers found new evidence of a glass ceiling for ethnic minorities seeking employment in both leadership and non-leadership positions. They sent over 12,000 job applications, containing identical resumes but differing in whether the name was English or non-English, to 4,00 job advertisements across Australia. The experiment showed that ethnic minorities receive 45% fewer positive responses for non-leadership positions, and 57% fewer positive responses for leadership positions.

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[74] Australian Human Rights Commission. (2020). *Respect@Work: Sexual harassment national inquiry report.* https://humanrights.gov.au/our-work/sex-discrimination/publications/respectwork-sexual-harassment-national-inquiry-report-2020

[75] Australian Council of Learned Academies. (2023). *Research assessment in Australia: Evidence for modernisation*. The Office of the Chief Scientist, Australian Government. https://www.chiefscientist.gov.au/ResearchAssessment

[76] Department of Education. (2023). *Australian Universities Accord interim report*. Australian Government. https://www.education.gov.au/australian-universities-accord/resources/accord-interim-report

[77] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

[78] Gayen, M. & Nixon, C. (2023). *Creating cultural change to support gender equality in the Australian oil, gas and pipeline industry*. https://apga.org.au/research-and-other-reports/creating-cultural-change-to-support-gender-equality-in-engineering-and-in-the-oil-gas-and-pipeline-industry

[79] Perales, F. (2022). Improving the wellbeing of LGBTQ+ employees: Do workplace diversity training and ally networks make a difference?. *Preventive Medicine*, 161. https://doi.org/10.1016/j.ypmed.2022.107113

[80] Submission to the Pathway to Diversity in STEM Review from Queers in Science.

[81] Adamovic, M., & Leibbrandt, A. (2023). Is there a glass ceiling for ethnic minorities to enter leadership positions? Evidence from a field experiment with over 12,000 job applications. *The Leadership Quarterly*, 34(2), 101655. https://doi.org/10.1016/j.leaqua.2022.101655

These examples demonstrate significant occurrences of bullying, harassment and discrimination. This prevents Australian organisations employing STEM workers from being safe, inclusive and attractive workplaces. It also prevents individuals from underrepresented cohorts from fully accessing and belonging to workplaces.

As a result, organisations are unable to draw on the full diversity of knowledge and talent within Australia. This limits the effectiveness and growth potential of organisations that rely on STEM-skilled people.

A clear commitment to addressing these issues is a major opportunity to break the cycle and create a culture that celebrates the diversity within Australia.

Rio Tinto *Everyday respect report*

The *Everyday respect report* is an example of how industry can drive cultural change to address bullying, harassment, and discrimination.

Rio Tinto is one of the world's largest mining companies, employing over 45,000 people in 35 countries. Following an increased social focus on safety and workplace dynamics, as well as recent decisions drawing heavy criticism in Australia, Rio Tinto engaged an external expert to review its workplace culture.

The *Everyday respect* report was an independent review commissioned in 2021 and published in February 2022. The report found that:

- bullying is systemic and experienced by almost half of the survey respondents (48%), but is more commonly experienced by women
- sexual harassment and everyday sexism occur at unacceptable rates
- racism is common
- harmful behaviour occurs between employees, managers and leaders. It is often tolerated or normalised, and can be an 'open secret'
- employees believe there is little accountability for senior leaders and 'high performers', who are seen to avoid consequences for harmful behaviour.

In response to the above findings, *Everyday respect* makes 26 recommendations across 5 distinct areas:

- caring, courageous and curious leadership
- creating a positive onus to prevent harmful behaviour
- caring and human-centred responses to disrespect and harmful behaviour
- ensuring appropriate facilities for all as a precursor to dignity and safety at work
- embedding, sustaining, monitoring and evaluating progress of cultural reform.

Rio Tinto is currently in the planning and co-design phase of its response. The intention is for this to ensure that it develops the right solutions for real impact in a way that takes local contexts into account. Initial actions include:

- leadership training around psychological safety

- assessing and updating facilities to make them safer and more inclusive
- tracking and reporting progress against recommendations to the executive committee and the board.

Implementation and impact metrics are not yet available for these measures. However, Rio Tinto recognised a problem, engaged external experts and took the findings seriously. This is a strong example of industry self-reflecting and changing to ensure a more welcoming and accepting environment for people from diverse cohorts.

The response to the report has promoted organisational change within the organisation and the sector more broadly. It has prompted other reviews on its workplace culture (for example, at the Gold Fields Mine).

Photo credit: Engineers Australia.

Taking action to eliminate bullying, harassment and discrimination

Eliminating bullying, harassment and discrimination will take sustained effort and cultural change across organisations and by governments. This must go beyond putting policies in place or making a commitment alone. These policies must be backed up with formal compliance and accountability mechanisms, and clear buy-in from leadership. Individuals must be provided with a safe and anonymous mechanism to report instances of bullying, harassment and discrimination.

Processes for managing allegations and findings of misconduct should align with legal requirements for reporting and compliance. For example, adhering to the Guidelines for Complying with Positive Duty under the *Sex Discrimination Act 1984* (Cth).[82]

Recommendations 4 and 5 cover these issues and outline ways to implement this commitment in more detail.

A submission from Queers in Science outlined the need for a multifaceted approach:

[82] Australian Human Rights Commission. (9 August 2023). *The positive duty under the Sex Discrimination Act*. https://humanrights.gov.au/our-work/sex-discrimination/projects/positive-duty-under-sex-discrimination-act

‘Institutes and organisations must implement inclusive policies, engage executive leadership, and employ both top-down and bottom-up strategies. Systemic inclusion in policies (such as gender affirmation policies), processes (including HR practices like onboarding, recruitment, and promotions), systems (such as IT systems and forms), and infrastructure (such as gender-neutral bathrooms) is essential. The Australian Workplace Equality Index by Pride in Diversity offers a comprehensive benchmark for LGBTQIA+ workplace inclusion.’ [83] – Queers in Science

The Women’s Economic Equality Taskforce also recognised the importance of supporting women to take action against discrimination. Its final report recommends strengthening the capacity of women to access representation when seeking action against discrimination. It also recommends ensuring institutions (such as the Office of the Sex Discrimination Commissioner and Fair Work Commission) are appropriately resourced to meet demand.[84]

Unconscious bias must also be considered and addressed by organisations employing STEM workers. People can often be unaware of their biases, but bias is a significant factor underlying bullying, harassment and discrimination. This is something that everyone must grapple with as individuals. However, organisations must acknowledge that unconscious bias exists pervasively and systemically. Ways to counteract and limit the effect of unconscious bias, through well-designed policies and processes, should be considered and implemented across STEM.

[83] Submission to the Pathway to Diversity in STEM Review from Queers in Science.

[84] Women’s Economic Equality Taskforce. (2023). *A 10-year plan to unleash the full capacity and contribution of women to the Australian economy*. Australian Government. https://www.pmc.gov.au/resources/10-year-plan

Australian Council of Graduate Research – Respectful Research Training

The Respectful Research Training resource suite is an example of resources to address harmful behaviours that institutions can tailor to their specific context for promising results.

The Australian Council of Graduate Research (ACGR) is a not-for-profit peak body of university Deans and Directors of Graduate Research. Its mission is to promote excellence in research training and improve national standards for all graduate research degree programs. Since research students are vulnerable to sexual harassment, gender bias and discrimination, the organisation developed the Respectful Research Training resources to help address these behaviours. The resources were launched in 2018.

The Royal Melbourne Institute of Technology (RMIT) adapted the learning materials into a complete learning program for their institutional context. RMIT's senior executive endorsed the program, and mandated this training for all supervisors.

'This strong executive support enabled additional resourcing and allowed the program to be framed as part of the university's broader response to Change the Course and leverage off the range of existing campaigns under the banner of respect.'[85]

As of April 2023, all existing supervisors (around 1400 academics) had completed the training. This program is also a requirement for all research candidates commencing from 2023. RMIT have 2 evaluation mechanisms in place: post-seminar supervisor evaluations and a comprehensive participant evaluation.

Results to date are promising, with 250 participating supervisors giving the program a mean score of 4.5 out of 5. Supervisors are also showing improvement across every item tested. However, it is too soon to know whether the cultural changes sought will be fully realised in terms of measurable impacts and outcomes.

Researchers from RMIT formed the view that programs like this have the potential to raise important awareness and increase participants' confidence to deal with critical situations. However, the researchers note that this approach does not significantly address the underlying causes of gender-based violence.

For further information, see the full article on the ACGR website.

The review revealed a clear need for targeted action to keep more people in academic and scientific careers. Recommendation 4 includes the importance of recognising findings of bullying, harassment and discrimination as scientific and academic misconduct. Several submissions to the review were supportive of this suggestion, including those from:

- SAGE
- the Early and Mid-Career Researcher Forum
- the Regional Universities Network
- the Space, Spatial, Surveying Diversity Leadership Network.

The panel also heard this directly through engagement with stakeholders throughout the sector.

[85] Barnacle, R., Cuthbert, D., & Sidelil, L. T. (2023). *Adapting the ACGR Respectful Research Training resource to lead change at RMIT*. https://www.acgr.edu.au/impact-blog/adapting-the-acgr-respectful-research-training

A submission from professors Denise Cuthbert, Kay Latham and Nicola Henry; Associate Professors Robyn Barnacle and Ceridwen Spark; and Dr Leul Sidelil proposed that:

‘… a positive duty to achieve acceptable GEDI [gender, equality, diversity and inclusion] participation in STEMM organisations is imposed on STEMM organisations and that consequences should flow from failure to meet acceptable levels of participation.
Accountability via a positive duty should rest with leaders of organisations and cascade to all management levels.
Failure to achieve acceptable levels of gender, equity, diversity, and inclusion within a nominated time frame should disqualify organisations from bidding for government business and receiving government funding, including research funding.’ [86] – RMIT Respectful Research and Women in STEMM Research Team

[86] Submission to the Pathway to Diversity in STEM Review from Professors Denise Cuthbert, Kay Latham and Nicola Henry, Associate Professors Robyn Barnacle and Ceridwen Spark, and Dr Leul Sidelil.

Organisations employing STEM workers must create inclusive workplaces that value diversity.

Recommendation 4

The panel recommends that every organisation employing STEM workers, including in the Australian Government, adopt and make public a plan to increase attraction, retention and promotion of underrepresented cohorts, and commit to implement it in full. The Workplace Action Framework should form the basis of this work.

A further role for the Australian Government in supporting this recommendation is outlined at Recommendation 5.

Photo credit: Engineers Australia.

Workplace Action Framework

Organisations employing STEM workers should:

Develop policies for management and oversight	Embed actions to support and change behaviour	Demonstrate accountability and transparency to accelerate change
Create a safe and inclusive environment		Set measurable objectives and track progress. Benchmark against industry peers and leading practice.
Have and disclose values and a code of conduct and have a confidential and anonymous reporting system.	Establish clear consequences, investigate adverse behaviour[87] promptly, and enforce disciplinary action.	
Have and disclose a diversity strategy.	Deliver mandatory training programs to develop inclusive attitudes and behaviors.	Objectively assess actions to increase diversity e.g. through an independent audit.
Attract and recruit underrepresented talent		
Have and disclose an equal employment opportunity policy.	Implement inclusive hiring practices and regulatory education for hiring managers.	Disclose to the board actions taken to address adverse behaviour and progress towards achieving diversity objectives.
Establish a structured compensation model with standardised pay steps.	Commit to pay equity at point of hire and throughout an employees' career.	
Retain and support underrepresented talent		Introduce inclusion as a core competency for leaders and link diversity objectives to performance and compensation.
Have and disclose policies that demonstrate a commitment to inclusion.	Offer flexible working as 'opt-out' and ensure workplaces are accessible by default.	
Establish recognition and reward systems that eliminate bias and ensure equity.	Set up employee networks to provide support, inspiration and engagement.	Publicly disclose wage statistics and all strategies, policies, progress and data related to diversity.
Develop a skills matrix and succession plan to identify future leaders.	Create programs for future leaders to develop leadership skills and connections.	Investigate and address disparity in hiring and promotion rates amongst underrepresented groups.
Establish a culture of continuous improvement		
Establish a framework to monitor and assess the success of all initiatives.	Implement changes based on regular monitoring and assessment of outcomes.	

[87] Adverse behaviour includes bullying, harassment and discrimination, including racism.

Key considerations for this recommendation

Plans should:

- expand existing efforts (including those based on legislative requirements), not duplicate them
- build on the actions in the Workplace Action Framework, incorporating evidence-based policies and programs
- include explicit actions to eliminate bullying, harassment and discrimination
- be ambitious and tailored for the context of the organisation
- be evaluated and updated regularly.

Improved governance, transparency and accountability measures should include:

- providing the plan to all employees and making it publicly available and easy to find
- reporting publicly on progress implementing the plan
- tying executive and board evaluation to effective governance and delivery of the plan
- organisation-wide training for leaders on safety and inclusion as key components of organisational productivity and success
- completing regular independent audits on bullying, harassment and discrimination policies and procedures and reporting outcomes and actions to the board/governing bodies
- recognising findings of bullying, harassment and discrimination by researchers as academic and scientific misconduct. This approach should be taken within organisations and by funding bodies.

Why we recommend this

The need for workplace cultural change is not unique to STEM sectors but is critical in a labour market that is competitive for STEM-qualified employees. The imperative for rapid change is clear. Employers must fix the workplace practices that are forcing people out of STEM occupations—research by the Office of Australia's Women in STEM Ambassador has reinforced this.[88] Doing this will enable firms to perform better and deliver greater returns on assets. Recent research published by Blackrock found that there was a robust link between workforce diversity and corporate performance.[89]

Culture is created and sustained at all levels of an organisation but, to create real change, the shift must start with the behaviours of leaders. The board and senior leadership of organisations employing STEM workers need to have a clear strategic plan, with strong accountability and transparency, to increase safety, diversity and inclusion in the workplace.

The actions outlined in the Workplace Action Framework above provides a basis to build a strategic plan and accelerate cultural change. This recommendation does not suggest replacing

[88] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

[89] Blackrock. (November 2023). *Lifting financial performance by investing in women*. https://www.blackrock.com/corporate/literature/whitepaper/lifting-financial-performance-by-investing-in-women.pdf

existing diversity and inclusion plans. Instead, it recommends building and strengthening existing actions. This includes ensuring:

- policies are in place to clearly outline behavioural expectations and the organisation's commitment to inclusivity
- programs and initiatives, that are evidence-based, are implemented to ensure policies are acted upon
- strong accountability and transparency to ensure people are putting practices in place, and that they are working.

For example, in the Australian Public Service, this would mean building on existing and future diversity and inclusion strategies to support employment and retention of employees living with a disability, and Aboriginal and Torres Strait Islander, CALD (culturally and linguistically diverse), and gender diverse employees.

This recommendation also recognises that different organisations may require different actions based on their size, complexity, history and structure. The actions in the Workplace Action Framework, together with the Toolkit for Employers at the end of this section, offers leading practice examples and resources which can be readily tailored, adopted, and built upon.

Leadership, accountability and transparency

Creating safe and inclusive workplaces must start with commitment from boards and senior leadership, and accountability for them to drive change. This includes what they say, what they do, what they prioritise and what they reward.

Inclusion is much more about actions than words. Boards and senior leadership must set the tone, sending the message that inclusion is not just a slogan but is genuinely valued and respected. Aspirational objectives such as 'achieving a culture of inclusion' are unlikely to be effective. Words need to be backed up by accountability and transparency mechanisms, such as appropriate numerical targets, audits of policies and practices, and regular monitoring and reporting.[90]

Organisations should be transparent about their efforts to create safe and inclusive workplaces. They should regularly monitor and publicly report on progress. Increasing transparency not only enables continuous improvement but can attract a wider pool of diverse talent.[91]

Senior leadership needs to ensure middle managers are accountable for safety and inclusivity. These managers greatly influence the day-to-day experiences and career opportunities of diverse groups working in STEM organisations.[92] This is important because often the message gets 'lost in the middle'.[93]

[90] ASX Corporate Governance Council. (February 2019). *Corporate Governance Principles and Recommendations*. https://www.asx.com.au/about/regulation/asx-corporate-governance-council

[91] Submission to the Pathway to Diversity in STEM Review from Dr Deborah Devis.

[92] Williamson, S., Colley, L., Foley, M., & Cooper, R. (2018). *The role of middle managers in progressing gender equity in the public sector*. https://www.unsw.adfa.edu.au/sites/default/files/documents/Middle-Managers-and-Gender-Equity.pdf

[93] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

Board

Establish and commit to a plan for achieving safety, diversity and inclusion in STEM.

Set the **tone from the top.**

Maintain **oversight.**

Senior Leaders

- **Implement and monitor** actions to increase safety, diversity and inclusion in STEM.
- **Demonstrate leadership** of safety, diversity and inclusion in STEM.
- Incorporate safety, diversity and inclusion into all **business practices.**

Middle Managers

- **Demonstrate alignment** to safety, diversity and inclusion through decisions related to recruitment, remuneration and incentives.
- Drive **organisational change** programs to ensure safety, diversity and inclusion in STEM.

Audit

- **Assess** how safety, diversity and inclusion is being managed.
- Provide an **objective assessment** of all actions and associated business practices.

Inclusive management and practice should be a core competency for leaders with outcomes linked to performance evaluations and remuneration. Leaders should be supported with mandatory and ongoing education on how to drive equity and inclusion.[94]

An example of a STEM organisation embedding diversity and inclusion in its leadership structure is Salesforce. Salesforce has a Chief Equality Officer and an Office for Equality in the United States which supports Salesforce offices across the globe to tailor diversity and inclusion practices. In

[94] Submission to the Pathway to Diversity in STEM Review from Professors Denise Cuthbert, Kay Latham, Nicola Henry, Associate Professors Robyn Barnacle, Ceridwen Spark, Dr Leul Sidelil.

Australia, this includes establishing networks that supports First Nations people, women and those who have caring responsibilities.

Creating a safe and inclusive environment

Organisations must create safe workplaces that are free of bullying, harassment and discrimination. Recommendation 3 outlines the importance of eliminating these behaviours to accelerate progress on diversity in STEM.

Organisations should adopt and promote a statement of values and code of conduct that clearly outline behavioural expectations.[95] These values must be embedded in everything an organisation does. Policies should be supported by programs and initiatives[96] to ensure:

- employees understand these expectations
- employees know how they can help eliminate bullying, harassment and discrimination
- there is a clear mechanism for employees to confidentially report breaches of the code of conduct.

Diversity and inclusion policies and practices must be monitored and enforced. Senior leadership and middle management must take immediate and visible action where there is a gap between values and conduct.[97] Organisations must promptly investigate conduct-related matters, report them to the board or equivalent body, and enforce the consequences. Increasing employee trust in restorative actions creates an environment where employees are confident in reporting incidents.[98]

Pate and Beaumont report an example of accountability being demonstrated through a zero-tolerance policy. The policy resulted in the termination of several employees, some of them quite senior.[99] Perceptions of bullying at the workplace dropped from half of employees reporting it to be a problem to one quarter over the course of 3 years.[100]

Organisations must also ensure that workplace respect, health and safety barriers to inclusivity are addressed, particularly in male-dominated industries. For example, the Women's Economic Equality Taskforce recommended providing access to safe, secure and dedicated facilities such as bathrooms, uniforms and protective equipment.[101] This should also include providing accommodation for cultural or faith practices.

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[95] ASX Corporate Governance Council. (February 2019). *Corporate Governance Principles and Recommendations*. https://www.asx.com.au/about/regulation/asx-corporate-governance-council

[96] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

[97] Ibid.

[98] Ibid.

[99] Pate, J., & Beaumont, P. (2010). Bullying and harassment - A case of success? *Employee Relations, 32*(2), 171-183. https://doi.org/10.1108/01425451011010113

[100] Ibid.

[101] Women's Economic Equality Taskforce. (2023). *A 10-year plan to unleash the full capacity and contribution of women to the Australian economy*. https://www.pmc.gov.au/resources/10-year-plan

Attracting and recruiting underrepresented talent

Research shows that some candidates choose not to pursue a role because of a perceived lack of inclusion at an organisation.[102] Organisations can be more attractive employers if they get diversity and inclusion practices right.

Recruitment policies and practices are also essential. Recently, *Working future: The Australian Government's white paper on jobs and opportunities* highlighted that discrimination and unconscious bias can adversely affect migrant employment outcomes. It revealed that many employers, particularly in STEM fields, were less likely to offer interviews to women and people from certain ethnic backgrounds. It also showed that 1 in 3 HR professionals reported they would not hire someone over 50.[103]

Organisations must examine and adjust their recruitment and hiring practices. They must avoid practices that perpetuate biases stopping them from drawing on a full and diverse talent pool.

The ASX Corporate Governance Council recommends using a skills matrix to set out the mix of skills that boards currently have or are looking for. The skills matrix technique can be applied across broader workforce planning initiatives. This will help achieve wider workforce representation and strategies to attract and recruit diverse and underrepresented talent.

'I wish there were positions available that had disability-friendly workloads. A career in academia or industry is almost impossible for me, although I would have loved to have been a lecturer and researcher. It is difficult to be competitive if you aren't full time due to perceptions, overall output, and reduced access to grants.'
– Anonymous submission.

[102] McKinsey & Company. (June 2020). *Understanding organisational barriers to an inclusive workplace*. https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/understanding-organizational-barriers-to-a-more-inclusive-workplace

[103] Department of the Treasury. (2023). *Working future: The Australian Government's white paper on jobs and opportunities*. Australian Government. https://treasury.gov.au/employment-whitepaper/final-report

BHP South Flank – commitment to achieve gender equity

South Flank is a remote iron ore mine in Western Australia operated by BHP. This site has created the most gender-balanced large mine in Australia. The workplace has achieved 40% female representation out of the 869 frontline employees and 4 out of 6 senior managers are women.

Mining industries are traditionally male dominated. On average, women comprise 10% of the workers at large mining sites globally.[104] In 2016, BHP made a commitment to achieve gender balance across their global workforce by 2025.

BHP commissioned researchers from Monash University to deliver 5 workshops for South Flank's leaders on changing sexist and homophobic behaviours in traditionally male-dominated settings. While delivering the workshops, the consultants became aware of the progress on gender equity the mine had made. This prompted the researchers to study (via observations and interviews) how the mine has improved gender equity and inclusion of women.

The research identified the following key factors:

- leaders were engaged at all levels (including middle management) to attract and retain women in the mine
- senior leaders (including from the head office) set strict gender equity targets
- major investment was made to improve the safety and culture at the mine (for example, village amenities and security design measures, and limits on alcohol consumption)
- South Flank adopted purpose-built programs and used science and data-driven approaches to drive change
- the mine recognised that systemic change requires focus and ongoing work to sustain results.

South Flank's progress was driven by strong engagement from senior leaders, recognising that workplace diversity does not happen with time or through mandatory online training. This type of change happens through deep engagement and hard work from leaders at all levels of operation. Ongoing investment to develop cultural change in the workplace creates sustainable progress.

For further information, see the full article.

[104] International Labour Organization. (27 September 2021). *Women in mining: Towards gender equality*. https://www.ilo.org/sector/Resources/publications/WCMS_821061/lang--en/index.htm

Photo credit: BHP.

Retaining and supporting underrepresented talent

Flexible working and leave policies can lead to a more inclusive and supportive workplace culture. People with caring responsibilities, or different physical or cognitive needs (such as people living with a disability or neurodivergent people), have a greater opportunity for equal participation if their employer supports them to balance these needs.[105] Flexible working policies work best when they are provided by default - this reduces the guilt or stigma employees may feel if they are required to 'opt-in' or request flexible arrangements.[106]

Indigital

Indigital is an Indigenous led company working with critical technology organisations to ground their work in First Nations Country and Culture. Led by Mikaela Jade, a Cabrogal woman of the Dharug-speaking nation and one of the Diversity in STEM Review Panel members, Indigital integrates First Nations heritage and culture into all aspects of their products and their own organisation.

The Indigital workforce comprises 60% employees who identify as First Nations people and 90% female. To support all employees to take regular breaks and spend time with friends and family on Country, Indigital provides four weeks of paid 'Indigital Leave' over and above annual leave. In addition, all employees have the flexibility to work from a location that suits them, allowing them to stay on Country. This flexibility supports employees to balance work and their personal lives, enabling them to participate in the STEM workforce in a way that makes space for culture, connection and wellbeing.

Indigital recognises the importance of providing employees with the opportunity to devote time to care for their newborn, adopted, surrogate or long-term fostered children without disadvantaging their career. All primary carers can take up to 18 weeks of paid parental leave, and secondary carers receive 4 weeks paid leave. Employees can take this leave flexibly (in one block or multiple) and also receive superannuation payments while on paid parental leave.

'Despite being a small, growing business, we are committed to finding ways to support our people to balance work and commitment to their families, Country and Culture. In developing our policies we were told that it wouldn't be possible to provide the same parental leave benefits large organisations do and that providing an additional four weeks leave wouldn't be sustainable. We challenged this and have demonstrated the value these policies bring in supporting strong employee engagement, wellbeing and retention of great people,' said Mikaela Jade, CEO and Founder.

Who is Indigital?

Indigital is an Indigenous led profit-for-purpose company. Through their Connecting with Country programs, Indigital collaborates with Elders and Knowledge Holders to incorporate Indigenous ways of knowing, being and doing into development of critical technology infrastructure. Indigital's

[105] Science and Technology Australia. (2023). *STEM career pathways major research report*. https://www.chiefscientist.gov.au/STEM-CareerPathways

[106] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

education business works with schools and communities to teach kids and adults technology skills through an Indigenous lens.

Workplaces should accommodate different physical and cognitive needs. This might include providing supportive technology and accessible resources, processes and environments. Workplaces can optimise accommodations for staff living with a disability by consulting and collaborating with the employee and stakeholders working in disability services.[107]

Proactive strategies to retain and promote diverse employees in leadership positions benefits organisational performance and can further drive efforts to increase diversity and inclusion from the top.

One of the strongest indicators of organisational leadership's true values is who gets rewarded and promoted. When the basis for these decisions is unclear or communicated informally, the process is susceptible to bias. This makes it harder for underrepresented groups to understand the pathway for promotion and progression.

Organisations employing STEM workers should ensure processes for remuneration and incentives (including promotions) are transparent. Organisations can develop a succession plan using a skills matrix to identify future STEM leaders. They should address any skill gaps by implementing programs that focus on developing diverse employees and preparing them for leadership roles.

Organisations must recognise employee efforts to advance diversity and inclusion in the workplace as part of decisions on promotion and career progression. Organisations must also provide the time and resources for employees to undertake these activities when they are on top of their day-to-day work. This is important as the responsibility for inclusion initiatives frequently falls on the shoulders of a few individuals. These people are often from minority groups, with limited resources and authority to effect change.[108]

Allyship is a way to reduce the burden on individuals from underrepresented groups to effect cultural and organisational change. Allyship is where individuals actively advocate and support those who identify as being in underrepresented cohorts. The Champions of Change Coalition STEM Group is an example of an initiative designed to recruit industry leaders in the STEM sector to drive cultural change to increase participation of women. Another example is the Working Together with Men model, which provides an innovative framework for men to explore and learn about gender-based violence. The Working Together with Men 2.0 model includes 6 foundations and 8 best-practice steps to support men to become active and accountable allies.[109]

There is strong evidence that retention of STEM professionals in STEM careers can be improved by:

- strengthening access to professional development, professional networks and mentoring programs
- ensuring leaders actively nurture the careers of their employees.[110]

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[107] Office of Australia's Women in STEM Ambassador (Bergman, Ratcliffe, Harvey-Smith, Williams) (2023). *Initiatives for workplace equity and inclusion: A series of rapid systematic reviews of the peer-reviewed literature*. https://osf.io/preprints/osf/zmvjn

[108] Submission to the Pathway to Diversity in STEM review from Queers in Science.

[109] Hewson-Munro, S. & McCook, S. (2023). *Working Together with Men 2.0*. https://www.rmit.edu.au/about/our-values/respect-rmit/gender-equity-and-justice

[110] Science and Technology Australia. (2023). *STEM career pathways major research report.* https://www.chiefscientist.gov.au/STEM-CareerPathways

Recognising and valuing diverse researchers

Researchers from diverse cohorts may be disadvantaged by traditional metrics of success, such as the quantity of research publications and citations. They are also disadvantaged by inherent biases in the system. This can impact promotion and advancement.

The Australian Council of Learned Academies (ACOLA) studied research assessment in Australia. Less than half (46%) of researchers surveyed felt their employer's policies for assessing performance relative to opportunities were not appropriately reflected in practice.[111] The ACOLA research highlighted several factors that should be considered in organisation processes, including:

- career disruptions or flexible working arrangements. This can include caring for family, cultural obligations, moving across sectors or part-time working arrangements
- community responsibilities and advocacy. Assessment should recognise and reward additional work to advance diversity in the research sector
- research topics and interests. First Nations research, including First Nations-led research, may take longer due to appropriate community engagement. It may also be less likely to be published, impacting research volume and citations.

Organisations employing researchers must improve research assessment metrics and processes to ensure they capture diverse contributions and life circumstances. Organisations must make these processes transparent to avoid bias and discrimination.

These organisations must also provide greater job security for researchers to retain them in research careers. A submission to the review from Science and Technology Australia highlighted the negative impact of repeated cycles of short-term research funding contracts, especially in the early years of a science research career.[112] This submission suggested research grants should be shifted to longer terms of 5-10 years.

Organisations in Australia can follow the lead of other countries modernising their research assessment systems. For example, universities across the Netherlands are working together to develop a new assessment system for researcher recognition and rewards. The universities are reshaping their assessment models and practices under a common framework. Universities are producing a roadmap to implement and monitor the framework's long-term goals.[113]

[111] Australian Council of Learned Academies. (2023). *Research assessment in Australia: Evidence for modernisation*. https://acola.org/research-assessment

[112] Submission to the Pathway to Diversity in STEM Review from Science and Technology Australia.

[113] Australian Council of Learned Academies. (2023). *Research assessment in Australia: Evidence for modernisation*. https://acola.org/research-assessment

Toolkit for Employers

Many organisations are doing good work to improve diversity and inclusion practices. It is important to build on this good work to accelerate change, measure success, and share lessons of what works and what needs improvement. STEM organisations can strengthen their governance and model best-practice action to support diversity and inclusion by engaging with existing resources like the below.

- ASX Corporate Governance Principles and Recommendations provide a strong governance framework which can be voluntarily adopted, where appropriate, by non-ASX listed organisations.
- Australian Institute of Company Directors delivers boardroom education for practicing and aspiring directors and governance professionals.
- IncludeAbility resources support employers to create meaningful employment opportunities for people with disability and accessible and inclusive workplaces for everyone.
- Diversity Council of Australia provides expert advice, resources and programs to build diversity and inclusion in the workplace.
- Respect@Work brings together a comprehensive set of resources to support individuals and organisations to better understand, prevent and address workplace sexual harassment.
- Office of Australia's Women in STEM Ambassador developed a National Evaluation Guide and Portal where employers can assess their existing STEM equity programs and share their findings publicly to improve future programs.
- Australian Academy of Technological Sciences and Engineering is committed to improving diversity and inclusion in STEM. It developed the Diversity and Inclusion Toolkit to support, encourage and enable small and medium-sized businesses to create and benefit from diverse and inclusive workplaces.
- Accreditation schemes can increase accountability and support organisations to enhance diversity and inclusion practices.

Below are 2 examples of organisations adopting accreditation schemes to enhance their efforts to increase diversity and inclusion in the workplace. These are:

Adopting SAGE at Griffith University to achieve gender equity and inclusion

Griffith University is a member of SAGE (Science in Australia Gender Equity) and adopted the SAGE program in 2018. SAGE is an independent body that administers the Athena Swan Charter framework, which helps member organisations improve gender equity, diversity and inclusion. Members are predominantly tertiary education providers or research organisations.

SAGE provides a transformational gender equity, diversity and inclusion program in Australia. It is an independent body that helps tertiary education providers or research organisations to achieve meaningful systemic, structural and cultural change. Griffith University is the first Queensland University to achieve a SAGE Cygnet Award. This was for its efforts in reducing barriers for people of diverse genders, bodies and sexuality.

Griffith staff and senior leadership committed to ensuring all staff and students, including LGBTQIA+ people, feel safe and supported at work. This commitment succeeded through a deep engagement from leadership at all levels to ensure the workplace is safe and inclusive for all people.

The university has adopted practices to support their commitment, including:

- increasing the LGBTQIA+ resources and development offerings available to staff and students
- removing identified systems and process barriers such as the requirement to provide legal documents to update gender, prefixes or chosen names in staff and student systems
- installing Progress Pride Flag crossings and stairs across campuses to increase visibility
- adding an option to add pronouns to staff and student emails, profile cards and email signatures
- increasing external engagement with LGBTQIA+ groups, speakers and events.

SAGE provides the university with accountability and monitoring of the program. The framework provides the university with ongoing guidance on how to improve diversity and inclusion.

Canva accreditation through Project F

Project F aims to address stereotypes, unique to the technology sector, that impact women's ability to remain and progress in tech jobs.

Accredited organisations can track progress, receive guidance and work towards higher levels of accreditation as a gender-equitable workplace. Organisations accredited by Project F have seen increases in hiring, promotions, employee engagement and, in some cases, reduced attrition.

Tech company, Canva, has earned a level 3 accreditation through Project F. The company has implemented initiatives to increase diversity, such as:

- equal parental leave
- extended paid parental leave for stillbirth and neonatal death
- a skills/level matrix with salaries linked to it
- a coaching & development program supporting women engineers towards leadership
- redesigning the performance management instrument and process to reduce bias
- hiring targets and inclusive talent acquisition practices.

As a result, since 2020 Canva has:

- increased representation of women by 5.7 percentage points and women in senior engineering/engineering manager roles by 5.4 percentage points
- increased the proportion of women graduates / interns to 50%.
- achieved 50/50 gender balance in Product and Design teams.

Photo credit: Canva.

The Australian Government must hold organisations employing STEM workers that receive public funding accountable for creating safe, diverse and inclusive workplaces.

Recommendation 5

The panel recommends that the Australian Government take action to make Australian STEM workplaces safer and more diverse and inclusive, by:

- changing processes for Australian Government grants and procurements for STEM-related programs, services or activities to require action on Recommendations 3 and 4
- adequately resourcing government research-funding bodies to incorporate these additional requirements in their grants processes
- providing guidance to help organisations implement Recommendations 3 and 4
- examining if further changes are needed to increase action on Recommendations 3 and 4, such as:
    - changes to legislation
    - changes to processes for other financial arrangements, such as support for venture capital and loans.

Private funders, industry and the higher education sector should accelerate cultural and systemic change by setting similar requirements for their funding and procurement processes. Private funders can quickly align funding decisions with their values and commitment to creating safe, inclusive and diverse STEM workplaces.

Key considerations for this recommendation

Changes to grant and procurement processes should include:

- recipient declarations and ongoing reporting commitments on instances and mismanagement of bullying, harassment and discrimination within the teams relevant to the funding
- requirements for independent auditing of bullying, harassment and discrimination practices and procedures. It should be similar in approach to financial auditing requirements, including thresholds for the requirement
- repercussions for non-disclosure or mismanagement of bullying, harassment or discrimination, such as funding being denied or withdrawn
- broader requirements for action to create diverse and inclusive workplaces.

Guidance to help organisations implement Recommendations 3 and 4 should include:

- bringing together existing high-quality tools and resources to make them easier to find and use
- guidance on expected policies and practices based on organisation size and maturity.

Why we recommend this

The Australian Government has a key role in ensuring public money goes to STEM organisations committed to eliminating bullying, harassment and discrimination. It can also lead by example as a model employer. Submissions to the review and individual interviews frequently reiterated the importance of strong government leadership and action to address these issues.

Increasing accountability through government funding mechanisms

The government can further contribute to changes by requiring real action and accountability to eliminate bullying, harassment, and discrimination through the administration of public funds. This recommendation includes several options that the dedicated advisory council, proposed in Recommendation 1, should explore in depth.

The Women's Economic Equality Taskforce has also recommended leveraging government grants and procurement to incentivise and support organisations demonstrating positive action to achieve inclusive employment practices.[114] If agreed, there is an opportunity for these actions to be closely aligned and drive diversity beyond gender.

Measures for ensuring accountability and actively increasing diversity in STEM can be linked to funding agreements between the Australian Government and STEM organisations. For example, grant guidelines, assessment processes and data collection should include requirements for:

- reporting bullying, harassment and discrimination, including sexual assault and harassment
- progress on diversity and inclusion, including underrepresented cohorts in leadership roles.

Wellcome

Wellcome is an international example of a funding body that requires accountability and action relating to bullying, harassment and discrimination.

Wellcome is a global charitable foundation that supports science to solve urgent health issues. Through an investment portfolio currently valued at £37.8 billion, it funds curiosity-driven research, particularly regarding climate change, infectious disease and mental health.

The Wellcome Fund has strengthened its stance on bullying and harassment with a policy that holds organisations that receive grant funding accountable for the actions of their researchers.[115]

An organisation seeking funding must confirm the lead applicant has not had an allegation of bullying, harassment, abuse or harm upheld against them for which there is a current formal

[114] Women's Economic Equality Taskforce. (2023). *A 10-year plan to unleash the full capacity and contribution of women to the Australian economy*. https://www.pmc.gov.au/resources/10-year-plan

[115] Wellcome. (April 2023). *Bullying, harassment, abuse and harm policy.* https://wellcome.org/grant-funding/guidance/bullying-and-harassment-policy

disciplinary warning or an active sanction. The Wellcome Fund may reject the application if it feels there is continued risk to other people or to Wellcome's principles.

After receiving funding, the organisation is responsible for making the Wellcome Fund aware of any formal investigation being opened into bullying or harassment. The fund can:

- monitor any complaints and ensure that they are dealt with appropriately
- ensure that grant-holders receive adequate support as needed
- make any necessary onward reporting deemed necessary by the fund's regulator.

The fund will revoke funding for researchers who are later found guilty of bullying, harassment, abuse or harm.

Audits are an important corporate reporting measure to track progress, usually related to financial outcomes. Submissions to the review frequently noted the importance of auditing, by an independent or external party, to an organisation's diversity practices.

Introducing diversity audits to reporting requirements for funding agreements or contracts would create transparency for diversity and inclusion policies and procedures and the organisation's adherence to these practices. Undertaking, and sharing the outcomes of, these audits should be a requirement for government-funded organisations. This could be introduced under specific funding arrangements where financial auditing is required.

The advisory council should lead work on guidance and communications materials for government funding agencies. These materials, developed through consultation across government, would explain opportunities for these agencies to request a commitment to eliminating bullying, harassment and discrimination.

Australian Research Council and National Health and Medical Research Council: Code of Conduct and funding requirements

The Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) are the Australian Government's principal research funding agencies. In 2018, the ARC, NHMRC and Universities Australia issued the *Australian Code for the Responsible Conduct of Research 2018*. The code articulates principles of an honest, ethical and conscientious research culture. It also outlines the expectations for research conducted in Australia or under Australian institutions.

To be eligible for NHMRC funding, institutions must carry out research activities in an ethical, responsible, diligent and competent manner. Institutions must also ensure compliance with a range of requirements and agreements, including funding agreements, policies, conditions and the code. The ARC also requires compliance with requirements, including the code.

Retaining eligibility requires yearly reporting on compliance with the NHMRC's funding agreement, through the *Institutional Annual Compliance Report*. NHMRC requires institutions receiving funding to have policies in place to support gender equity in health and medical research, including:

- strategies that address the underrepresentation of women in senior positions and leadership development for women
- strategies that encourage the recruitment, retention and progression of women in health and medical research.

- employer-funded primary carer's leave for parents and transitional support to encourage a return to work
- flexible working arrangements that cater for individuals with caring responsibilities
- policies, procedures and training to support research environments that are free from bias, discrimination and sexual or other harassment. It also requires procedures in place to fairly address any instances of such behaviour.

These policies and procedures are a good start, but there are opportunities to accelerate cultural change through improved, and adequately resourced, monitoring, compliance and reporting. For example, through auditing requirements outlined in Recommendation 5.

Guidance material on the code is available online.

Private organisations, such as those funding research and providing venture capital, also have a clear role to play in ensuring the organisations they fund are taking action to eliminate bullying, harassment and discrimination. Private organisations have the power to enact quick changes to policies and procedures. An example of this is start-up accelerator Techstars Tech Central, which declined a request for funding from a founder who had engaged in overt sexist online behaviour as reported in the *Australian Financial Review*.[116] Another example of a private organisation taking leadership in this space is the Snow Medical Research Foundation.

Snow Medical Research Foundation

Snow Medical is a local example of a values-based funding body that took action to establish a diversity benchmark.

Snow Medical is an Australian not-for-profit biomedical research funding organisation. One of Snow Medical's core values is diversity. It aims to only work with organisations strongly committed to achieving results in gender equality. To this end, Snow Medical designed and delivered a gender equality benchmark report pilot.

Ten organisations participated in this pilot. It established a benchmark of gender equity considerations Snow Medical can use to inform their funding.

'… through the Gender Equality Benchmark, we will work with organisations on an individual basis to identify challenges and highlight areas where they are succeeding. The Gender Equality Benchmark can also be used to encourage organisations to share successful initiatives with their peers to achieve better outcomes in gender equality in the sector overall.

The Gender Equality Benchmark allows us to make informed decisions on where Snow Medical invests its funds and which organisations we partner with.'

Building a baseline to inform funding decisions is a clear path towards strategic, coordinated and values-based funding decisions. It can also hold organisations to account. For example, in 2022, Snow Medical barred an Australian university from their funding program, 'as the University's outcomes on gender equality and diversity do not align with the values of Snow Medical'.[117]

[116] Sier, J. & Bonyhady, N. (12 November 2023). After viral sexist post, women in start-ups say worse issues are buried. *Australian Financial Review*. https://www.afr.com/technology/after-viral-sexist-post-women-in-start-ups-say-worse-issues-are-buried-20231108-p5eigj

[117] Snow Medical. (7 March 2022). *Statement.* https://snowmedical.org.au/diversity-statement

Photo credit: Snow Medical Research Foundation.

Reviewing existing and upcoming legislative changes

The Australian Government also has the power to enact and amend legislation. While existing legislation covers the rights of employees to safe workplaces, the breadth and depth of evidence presented to the review indicates that these protections may not be sufficient.[118] This evidence includes multiple accounts of bullying, harassment and discrimination communicated to the review through anonymous submissions and personal communications.

A submission from Girl Geek Academy contained findings from an independent survey demonstrating widespread gender discrimination, unconscious bias and sexual harassment in the technology industry.[119] This led the Girl Geek Academy to make the impassioned charge to 'fix the system, not the girls'.

The Australian Government recently passed the Workplace Gender Equality Amendment (Closing the Gender Pay Gap) Bill 2023 to accelerate action to close the gender pay gap. Relevant employers must now comply with expanded reporting requirements.[120] This includes reporting on prevention and responses to sexual harassment, harassment on the ground of sex and discrimination in the workplace.

The Anti-Discrimination and Human Rights Legislation Amendment (Respect at Work) Bill 2022 also introduced significant changes. The Bill followed the *Respect@Work: National inquiry into sexual harassment in Australian workplaces* report.

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[118] Australian Academy of Science and Australian Academy of Technology & Engineering. (2019). *Women in STEM Decadal Plan. https://www.science.org.au/support/analysis/decadal-plans-science/women-in-stem-decadal-plan*

[119] Submission to the Pathway to Diversity in STEM review from Girl Geek Academy.

[120] Defined as either:

- Standalone organisations with 100 or more employees, or
- A corporate structure with 100 or more employees in total across all entities.

These changes commenced in late 2023 and 2024 and could significantly change the experience of women in Australian workplaces. If these changes are successful, the Australian Government should explore further legislative changes to improve the experience of other underrepresented cohorts.

The Women's Economic Equality Taskforce has also recommended that the Australian Government harmonise anti-discrimination and industrial legislation to include positive, enforceable legal duties on employers to eliminate discrimination and harassment and advance gender equality.[121]

Workplace Gender Equality Procurement Principles

The principles aim to ensure that government only deals with organisations who comply with the *Workplace Gender Equality Act*. Non-public sector employers with 100 or more employees must supply a letter of compliance before entering a contract with an Australian Government agency. A user guide assists with understanding and implementing the principles.

Recent changes to the Act, passed on 30 March 2023, will introduce additional requirements:

- from November 2023, relevant employers must comply with increased reporting requirements, including to provide WGEA executive summary and industry benchmark reports to their board
- from early 2024, the Workplace Gender Equality Agency is due to publish private sector employer gender pay gaps to encourage accountability and greater action. Public sector data is due to be published in late 2024 or early 2025
- from April 2024, employers reporting to WGEA must provide remuneration information for their CEO, head of business and casual managers. Employers with 500 or more staff will need a policy or strategy for each of the 6 gender equality indicators.

The Workplace Gender Equality Agency has produced a range of materials to ensure awareness and understanding of these changes well in advance, such as the information on this webpage.

Australian Government leadership on diversity and inclusion

The Australian Government can model cultural and organisational change by being an exemplary employer of STEM workers.

Continued increases to transparency and accountability such as the recent move to publish APS Census results across the APS is crucial to the Government's commitment to eliminate bullying, harassment and discrimination. This approach also sends a clear message to organisations employing STEM workers across Australia.

The proposed advisory council would be well situated to work with the Australian Public Service Commission to coordinate across Australian government agencies to ensure alignment and reduce duplication with existing initiatives. This should include further options to increase accountability and compliance.

[121] Women's Economic Equality Taskforce. (2023). *A 10-year plan to unleash the full capacity and contribution of women to the Australian economy*. Australian Government. https://www.pmc.gov.au/resources/10-year-plan

Photo credit: The STEM Teacher Enrichment Academy (University of Sydney).

The Australian Government must reduce the barriers to STEM-qualified and STEM-skilled migrants entering the workforce.

Recommendation 6

The panel recommends that the Australian Government include a focus on STEM in implementing any strategies in response to the 2023 Review of the Migration System, to address barriers faced by skilled STEM migrants in having their skills and qualifications recognised and valued in Australia.

Organisations employing STEM workers should take immediate action to correct for conscious and unconscious biases in recruitment processes that may prevent employment of STEM-skilled migrants. This includes changing perceptions around skills and cultural differences, visa and work rights, and recognition of overseas qualifications.

Organisations must implement Recommendations 3 and 4 to ensure workplaces are safe and inclusive for migrant professionals.

Key considerations for this recommendation

Successfully implementing this recommendation includes finding opportunities to:

- simplify processes and reduce the costs to recognise overseas STEM qualifications
- support agreed principles and best practice guidance on skills assessment
- streamline mutual recognition of skills and qualifications across all Australian states and territories, in coordination with professional bodies and state and territory authorities
- pursue international mutual recognition of occupational licences from a broader range of countries
- improve access to courses, employment supports or work experience and networks in Australia
- improve guidance for workplaces to eliminate bias and better value the qualifications and expertise of migrant professionals
- scale successful approaches in specific STEM sectors or organisations.

Photo credit: WiseTech Global.

Why we recommend this

University qualified STEM professionals born overseas make up 59% of all university qualified STEM professionals in Australia, emphasising the important role migrant workers play in sustaining the STEM workforce. [122]

However, skilled migrants face barriers entering the Australian workforce, often working in jobs well beneath their skill level, experience and qualifications.[123] Almost half of all skilled migrants are not using the skills and experience they gained before coming to Australia. This rises to 58% for

[122] Australian Bureau of Statistics. (2021). *TableBuilder*. Australian Government. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

[123] Migrants with completed higher education qualifications, post-secondary technical and/or general vocational overseas qualifications.

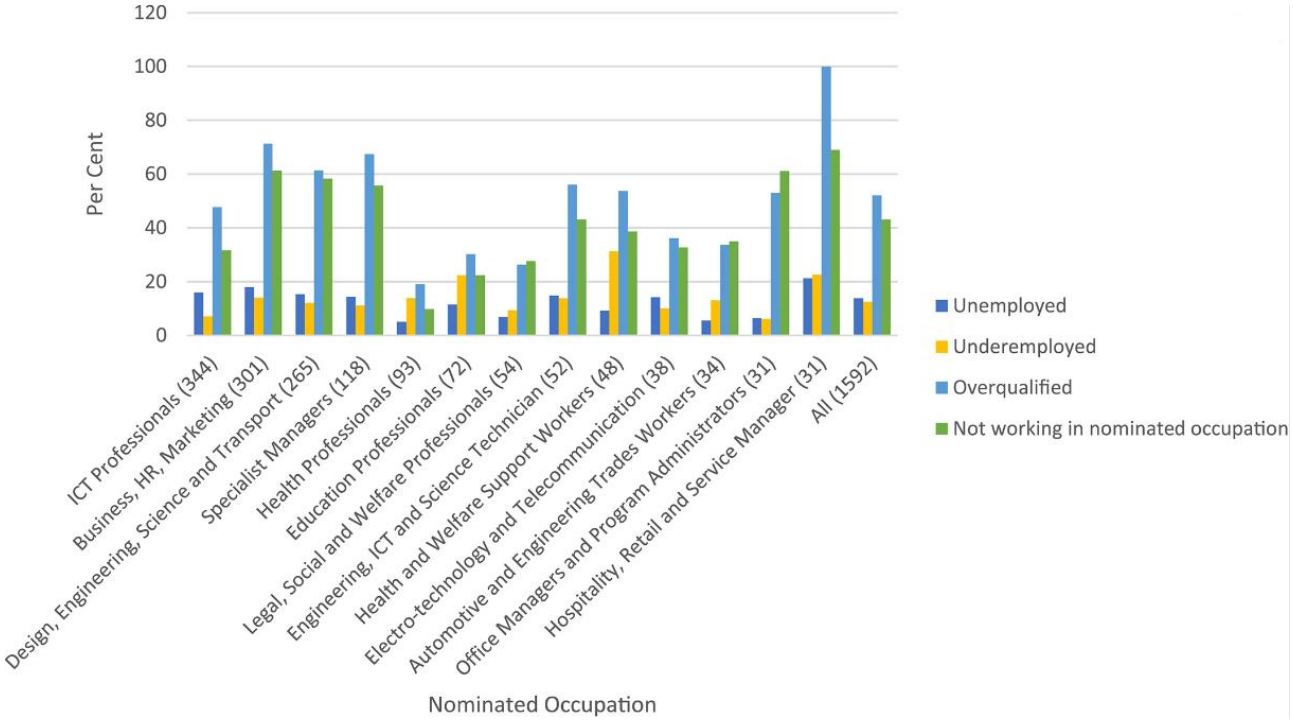
migrant women. Around 20% of these skilled migrants are in the engineering and IT sectors.[124] A 2022 report found that 43% of skilled migrants in South Australia are working in occupations other than the one nominated in their visa application.[125]

Working future: *The Australian Government's white paper on jobs and opportunities,* identifies the need to better target skilled migration and use of migrants' skills. The white paper notes migrants are likely to:

- be in less secure jobs with lower-than-average employment rates
- face wage and promotion barriers
- experience exploitation (9% to 10% are underpaid)
- experience discrimination and racism
- have difficulty getting their qualifications recognised, particularly for women migrants and young migrants and refugees.

Coupled with significant skill shortages in STEM areas, there is a clear need to address these barriers faced by overseas-qualified STEM workers.

Figure 3: Migrant unemployment, underemployment, overqualification and working outside nominated occupation, by occupation. Source: *When what you have is not enough – acquiring Australian qualifications to overcome non-recognition of overseas skills* (2022).[126]



[124] Deloitte Access Economics. (November 2018). *Seizing the opportunity: Making the most of the skills and experience of migrants and refugees*. Multicultural Affairs Queensland. https://www.des.qld.gov.au/multicultural-affairs/programs-initiatives/research-report

[125] Tan, G., & Cebulla, A. (2022). When what you have is not enough – acquiring Australian qualifications to overcome non-recognition of overseas skills. *International Migration,* 61(3), 175-195. https://onlinelibrary.wiley.com/doi/full/10.1111/imig.13030

[126] Ibid.

Skills recognition and the Review of the Migration System report

Australia has a shortage of workers in essential services. Yet an overseas-trained nurse will pay up to $20,000 and wait up to 35 months to get their qualifications recognised and visa granted.[127] Further, in fields such as engineering, 100,000 overseas-trained engineers are living in Australia unemployed.[128]

The Review of the Migration System report notes ongoing concerns with the way skills recognition occurs in the current system.[129] This is reflected in the European Union's Migrant Integration Policy Index (MIPEX), which measures policies that integrate migrants in 56 countries, including Australia. The 2019 MIPEX report notes Australia has gone backwards in its commitment to integration. Negative changes included recognition of academic qualifications where there were no positive changes. Of the 56 countries, 34 countries, excluding Australia, provide equal access when recognising foreign qualifications.[130]

The Review of the Migration System report made recommendations supporting the objectives of this report that the government should endorse. This includes:

- pursuing international mutual recognition of occupational licences from a broader range of countries. This would allow occupational licences obtained elsewhere to be recognised without the need to formally apply for recognition
- considering driving greater synchronisation between skills assessments and licence or registration processes.

The review also recommends the Australian Government works with states and territories on a strategy to streamline processes for occupations with the most benefit to the economy. The dedicated advisory council, proposed in Recommendation 1, should consider if further work is needed to address these barriers. It should also endorse best-practice principles and standards for the skills and assessment process being developed as part of the Review of the Migration System. This will raise the integrity, quality and timeliness of migration skills assessments.

If skilled migrants' overseas qualifications are not recognised, the advisory council should consider alternative pathways into the STEM workforce. These should include bridging courses, micro-credentials and upskilling opportunities in STEM areas.

A submission to the review from Engineers Australia stated that 'there is existing uncertainty around whether overseas certifications are relevant to engineering in Australia when those certifications are acquired from countries with seemingly disparate systems. Some employers have also expressed reservations about the legitimacy of non-Australian qualifications.'[131]

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[127] Department of Home Affairs. (April 2023). *A migration system for a more prosperous and secure Australia: Outline of the government's migration strategy.* Australian Government. https://immi.homeaffairs.gov.au/programs-subsite/files/migration-strategy-outline.pdf

[128] Engineers Australia. (14 July 2023). *Tens of thousands of qualified, skilled migrant engineers missing out on engineering work.* https://www.engineersaustralia.org.au/news-and-media/2023/07/tens-thousands-qualified-skilled-migrant-engineers-missing-out-engineering

[129] Department of Home Affairs. (2023). *Review of the Migration System final report.* Australian Government. https://www.homeaffairs.gov.au/reports-and-publications/reviews-and-inquiries/departmental-reviews/migration-system-for-australias-future

[130] Migration Policy Group. *Migrant Integration Policy Index 2020: Key findings Australia.* https://www.mipex.eu/australia

[131] Submission to the Pathway to Diversity in STEM Review from Engineers Australia.

Migrants report skill and qualification recognition as an issue, although this is not as significant as other barriers to labour market success.[132]

Reducing the cost of skills and qualification recognition

The costs of skills and qualification assessments and visa applications are barriers to migrants and Australian employers.[133] Occupations that require specialised knowledge and skills in Australia have registration, licensing, professional membership or other industry requirements. These must be assessed by professional authorities before starting work.

Professional authorities charge for general skilled migration assessments, recognition of prior learning and competency, overseas skill and PhD assessment. Fees range from $560 to over $1600 per assessment.

Assessment authorities could reduce the cost of fees, particularly for STEM migrants. Or they could consider subsidising costs and developing a payment plan so migrants can pay the fees back when employed.

Improving local networks and experiences

The 2021 Committee for Economic Development in Australia (CEDA) report notes the main difficulty for skilled migrants obtaining jobs in Australia is the lack of Australian work experience and local references.[134] This is supported by a 2021 report commissioned by Engineers Australia[135] which looks at the main barriers for migrant engineers finding employment in Australia.

Information passed on through these local networks is central to labour market integration of migrants. These networks help with immigration processes, finding jobs and adjusting to their new society. They determine the extent to which migrants integrate into their host countries.[136]

The advisory council should develop information on networks and contacts for professional STEM skilled migrants by working with:

- migration support organisations
- Department of Employment and Workplace Relations
- Department of Home Affairs
- state and territory migration agencies.

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[132] Department of Home Affairs. (2023). *Review of the Migration System final report.* Australian Government. https://www.homeaffairs.gov.au/reports-and-publications/reviews-and-inquiries/departmental-reviews/migration-system-for-australias-future

[133] Joint Standing Committee on Migration. (2021). *Final report of the inquiry into Australia's skilled migration program*. Parliament of Australia. https://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Migration/Completed_inquiries#Tabcontent-tab-1

[134] Committee for Economic Development in Australia. (2021). *A good match: Optimising Australia's permanent skilled migration*. https://www.ceda.com.au/ResearchAndPolicies/Research/Population/A-good-match-Optimising-Australia-s-permanent-skil

[135] Engineers Australia. (October 2021). *Barriers to employment for migrant engineers.* https://www.engineersaustralia.org.au/publications/barriers-employment-migrant-engineers

[136] Poros, M. (March 2011). Migrant social networks: Vehicles for migration, integration and development. *The Online Journal of the Migration Policy Institute*. https://www.migrationpolicy.org/article/migrant-social-networks-vehicles-migration-integration-and-development

This information could be provided after the visa application process. Consideration could be given to a one-stop-shop website for professional STEM skilled migrants with links to relevant government departments, networks, support groups and advice.[137]

Global Engineering Talent Program

The Global Engineering Talent Program is an initiative developed by Engineers Australia. It supports migrants to overcome barriers to employment. Supported by the Northern Territory Government, the program aims to help an initial 20 overseas-born engineers currently in Australia. The engineers will be either on a skilled migration visa but unable to find work or were in an engineering position not commensurate with their skill and experience level.

The program includes a 6-week preparatory course through Engineering Education Australia. The course includes engineering standards training and a 12-week paid work placement at an engineering firm. This provides migrant engineers with local experience, references and networks.

The Queensland Government has also co-funded up to 20 places in the Global Engineering Talent Program for engineers with skills needed for future clean energy roles. Engineers Australia opened expressions of interest for these places in October 2023. At an information session, one migrant engineer noted they gained knowledge in making a resume and LinkedIn profile more effective. They also gained experience networking with other professionals and recruiters.[138]

Based on the outcomes of these programs, Engineers Australia will continue working with migrant engineers, and engineering employers and partners, to connect and create sustainable pathways to employment.

Photo credit: Engineers Australia.

[137] An example of this approach can be seen at https://migration.wa.gov.au/our-services-support/skilled-migration-job-connect

[138] Engineers Australia. (2003). *Engineers Australia launches Queensland migrant work placement program* https://www.engineersaustralia.org.au/news-and-media/2023/10/engineers-australia-launches-queensland-migrant-work-placement-program

Managing unconscious bias

Many employers in Australia hold an unconscious bias toward hiring non-Australians, believing:

- their language skills will be inadequate
- the lack of local experience, qualifications, references and networks will stop them succeeding in the Australian workforce.

There is also a perception that employers do not value skilled migrants' international experience.[139]

Discrimination by employers based on a person's name or English proficiency is evident.[140] A workshop undertaken by this review agreed that English language proficiency requirements for STEM-related occupations were often excessive. As a result, they constituted an artificial barrier to employment.

Overseas learning environments may include non-English language teachers without competence in the deep grammatical structure of the English language. This supports the case for adjusting the English language proficiency requirements for skilled migrants. Governments, employers and accrediting bodies should consider:

- reviewing current policies and programs related to language assessment of skilled migrants
- creating an understanding of non-English learning environments.

Photo credit: Faculty of IT, Monash University.

[139] Engineers Australia. (October 2021). *Barriers to employment for migrant engineers.* https://www.engineersaustralia.org.au/publications/barriers-employment-migrant-engineers

[140] Bursell, M., Bygren, M., & Gahler, M. (August 2021). Does employer discrimination contribute to the subordinate labor market inclusion of individuals of a foreign background? *Social Science Research,* 98. https://doi.org/10.1016/j.ssresearch.2021.102582

Lifelong learning

Australian government and education providers must remove barriers and create accessible pathways for diverse people to thrive in STEM learning.

Recommendation 7

The panel recommends that the Australian Government, through the Department of Education and Department of Employment and Workplace Relations, use its convening power to work with state and territory governments to improve participation and achievement in STEM skills and subjects in schools by:

- negotiating and implementing the next National School Reform Agreement
- implementing the National Teacher Workforce Action Plan and exploring further opportunities to grow the STEM teaching workforce
- improving the Australian Curriculum through future reviews.

Key considerations for this recommendation

The parties should aim to:

- improve national measurement and reporting of student participation and attainment in STEM subjects
- increase the number and diversity of STEM trained teachers
- improve nationally consistent approaches to support STEM VET in high-school and industry-school partnerships to support hands-on STEM learning.

Recommendation 8

The panel recommends that the Australian Government, through the Department of Education, work with national education agencies to prepare and support educators to teach STEM in a way that is responsive to the needs of diverse cohorts, through:

- work of the Australian Institute for Teaching and School Leadership to improve the quality and consistency of initial teacher education programs, and to develop new teacher mentoring standards to support out-of-field teachers to teach STEM
- work of the Australian Curriculum, Assessment and Reporting Authority to enhance curriculum support resources
- improving access to professional development in responsive STEM teaching practices.

Industry and academia should also take action now to consider how to adjust STEM outreach programs in schools to better connect with and inspire diverse students.

Key considerations for this recommendation

STEM teaching resources and teacher education should include a focus on:

- trusted resources that support educators and schools to incorporate First Nations Knowledges in STEM curricula
- methods of teaching students living with a disability
- resources that include diverse representation
- resources that highlight the range of STEM career opportunities and diverse pathways, including through vocational education and training.

Any new or amended resources should be designed in partnership with representatives from diverse cohorts to ensure they are culturally safe, relevant and accessible.

Why we recommend this

Educators and schools have an important role in building young people's confidence in STEM skills and understanding of pathways to a career in STEM.

The panel acknowledges the value of teachers, and also acknowledges the emotional, physical and administrative pressures they are under. The recommendations in this section focus on increasing support from governments, schools and national education agencies to provide teachers with the support they need to help students achieve better outcomes. A larger teaching workforce and better support for teachers generally will flow onto STEM learning outcomes.

Differences in STEM subject engagement

Current data show clear differences in perceptions and choice of STEM subjects. These vary by subject and change with age.

The proportion of year 12 STEM subject enrolments overall has slightly increased over time, from 45% to 47% between 2013 and 2021. However, girls remain unrepresented in IT (24% of enrolments), physics and astronomy (24%) and engineering and related technologies (23%).[141]

When it comes to interest, the *2021-22 YouthInsight Youth in STEM survey report* found that while there was similar interest in science subjects between girls and boys (62% and 64% respectively) – there was a clear difference in their interest in engineering, with 31% of girls interested compared to 56% of boys.[142]

Girls' confidence in STEM subjects generally fell as they got older, for example, confidence in technology dropped from 68% at 12-13 years to 56% at 22 to 25 years. Girls were more likely to state lack of interest as the barrier to studying STEM and were half as likely as boys to aspire to a career in STEM.[143]

Aspiration and interest among women and girls are further impacted by intersectionality. For example, those from lower socioeconomic and rural and remote areas were less interested and less confident in STEM study. First Nations women and girls were also less confident and interested, with just 10% expressing an interest (compared to 21% of non-First Nations girls).

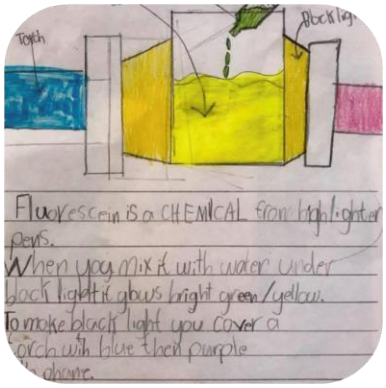


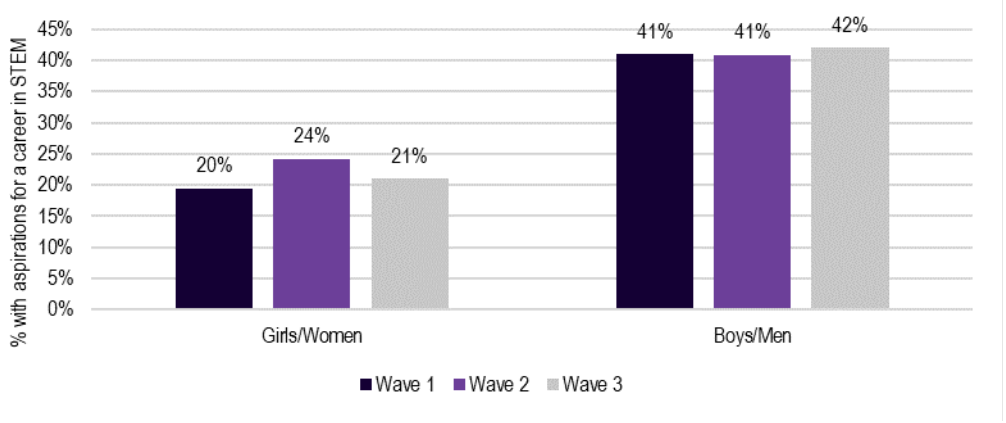
Photo credit: DeadlyScience.

[141] Department of Industry, Science and Resources. (20 July 2023). *STEM Equity Monitor*. Australian Government. https://www.industry.gov.au/publications/stem-equity-monitor

[142] Ibid.

[143] Ibid.

Figure 4: STEM career aspirations (ages 12 – 25 years). Wave 1: 2018-19 Wave 2: 2019-20. Wave 3 2021-22. Source: *YouthInsight* from *Women in STEM Evaluation Final Report* (2023)[144]



Data is lacking on engagement of students from other diverse cohorts in STEM school subjects. This highlights the need for better data collection to provide an evidence base for policy and program design within Australia.

A key barrier to understanding student engagement across the STEM education pathway is the lack of a student identifier that captures student achievement from school through to tertiary education.[145]

Improving STEM outcomes through teaching and learning reforms

Work is underway across Australian governments to improve student outcomes. This presents an opportunity to include actions to help underrepresented cohorts excel in STEM learning and increase exposure to STEM career pathways.

The new National Schools Reform Agreement is an opportunity to improve how we measure and drive student achievement against STEM competencies, including among diverse students. This is a joint agreement between the Australian Government, states and territories that aims to lift outcomes across Australian schools.

Improving STEM education for all students will require more STEM-qualified teachers. Australian governments are working on ways to address national teacher workforce shortages through implementation of the National Teacher Workforce Action Plan.[146] This is an opportunity to attract more diverse STEM teachers, who can be role models for students. It can also provide better support for teachers who are teaching STEM out-of-field.

Submissions to the review highlighted the need for more accessible resources and professional development for teachers. This would help teachers provide responsive STEM education for diverse cohorts.[147]

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[144] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

[145] Education Council. (12 April 2018). *Optimising STEM industry-school partnerships: Inspiring Australia's next generation*. https://www.chiefscientist.gov.au/2018/05/optimising-stem-industry-school-partnerships-report-released. Note: the current Unique Student Identifier captures vocational education and training activity and movements within the VET and Higher Education systems.

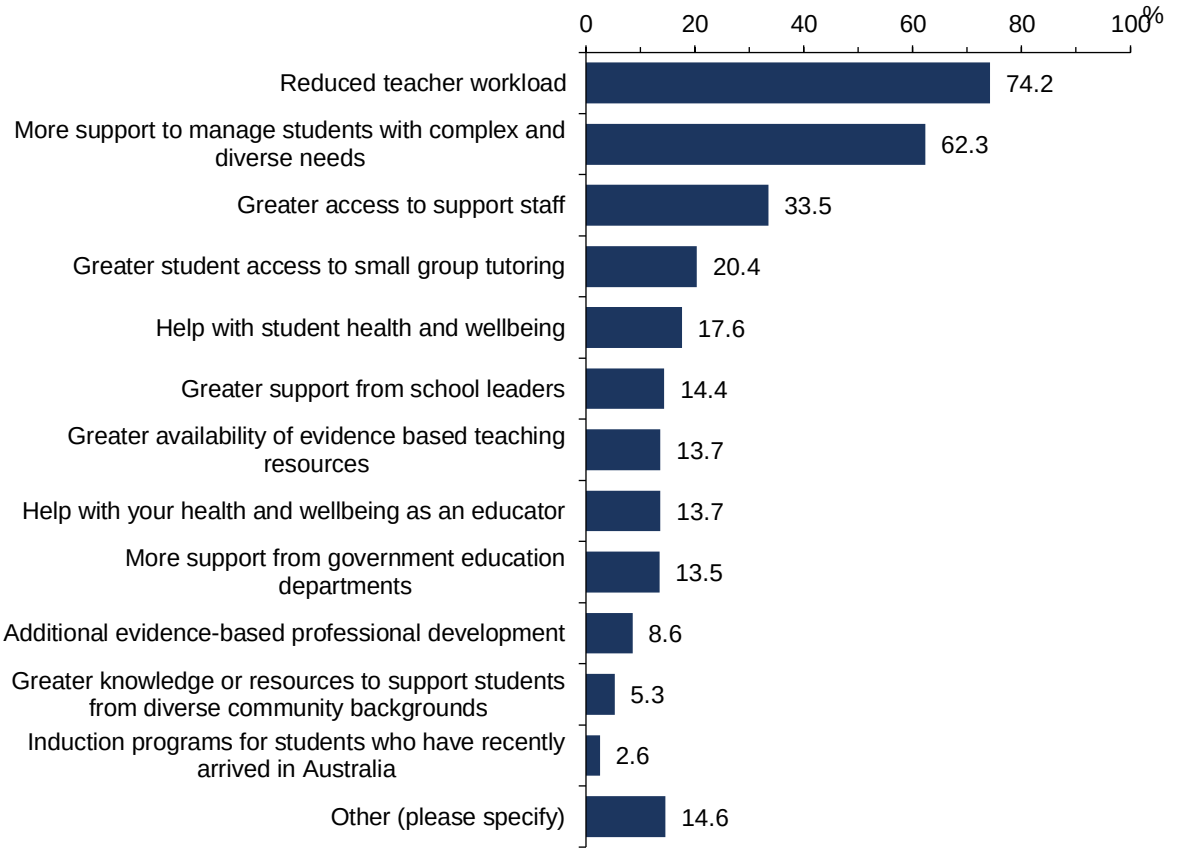
[146] Department of Education. (December 2022). *The National Teacher Workforce Action Plan*. Australian Government. https://www.education.gov.au/teaching-and-school-leadership/resources/national-teacher-workforce-action-plan-publication

[147] Submissions to the Pathway to Diversity in STEM Review from Wisetech Global; University of Sydney School of Chemistry.

This need was reinforced by a survey to inform negotiation of the new National Schools Reform Agreement. Teachers stated that support to manage students with complex and diverse needs is the second-most important factor to help them improve student outcomes.[148]

Work is underway to support teachers to implement the national curriculum. This presents opportunities to ensure teachers and schools can access resources to help them teach STEM in a way that responds to the needs of diverse students. The sections below have further detail on this work. Participants in the review's workshops and interviews stressed the importance of supporting educators in this role and avoiding placing extra burden on them.

Figure 5: Most important factors to help educators improve student outcomes. Source: *Review to Inform a Better and Fairer Education System – initial consultation surveys* (2023)[149]



Improving teaching approaches to improve STEM engagement

The way STEM is taught can connect young people to the value of STEM skills and future learning and career opportunities. Positive experiences and attitudes towards STEM subjects can result in better engagement and learning outcomes. Negative experiences can result in the opposite. For example, one study found that year 11 and 12 students who reported being more anxious about science found the subject more difficult and had lower self-efficacy.[150]

[148] Social Research Centre, Department of Education. (July 2023). *Review to Inform a Better and Fairer Education System - initial consultation surveys.* Australian Government. https://www.education.gov.au/review-inform-better-and-fairer-education-system/resources/initial-consultation-surveys-summary-report

[149] Ibid.

[150] Kennedy, J.P., Thompson, K., Fowler, S., & Leonard, S. (24 August 2021). *A novel approach to mapping changes in student attitudes towards science and mathematics in reaction to changes in their learning environment.* https://www.ncsehe.edu.au/publications/mapping-student-attitudes-science-mathematics-learning-environment

Perceptions of STEM skills, abilities and jobs are shaped from a young age. Many ideas about careers are already in place by the time children finish primary school.[151,152] Building positive experiences with STEM skills in early childhood and primary years is just as important as high-school STEM education and can influence subject choice.

Early Learning STEM Australia (ELSA)

The ELSA program is designed to increase numeracy and STEM thinking through a hands-on and digital approach for children aged 4 and 5 years of age. Funded by the Australian Government and developed at the STEM Education Research Centre (SERC) at the University of Canberra, it includes:

- an app with resources for early childhood educators
- a pedagogical framework
- STEM practices that link to the early years learning framework
- a play-based learning app for children
- an app for families.

ELSA piloted the program in preschool and early learning centres during 2018 and 2019. It found that:

- the apps aligned well with the early years learning framework (EYLF)
- there were high levels of engagement amongst educators and children
- diversity and inclusion were considered with the adoption of an inclusive pedagogy to engage students from diverse backgrounds.[153]

Research by the University of Canberra found that children who engaged in the ELSA program experienced an improvement in STEM literacy skills 3 times faster than children not in the program.[154] This led to the program being commercially available to all Australian preschools, kindergartens and early learning centres.

The ELSA concept is being expanded into primary schools to increase participation in STEM education and digital literacy for students up to year 2. The pilot is funded by the Australian Government and will commence in early 2024.[155]

[151] Dockery, A.M. & Bawa, S. (2018). Labour market implications of promoting women's participation in STEM in Australia. *Australian Journal of Economics 21*(2), 126-152. https://bcec.edu.au/publications/labour-market-implications-of-promoting-womens-participation-in-stem-in-australia

[152]Hooley, T. (2021). *Career education in primary school*. (myfuture Insights series). https://myfuture.edu.au/assist-others/insights

[153] Dandolo Partners. (January 2020). *Evaluation of early learning and schools initiatives in the National Innovation and Science Agenda (NISA): The Early Learning STEM Australia (ELSA).* https://www.education.gov.au/national-innovation-and-science-agenda/resources/evaluation-early-learning-and-schools-initiatives-national-innovation-and-science-agenda

[154] White, K. (2023). *Research shows UC's ELSA Program significantly boosts STEM outcomes and improves language skills, rolling out now for 2023*. University of Canberra. https://www.canberra.edu.au/about-uc/media/newsroom/2022/december/research-shows-ucs-elsa-program-significantly-boosts-stem-outcomes-and-improves-language-skills,-rolling-out-now-for-2023

[155] University of Canberra. (2023). *ELSA: STEM in schools*. https://elsaschools.edu.au

Similar to other STEM programs, ELSA needs long-term data to demonstrate how children engaged in the program make education and career choices as they move along the education pathway.

STEM outreach activities and teaching that focus on creativity, problem-solving and different ways of thinking can help form positive attitudes towards STEM.

> ‘By up skilling and uplifting teacher STEM capability, the STEM message spreads…STEM programs for individual teachers, are critical, especially as they cater to teachers’ affinity and belonging with their identifying discipline, which reflects in their teaching, enthusing and motivating students.’[156] – Anonymous submission

The National STEM Education Resources Toolkit provides 9 principles for teaching STEM effectively. For example, using inquiry-based learning approaches that allow for social interaction and exploration and comfort with failure, and providing opportunities to solve real-world problems.[157]

The *Big Mob: STEM it Up research report* highlighted how teaching practices and implementation of the curriculum can impact STEM performance and interest of First Nations students. The research explains that the school curriculum and standardised measures of achievement do not consider the different learning styles or world views of First Nations students.[158] For example, Indigenous students may be less familiar with Western mathematical constructs because they are different to how their family or community use maths in an everyday context. Teachers who understand the strengths in how First Nations people approach STEM learning from their own knowledge and understanding of the world can better support their success and confidence.

This research also highlighted effective approaches implemented internationally to support Indigenous populations across Canada, the US and New Zealand, for example:

- real life application of science and maths focusing on culturally responsive pedagogies that integrate Indigenous and Western knowledge systems
- place-based curricula which privileges Indigenous customs, traditional practices, connections to Country and native languages

[156] Submission to the Pathway to Diversity in STEM Review. Respondent opted to submit anonymously.

[157] Department of Education. (21 June 2021). *What works best when teaching STEM?.* Australian Government. https://www.education.gov.au/australian-curriculum/national-stem-education-resources-toolkit/i-want-know-about-stem-education/what-works-best-when-teaching-stem

[158] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z, Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

- engagement with Elders, parents and Indigenous communities and organisations to guide program design and implementation
- prioritising teacher professional development and ensuring that teachers are skilled in using culturally responsive teaching strategies
- commitment to improve STEM achievement, to generate an interest in STEM in students and increase self-efficacy for Indigenous learners.[159]

One example of this approach in Australia is the Inquiry for Indigenous Science Students program. It supported teachers to carry out inquiry-based teaching of First Nations scientific approaches. A 2018 program evaluation found that the number of 'low achieving' students receiving a passing grade increased from 0 to 42%. These results were similar for First Nations and non-Indigenous students.[160]

Another example is the Teachers of STEM Initiative (ToSI). This provides financial and mentoring support to up to 99 First Nations women to complete a STEM teaching qualification. The initiative is being delivered by the Stronger Smarter Institute (SSI) with funding from NIAA ($5 million over 10 years as part of the Indigenous Girls' STEM Academy). There are also professional development opportunities (Jardibirrijiba, Jardi Dadarrinyi, Jarlarla) to support participants to build their confidence to integrate First Nations culture and knowledge into their teaching. Currently there are 42 participants in ToSI, with 6 who have completed their studies.

Diverse representation and perspectives in STEM learning content and materials can further inspire and build confidence among students from diverse cohorts that they belong in STEM. A study of Australian secondary school courses in biology, chemistry, environmental science and physics found a lack of diversity in the scientists represented, particularly female representation. The study also found a clear 'Eurocentric' focus of the scientists included in the syllabuses reviewed.[161]

'In high school, teach about women in the history of STEM such as Rosalind Franklin, Marie Curie and Katherine Johnson: make women in STEM visible.'[162] – Anonymous submission

[159] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z, Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

[160] Commonwealth Scientific and Industrial Research Organisation. (2021). *Indigenous STEM Education Project final evaluation report September 2014 – June 2021*. https://www.csiro.au/en/education/programs/indigenous-stem-education-project/monitoring-and-evaluation/final-evaluation-report
Note: 'Low achieving' was defined as those receiving a grade of 'D' or 'E' before participating.

[161] Ross, K., Galaudage, S., Clark, T., Lowson, N., Battisti, A., Adam, H., Ross A.K., & Sweaney, N. (28 August 2023). Invisible women: Gender representation in high school science courses across Australia. *Australian Journal of Education*. https://doi.org/10.1177/00049441231197245

[162] Submission to the Pathway to Diversity in STEM Review. Respondent opted to submit anonymously.

The review heard about the importance of including First Nations Knowledges in STEM teaching to increase engagement and retention in STEM education.[163]

Resources and approaches to teaching First Nations students should be developed in partnership with Traditional Owners and local communities.[164] One way of doing this, recommended through the *Big Mob: STEM it Up project research report*, is a clearinghouse of trusted sources on First Nations Knowledges for educators which could be used in both school and university settings.

DeadlyScience

DeadlyScience is an example of a First Nations led initiative that aims to inspire and bring STEM learning to students in regional and remote schools.

Corey Tutt, a Kamilaroi man, founded DeadlyScience in 2018 after he identified regional and remote schools were under-resourced to provide STEM education compared to students in urban areas. He saw an opportunity to encourage and engage First Nations students to pursue further STEM education or STEM careers.[165]

DeadlyScience has provided STEM resources to over 800 schools and community organisations across all states and territories in Australia. These resources include telescopes, microscopes and science kits accompanied by teacher lesson resources. Schools involved with DeadlyScience have reported a 25% increase in engagement in STEM and increased school attendance.[166,167]

Photo credit: Australia Post via DeadlyScience.

[163] Submission to the Pathway to Diversity in STEM Review from DeadlyScience.

[164] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

[165] DeadlyScience. (2021). *About Us*. https://deadlyscience.org.au/about-us/

[166] DeadlyScience. (2021). *DeadlyScience*. https://deadlyscience.org.au/

[167] Western Sydney University. (14 June 2023). *Western appoints the deadly Corey Aden Tutt OAM to the position of Adjunct Associate Professor in the School of Science.* https://www.westernsydney.edu.au/newscentre/news_centre/more_news_stories/western_appoints_the_deadly_corey_aden_tutt_oam_to_the_position_of_adjunct_associate_professor_in_the_school_of_science

Existing teaching and learning tools and resources

Many national resources and programs exist to support teachers to improve student learning outcomes, including in STEM subjects:

- The Australian Curriculum Assessment and Reporting Authority (ACARA) provides national resources, including a professional development portal and resources to help teachers implement the national curriculum.
- The Australian Institute for Teaching and School Leadership (AITSL) provides support, resources and tools for initial teacher education. It also offers tools to help teachers improve student outcomes (such as professional standards and professional development resources).
- Education Services Australia (ESA) brings together curriculum-aligned digital teaching and professional development resources, including tools to support STEM teaching.
- The Australian Education Research Organisation (AERO) is an independent body that builds evidence about what works to achieve equity and improvements in education. AERO provides a practice hub with evidence-based resources for educators. It is establishing a First Nations Expert Reference Group to guide improvements in First Nations education.
- The Australian Council for Educational Research (ACER) develops and distributes evidence-based resources for people in education and related fields. This includes specific resources in STEM education.
- The Girls in STEM Toolkit and Future You have developed targeted resources to support teachers and parents to engage young women and girls in STEM learning and career pathways.
- The University of Adelaide's Computer Science Education Research Group runs a range of STEM teaching and professional development programs for Australian teachers. This includes massive open online courses, a lending library and digital technologies teaching resources.

Despite the breadth of resources to support STEM teaching and professional development, few options exist to help teachers tailor STEM teaching practices to engage students from diverse cohorts. Compounding this is the challenge of resources being spread across different platforms. It is critical that quality-assured STEM teaching and professional development resources are easy for teachers to find, rather than further fragmenting them across platforms.

In the UK, for example, the STEM Learning Network provides all teachers a single point to engage with STEM teaching resources and professional development.[168] There is also a community of practice of over 20,000 teachers and technicians to support school teaching in STEM subjects.[169]

There is an opportunity to address this through work underway as a result of the National Teacher Workforce Action Plan. This includes as part of scoping work underway by ACARA to support teachers to implement the national curriculum.

[168] STEM Learning. *STEM Learning Network*. https://www.stem.org.uk/about-us/our-network

[169] STEM Learning. *STEM Community*. https://www.stem.org.uk/stem-community

Providing early exposure to STEM experiences and career pathways

Students can be inspired to engage in STEM subjects when they can see a clear link to these skills and the possibilities and opportunities they create. This includes:

- providing opportunities to solve real-world problems using STEM
- drawing on school–industry partnerships and VET in schools to provide exposure and insights into meaningful future career opportunities.

> ‘Without knowing the full range of opportunities available to students, it is very difficult to sell STEM occupations as a viable career pathway if its definition is limited… This can be remedied if there are greater opportunities for engagement with industry, at an earlier stage’.[170]
> – Ai Group

Access to VET STEM programs in schools can help provide a ‘taster’ of tertiary courses and exposure to the flexible and diverse pathways into a STEM career.[171,172] Recent reports have recognised the value of VET in schools to create these pathways to work. However, there are concerns these courses are of inconsistent quality, difficult to navigate and not well integrated in senior secondary studies.[173] A working group is developing a National VET in Schools Strategy. This offers an opportunity to ensure VET in schools provides high-quality and responsive STEM learning opportunities that support the needs of underrepresented cohorts.

[170] Submission to the Pathway to Diversity in STEM Review from Ai Group.

[171] Education Council. (12 April 2018). *Optimising STEM industry-school partnerships: Inspiring Australia’s next generation*. https://www.chiefscientist.gov.au/2018/05/optimising-stem-industry-school-partnerships-report-released

[172] Submission to the Pathway to Diversity in STEM Review. Respondent opted to submit anonymously.

[173] Department of the Treasury. (2023). *Working future: The Australian Government’s white paper on jobs and opportunities*. Australian Government. https://treasury.gov.au/employment-whitepaper/final-report

TAFE Taster Pilot

One recent approach to increase awareness of VET STEM pathways was the TAFE Taster pilot. CSIRO's Generation STEM and TAFE NSW delivered the pilot – Kingswood / Padstow in 2022.

A total of 20 secondary students participated in the pilot where 63% were female and 64% were culturally and linguistically diverse. For 7 days, the program provided opportunities for students to engage in hands-on practical activities and interact with industry professionals. Having the opportunity to experiment in a range of subject areas, including STEM, enables students to visualise what a job would look like and learn how TAFE NSW can help them forge a career they love.

Survey results following the program revealed 100% of respondents agreed or strongly agreed they were more interested in learning about STEM. Further, 92% agreed or strongly agreed they 'know more about potential STEM jobs'.[174]

This was a very small pilot and sample. However, it demonstrates ways to engage students who may not already have an interest or understanding in VET STEM career pathways.

Industry partnerships and initiatives can provide exposure to real-world problem-solving and job opportunities in STEM, including through site visits, classroom activities or work experience.[175]

There are good examples of these partnerships across the country. However, similar to VET in schools, these opportunities are not effectively embedded in the education system. Partnerships are difficult to establish and require dedicated effort from schools and teachers who are already overburdened.

There is an opportunity to make it easier for schools and industry to connect. Industry can also do more to support these opportunities in schools and design them to engage diverse students. At the same time, industry-led activities should be valued and intentionally integrated with curriculum content to ensure they are reaching disengaged students.[176]

[174] Commonwealth Scientific and Industrial Research Organisation. (April 2022). *Student feedback from TAFE Taster Program pilot 2022: Stem Community Partnerships Program, Generation STEM*.

[175] Education Council. (12 April 2018). *Optimising STEM industry-school partnerships: Inspiring Australia's next generation*. https://www.chiefscientist.gov.au/2018/05/optimising-stem-industry-school-partnerships-report-released

[176] Department of Education. (23 July 2020). *Looking to the future: Report of the Review of Senior Secondary Pathways into Work, Further Education and Training*. Australian Government. https://www.education.gov.au/quality-schools-package/resources/looking-future-report-review-senior-secondary-pathways-work-further-education-and-training

‘Many excellent programs operate within schools and provide resources to teachers for STEM engagement for underrepresented groups. However, many schools simply put forward their STEM or gifted students for these initiatives, and students who don’t see themselves in STEM remain disengaged and ignored.’[177]
– Careers with STEM

One example of an industry partnership initiative in schools is Curious Minds.

Curious Minds

Curious Minds targets female students in years 9 and 10 who come from remote, regional, low socioeconomic and/or Indigenous backgrounds.

The program is jointly delivered by the Australian Mathematics Trust and Australian Science Innovations. It is also supported by the Australian National University and Chief Scientist, Dr Cathy Foley AO PSM, is a patron. It is funded by the Australian Government’s Department of Education.

The program includes virtual and residential camps that enable students to explore STEM through guest lectures, interactive activities and field trips. It also includes a mentoring program that matches students with a STEM professional based on a shared area of interest. Participants can build their confidence, interest, and skills. Mentors can further develop their mentoring skills, inspire students and create networks with other STEM professionals.

Over 650 students have participated since 2015. Program outcomes from 2015-2021 revealed:

- 91% of participating students felt more confident in STEM after participating in the program.
- 77% of participating students reported intending to have a career in STEM, with a particular increase in intentions to study engineering and IT.[178]

An internal evaluation of the 2021-22 program cycle revealed the value of mentoring:

- 96% of students valued the opportunity to discuss university and career options with mentors
- 95% of participating STEM professionals said they would recommend being a mentor to their colleagues and peers.

[177] Submission to the Diversity in STEM review from Careers with STEM

[178] Department of Education (2021). *Curious Minds: Student outcomes.* https://curiousminds.edu.au/student-outcomes-infographic

An example of an industry-led initiative that builds on international success is FIRST Robotics.

FIRST Robotics and FIRST Australia

FIRST Robotics started in the United States as a not-for-profit initiative to inspire children aged 4 to 18 to pursue further STEM education and careers. FIRST Robotics has reached over 2.5 million students worldwide since its inception in 1989.[179]

Mentors lead programs and competitions that emphasise hands-on learning for all participants.

FIRST Robotics prioritises equity, diversity and inclusion. It has a range of resources to remove barriers so all youth can participate. This includes financial support for disadvantaged communities and training for participants and staff to foster a culture of inclusion.

An ongoing longitudinal study in the US is tracking 1,273 students (a FIRST Robotics alumni group and a comparison group) over 9 years. Preliminary findings demonstrate:

- participation in extracurricular STEM programs influences study choices in college, with a preference for engineering and technology[180]
- 61% of past participants were working in a STEM field, versus 44% in the comparison group.[181]

FIRST Australia, established in 2006, is based at Macquarie University. It partners with schools and universities across Australia with teams and competitions held in Sydney, Brisbane, Melbourne, Adelaide and Perth. Three main programs are run in Australia:

- the FIRST LEGO League (ages 4-16)
- the FIRST Technical Challenge (age 12-18)
- the FIRST Robotics Competitions (age 14-18).

Industry funding has allowed FIRST Australia to support participants from diverse cohorts. For example, a LEGO Foundation grant helped establish hubs so students in rural and remote areas can participate in FIRST Robotics programs.

Student engagement in FIRST Robotics programs include:

- 160 students participating in 2021-22 through the Shoalhaven hub in NSW
- 432 students participating in 2022-23 through two additional hubs on the NSW Central Coast
- 100 students participating in 2022-23 through a hub in Western Sydney.

Hubs are also being established in the Mackay/Whitsundays region and the Hervey Bay/Gundiah region in Queensland.

High-quality career advice is also critical. It can show alternatives to the traditional high-school-to-university pathway that may discourage some students from continuing STEM education.

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[179] First Inspires. (2023). *A global robotics community preparing young people for the future.* https://www.firstinspires.org/about/at-a-glance

[180] Burack, C., Melchior, A., & Hoover, M. (2019). Do after-school robotics programs expand the pipeline into STEM majors in college?. *Journal of Pre-College Engineering Education Research (J-PEER)*, *9*(2), 85-97. https://docs.lib.purdue.edu/jpeer/vol9/iss2/7/

[181] First Inspires. (February 2023). *Longitudinal study: 2022 results (108-month follow up). https://www.firstinspires.org/resource-library/first-impact*

In 2020, the Education Council published a report highlighting that while there was an abundance of career information available, it varied in quality and accuracy. This made it difficult for teachers, parents and students to navigate.[182]

All governments have a role to support teachers, students, parents and carers with up-to-date and reliable advice about career opportunities and the educational pathways to get there.[183] Considering the existing burden on teachers and career advisers in schools, more innovative ways of promoting STEM career pathways should be considered as part of a communication and outreach strategy (Recommendation 11).

> ‘Career advice is often of variable quality in the senior years of secondary school. Many teachers have little or no experience of work in the private sector. Continuous exposure in secondary school to information regarding possible STEM courses leading to interesting and rewarding jobs across many industries and organisations may lead to better choice of courses at the tertiary level and lower dropout rates.’[184] – Anonymous submission

Photo credit: Master Electricians Australia.

[182] Department of Education. (23 July 2020). *Looking to the future: Report of the Review of Senior Secondary Pathways into Work, Further Education and Training*. Australian Government. https://www.education.gov.au/quality-schools-package/resources/looking-future-report-review-senior-secondary-pathways-work-further-education-and-training

[183] Submission to the Pathway to Diversity in STEM Review. Respondent opted to submit anonymously.

[184] Ibid.

Recommendation 9

The panel recommends that the Australian Government, through the Department of Education and Department of Employment and Workplace Relations, use its convening power to work with state and territory governments to ensure national tertiary education reforms include a focus on increasing access, participation and attainment by underrepresented cohorts in STEM education. Including through:

- the Australian Government's response to the Australian Universities Accord
- implementation of initiatives under the new National Skills Agreement
- working with relevant Jobs and Skills Councils on industry-led advice on improvements to VET training.

Key considerations for this recommendation

As a priority, actions must focus on increasing accountability of all tertiary education providers to create safe and inclusive places to learn and study. This includes by eliminating bullying, harassment and discrimination.

Actions to address barriers and increase access to STEM tertiary education should include:

- increasing availability of Australian Government supported places at university for underrepresented cohorts in priority courses
- increasing availability or accessibility of tertiary STEM courses in lower socioeconomic and regional/remote areas
- creating more flexible pathways into STEM courses, particularly:
    - alternative pathways to benchmarked and scaled entry requirements
    - smoothing pathways from VET into university
    - accommodating diverse learning needs
- increasing access to academic, social support and wrap-around supports
- reducing financial barriers to undertake a STEM course, including increasing the base stipend for PhD students
- ensuring all places to learn and study are physically accessible and inclusive, particularly for people living with a disability
- supporting and promoting First Nations people into higher degree research pathways to increase First Nations-led STEM research
- ensuring learning materials, reading lists and resources are developed with diverse representation and draw on diverse knowledge. In particular, they should incorporate First Nations Knowledges and perspectives.

These efforts must meaningfully draw on the voices and aspirations of underrepresented cohorts to ensure measures are designed and implemented in a way that is culturally safe and responsive to their needs.

Why we recommend this

Different people experience different barriers and enablers for engaging in tertiary education, which are often compounded by intersectionality. These can include:

- distance from a tertiary education provider
- reliable internet access
- access to a like-minded peer network, community or family
- learning materials or schedules that accommodate for different physical or cognitive needs (including for people living with a disability, carers or neurodivergent people)
- the financial means to study or undertake placements.

Tertiary education providers (VET and universities) are working to address barriers, but participation data shows more needs to be done. Government-led tertiary education reforms offer an opportunity to accelerate progress on diversity and inclusion in tertiary education. These opportunities include:

- implementing recommendations of the Australian Universities Accord to improve equity and safety in higher education
- implementing the National Skills Agreement to increase equity in VET participation and completion, and ensure VET provides the skills required by critical and emerging industries. The agreement includes key reforms to increase diversity. These reforms include developing partnerships between states and First Nations people relating to implementation, and trialling new approaches to increase VET completion among underrepresented cohorts
- examining outcomes of the NSW Government's Vocational Education and Training Review for implementation beyond NSW. The review is exploring ways to improve equity access in VET, including how to improve completion rates, course design and delivery, and learning support[185]
- work by independent Jobs and Skills Councils, which are being established to provide industry-led advice on improvements to the VET system and filling skill gaps in their industries.

Careful consideration must be given to the unique requirements and demands of STEM courses and how they can create additional barriers if not addressed. The dedicated advisory council, proposed in Recommendation 1, could provide expertise to ensure these long-term reforms have a specific focus on increasing access and retention of diverse, underrepresented cohorts in tertiary STEM education.

Tertiary education providers must ensure places to learn are safe and inclusive. Access to tertiary education must be equitable, and pathways to attain a STEM qualification must be flexible and accessible.

[185] NSW Government. (19 September 2023). *NSW Vocational Education and Training (VET) Review*. https://education.nsw.gov.au/about-us/strategies-and-reports/our-reports-and-reviews/nsw-vocational-education-and-training-review

Participation in VET and university STEM courses

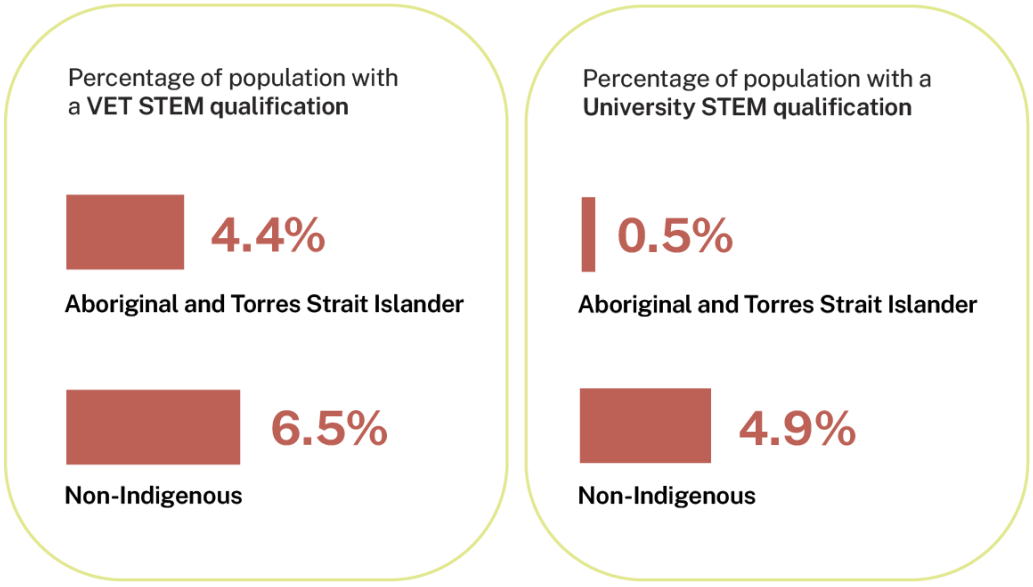
There have been some improvements in enrolment and completion in STEM education with respect to underrepresented cohorts. For example, there has been a 31% increase in the number of women enrolled in university STEM courses between 2015 and 2021. The number of First Nations students completing STEM degrees has more than doubled (from 124 to 366) between 2011 and 2021.

However, enrolment and completion rates are still low. Similar to participation in school, some disciplines have less diversity than others. This shows more is needed to understand and address the needs of different diversity cohorts and how to best support them on their pathway into a STEM career.

In 2021, 36.2% of STEM university students identified as female.[186] However, there are lower proportions of women in undergraduate IT and engineering courses, compared to natural and physical sciences that have more of a gender balance.[187]

Among other underrepresented cohorts, 4.6% of people studying university STEM subjects in 2021 were living with a disability.[188] In the same year, less than 1% of First Nations people held a university STEM qualification.[189]

In VET courses, engineering fields have the lowest proportion of women enrolled, with 10% or less since 2015. In 2021, less than 5% of First Nations people held a VET STEM qualification.[190]



Making sure tertiary education is safe and accessible

All education settings must be safe for all students and staff to thrive. Particularly, they must eliminate harmful or negative experiences students may face as a result of their identity. This includes education providers being transparent and accountable for preventing and taking action

[186] Submission to the Pathway to Diversity in STEM Review from Universities Australia.

[187] Science and Technology Australia. (August 2023). *STEM career pathways major research report.* https://www.chiefscientist.gov.au/STEM-CareerPathways

[188] Submission to the Pathway to Diversity in STEM Review from Universities Australia.

[189] Australian Bureau of Statistics. (2021). *TableBuilder*. Australian Government. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

[190] Ibid.

against bullying, harassment, racism and discrimination on the bases of gender, disability, race or sexual orientation.

The *Australian Universities Accord interim report* noted more needs to be done to address student safety, including in relation to sexual assault and harassment. A key action is for Australian governments to work together to strengthen university governing boards, with a priority to do more to improve student and staff wellbeing.[191]

University participation of students with a disability increased significantly during the COVID-19 pandemic, demonstrating the success of online or hybrid options.[192] However, progress to ensure equitable access for people living with a disability needs sustained attention. In particular, this means ensuring a move back to on-campus learning does not create disadvantages. For example, making sure:

- labs and spaces to learn are accessible
- learning materials accommodate for visual impairment or cognitive differences
- people living with a disability have equitable access to peer and academic support.

Informing these efforts needs better data collection on participation and attainment of people living with different types of disability, and what helps to remove barriers.[193]

Tertiary education providers must also make efforts to value, and accommodate, the unique skills and perspectives that people from diverse cohorts can bring to course content and peer learning.

> ‘I identify as neurodivergent, but only discovered that in the last 2 years. On reflection, I can see how the way that I think has been an asset for the way that I do science. I am systematic, I think deeply about concepts and problems, I bring unique solutions based on the broad range of experiences that I have.’[194] – Anonymous submission

The *Big Mob: STEM it Up research report 2024* highlighted that universities are missing opportunities to engage First Nations students if they don’t incorporate or accommodate First Nations Knowledges in STEM courses. This may help to attract more First Nations students into STEM courses, alongside linking qualifications to the needs of their communities.[195]

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[191] Department of Education. (2023). *Australian Universities Accord interim report*. Australian Government. https://www.education.gov.au/australian-universities-accord/resources/accord-interim-report

[192] Ibid.

[193] Ibid.

[194] Submission to the Pathway to Diversity in STEM Review. Respondent opted to submit anonymously.

[195] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

Providing financial and wrap-around support

Easy-to-access wrap-around supports can help address external barriers. The *Universities Accord interim report* highlights the need for additional resourcing for universities to meet higher costs of supporting students from underrepresented and disadvantaged cohorts. Consultation as part of the review aligns with the *Universities Accord interim report*. Key enablers of equal participation in tertiary education include:

- the affordability of measures to ensure equitable access for people living with a disability
- initiatives to generate social inclusion (such as mentoring and networking programs for specific cohorts)
- measures to provide academic support (such as tutoring, foundational skills and academic preparedness).[196]

Australian tertiary education providers are doing good work to improve supports for diversity cohorts, but these vary depending on the institution. Supports must be designed in a way that genuinely understand and meet these different needs. One example of a student-led initiative is CANDID (ChronicAlly ill, NeuroDiverse, Impaired and Disabled) at LaTrobe University. The initiative provides peer support to students that identify as chronically ill, neurodivergent, impaired or disabled. Peer support includes a safe space for peers to meet, share strategies and experiences and learn about resources available at the university.

Financial supports must also be accessible and equitable. Submissions to the review highlighted that financial barriers and pressures unique to STEM courses are significant.[197] These can disproportionately affect students from lower socioeconomic backgrounds. For example, students studying STEM courses can have more contact hours on campus than students studying in other fields. As a result, STEM students have less time to participate in paid part-time or casual work to support themselves. Financial assistance can also support students to undertake mandatory placements and provide equitable access to learning materials or technology required to fully participate in STEM courses.

Consultation through this review also highlighted that the PhD stipend must be increased for all students. PhD students make up 60% of the research workforce. The full-time base stipend rate in 2023 is $29,863.[198] This sits well below Australia's national minimum wage. Inadequate stipends can disproportionately impact people from underrepresented cohorts, particularly those from low-SES backgrounds, and can prevent them from progressing into research careers. This critical need has also been reflected in the *Australian Universities Accord interim report*.

Targeted scholarship schemes can help attract and retain underrepresented cohorts in STEM courses. For example, a survey of Elevate participants found that 73% of respondents said the program increased their interest in studying STEM. And 41% said they pursued STEM study because of the support offered by the program.[199] However, these programs are often

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[196] Department of Education. (2023). *Australian Universities Accord interim report*. Australian Government. https://www.education.gov.au/australian-universities-accord/resources/accord-interim-report

[197] Submissions to the Pathway to Diversity in STEM Review from ARC Centre of Excellence for Climate Extremes, Cooperative Research Australia, Danielle Udy, Regional Universities Network. Other submissions on this point were made anonymously.

[198] Department of Education. *Research Training Program stipend rates.* Australian Government. https://www.education.gov.au/research-block-grants/research-training-program

[199] ACIL Allen. (2023). *Women in STEM Evaluation Final Report*. Report for the Department of Industry, Science and Resources. https://www.industry.gov.au/publications/women-stem-initiatives-evaluation-report

oversubscribed and highly competitive. They are only part of the solution, as students may also be ineligible for some scholarships if they need to take-up flexible study arrangements or have caring responsibilities that require them to take breaks from study.

Universities should work with First Nations people on ways to build supported pathways into higher degree research for First Nations students. First Nations students currently make up only 1.7% of PhD enrolments.[200] Increasing the number of First Nations researchers will help to increase important First Nations-led research, and advance Indigenous Knowledge in STEM disciplines. This is a feature of the *Australian Universities Accord interim report*, and the Big Mob: STEM it Up research project findings.

Providing spaces for students to learn away from campus, and receive access to supports in one place, can help engage students from regional or remote areas and support them to maintain connections to their family and community. For example, the Wuyagiba Study Hub provides university education for First Nations students living on Arnhem Land. The hub employs cultural and academic experts to teach on Country, delivered in partnership with Macquarie University.

Regional University Study Hubs

Regional University Study Hubs (previously Regional University Centres) provide physical study spaces, equipment and wrap around support for students in regional and remote Australia. Students studying through any Australian higher education or vocational education and training provider can use the hubs to access and participate in tertiary education without having to leave their communities. This can remove barriers created by needing to travel to and from campus or losing family or community support when moving away from home.

There are 32 hubs currently open around Australia, with another 2 currently establishing. Up to 20 additional hubs were announced in response to the *Australian Universities Accord interim report*, alongside up to 14 new Suburban University Hubs. Department of Education data shows that the hubs supported over 3,400 students as of April 2023. Approximately 11% of students supported by the program in 2022 identified as First Nations people.

The Regional University Study Hubs aim to:

- enable students in rural, regional and remote Australia to access and complete higher or vocational education without having to leave their community
- meet a demonstrated gap in support for study in a regional, rural or remote community
- support students who wish to stay in their community while they complete their course of study
- enhance the experience of students studying within their own community
- encourage strong links between the centres and other organisations in the area, including other support services or industry that students may access
- complement, rather than replace, existing and planned university investments and activities in regional areas, such as satellite campuses and study centres.

A 2021 evaluation of the program found there was evidence that Regional University Study Hubs have a positive impact on student retention and support access to tertiary education for

[200] Department of Education. (2023). *Australian Universities Accord interim report*. Australian Government. https://www.education.gov.au/australian-universities-accord/resources/accord-interim-report

under-represented groups, including those who are first in family, from low socioeconomic status households and First Nations students.

Valuing and increasing flexible STEM education pathways

Flexible learning pathways to careers in STEM can engage people from diverse cohorts who do not want, or are not ready, to pursue a higher education degree. This can encourage people to re-skill into a STEM job, upskill, progress or re-enter their STEM career.

University and VET STEM qualifications are equally important to meeting STEM workforce needs. Students and employers must equally value them to expand the STEM workforce. In 2021, of the 12.7 million people in the Australian labour force, 9% had a VET STEM qualification and 8% had a university STEM qualification.[201]

Research suggests a significant proportion of Australian secondary students place a greater value on direct university entry (based on academic grades) compared to other pathways.[202] This fails to recognise the great benefit that VET and other alternative training options offer as a pathway to access or advance in a STEM career.

The consultation and research for this review showed that students were more likely to access, complete or return to STEM education if there are flexible options.[203] At a consultation session at the Batchelor Institute in Darwin, First Nations students explained that this TAFE model provided flexibility to study in 'blocks'. Blocks are more intensive learning periods followed by longer breaks to maintain close connection to their community and culture.

The workshop also revealed the benefit of hands-on, practical learning experiences offered by VET STEM courses, which help participants see the connection to a career. In particular, it allowed participants to see how tertiary education could help them meet their aspirations to capture and share their community's culture and stories.

Greater flexibility in how previous life or work experience or qualifications are recognised in entry requirements, or achieving tertiary qualifications, can also attract people with diverse experiences to attain or further their education in STEM.

[201] Australian Bureau of Statistics. (2021). *TableBuilder*. Australian Government. https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

[202] Bennett, D., Coffey, J., Bawa S., Carney, D., Dockery. A. M., Franklyn, K., Koshy, P., Li, I. W., Parida, S., & Unwin, S. (2022). *Ameliorating disadvantage: Creating accessible, effective and equitable careers and study information for low SES students.* National Centre for Student Equity in Higher Education.

[203] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

University of Technology Sydney – Additional ATAR points

The University of Technology Sydney has implemented more flexible entry requirements to encourage diverse and underrepresented cohorts to apply for and attend courses that they may not otherwise have applied for.

The university has granted female students an additional 10 ATAR points since 2020 in the fields of engineering, IT and construction. This was to encourage female students to pursue study and careers in these fields. The university sought and received permission from the NSW Anti-Discrimination Board before implementing the approach.

Across all courses that offered the extra ATAR points to women between 2019 and 2022, there was a 109% increase in female enrolments. In 2022 specifically, 28% of the students in these courses were female, an increase from the 19% that had previously been recorded in 2019.[204] The university is pleased with the uptake of enrolments in these fields by female students but acknowledges there is still more to be done to increase diversity by universities and at industry level.[205]

Upskilling and re-skilling – stackable courses and industry-led training

A lifelong learning approach to STEM education requires quick, affordable and easy-to-access options to upskill and re-skill in new or emerging skills. This will support a diverse STEM workforce that can navigate rapid technological change and take advantage of future labour market opportunities.[206] This is particularly important to support mid-career transitions and people re-entering the workforce following periods of caring, where a university degree may not be viable.

‘Tech Council research shows that women are twice as likely to enter the tech force at age 25-30, then before they are 25. This means early to mid-career transitions are the primary way they enter the sector. Therefore, to increase women’s participation in tech jobs, it will be vital to increase the opportunities for women to reskill and upskill into them.’[207] – Tech Council of Australia

[204] White, D. (8 November 2022). University boosts female enrolments in male-dominated subjects after lowering ATAR bar. *The Sydney Morning Herald.* https://www.smh.com.au/national/nsw/university-boosts-female-enrolments-in-male-dominated-subjects-after-lowering-atar-bar-20221010-p5bomw.html

[205] Baker, J. (28 August 2019). ‘A hand up, not a handout’: UTS lowers engineering entry bar for women. *The Sydney Morning Herald*. https://www.smh.com.au/education/a-hand-up-not-a-handout-uts-lowers-engineering-entry-bar-for-women-20190828-p52lpp.html

[206] Department of the Treasury. (2023). *Working future: The Australian Government’s white paper on jobs and opportunities*. Australian Government. https://treasury.gov.au/employment-whitepaper/final-report

[207] Submission to the Pathway to Diversity in STEM Review by the Tech Council of Australia.

The *Australian Universities Accord interim report* highlights the potential of more modular or stackable credentials that can build towards recognised qualifications. This includes a wide range of tertiary qualification types, such as undergraduate short courses, micro-credentials, cadetships, diplomas and advanced degrees. The Accord is considering changes to funding, credit and regulatory systems to support students to undertake quality micro-credentials in priority skill areas.[208]

Industry can play a critical role by identifying the skills it needs and working with training providers to design courses that meet these needs. This includes creating flexible and accessible education options that suit diverse needs.

National Australia Bank (NAB) - Upskilling existing workforce in cloud technology

NAB's work to upskill staff in digital technology is an example of industry leading efforts to identify and fill skill gaps in its workforce.

In 2018, NAB launched the Cloud Guild to provide in house, Amazon Web Services (AWS) certified, cloud technology training to prepare staff for a large-scale migration into the cloud.[209] A further benefit of the Cloud Guild is that it helped NAB with hiring and recruiting staff as it is seen as an attractive feature for future employees.[210]

Learnings from the Cloud Guild have informed other training initiatives at NAB, such as the 'She Builds CloudUp' initiative which offers in-house, AWS accredited cloud technology training for any female NAB employee. It is the first company in the world to offer this course internally, resulting in high demand. The first intake in 2022 was planned for 100 women but was extended to more than 500 women.[211] A second intake of 339 completed the course in September 2023, and a third is planned for 2024.

A key feature of the program is how the training is delivered to allow participants to complete their training alongside their day-to-day work at NAB. Employees are provided dedicated time to complete the 8-weeks of training, access to digital self-paced modules and weekly virtual Q&A sessions with AWS Mentors. Program participants have reported that the course helped them better understand cloud technology, providing the first step to reskill and move into a technology role.

Industry, education providers and government can work together on more innovative approaches to upskilling. Re-skilling into STEM has also shown promise.

[208] Department of Education. (2023). *Australian Universities Accord interim report*. Australian Government. https://www.education.gov.au/australian-universities-accord/resources/accord-interim-report

[209] Weber, K. (22 February 2021). NAB Cloud Guild reaches more than 7000 staff. *iTnews*. https://www.itnews.com.au/news/nab-cloud-guild-reaches-more-than-7000-staff-561266

[210] Crozier, R. (7 May 2019). NAB credits Cloud Guild for reversal in hiring fortunes. *iTnews*. https://www.itnews.com.au/news/nab-credits-cloud-guild-for-reversal-in-hiring-fortunes-524751

[211] Redrup, Y. (8 February 2023). Why 500 women from NAB signed up to a new tech program. *Australian Financial Review*. https://www.afr.com/technology/why-500-women-from-nab-signed-up-to-a-new-tech-program-20230131-p5cgpr

Institute of Applied Technology (IAT)

The IAT model is an example of industry, government and education providers collaboration to meet STEM workforce needs through micro-skills and micro-credentials.

The IAT is a collaboration between TAFE NSW, industry and universities. It was established in response to a recommendation of the 2020 review of the NSW vocational education system, which considered models of how to bring the best of vocational and higher education together to meet current and emerging labour market needs.[212]

The IAT – Digital pilot provides training in areas of technology including cloud computing, cybersecurity and software programming. The partnership arrangement allows for micro-credentials to be recognised as prior learning towards further study at one of the partner education providers (Macquarie University, University Technology Sydney or TAFE NSW). Subsidised training is available for permanent NSW residents.[213]

It is an example of an innovative education model that provides a flexible and accessible education option to allow for upskilling or reskilling to meet workforce needs.

Photo credits (left to right): CSIRO; The STEM Teacher Enrichment Academy (University of Sydney).

[212] Gonski, D., & Shergold, P. (2021). *In the same sentence: bringing higher and vocational education together*. NSW Government, Department of Premier and Cabinet. https://education.nsw.gov.au/about-us/strategies-and-reports/our-reports-and-reviews/review-on-the-nsw-vocational-education-and-training-sector

[213] TAFE NSW. *Institute of Applied Technology*. https://www.tafensw.edu.au/iat

Changing perceptions and valuing diverse knowledge

Australia's STEM leaders and the Australian Government must set the environment to change perceptions of what STEM is, who does it, and the breadth of opportunities available.

Recommendation 10

The panel recommends the Australian Government, through its research funding bodies:

- preference First Nations scientists and researchers applying for government funding for projects that affect or draw from First Nations Knowledges and knowledge systems, or that focus on First Nations engagement in STEM
- work with First Nations communities to develop further ways to elevate First Nations Knowledges.

The panel recommends the Learned Academies, as standard setters within the science and research community, work with the academic community and Traditional Knowledge holders to build respect, awareness and better practices to weave First Nations Knowledges into science and research systems. This work should be guided by First Nations people and inform the Australian Government's actions in response to this recommendation.

Key considerations for this recommendation

This work should include designing a framework to ensure that:

- First Nations people are resourced and supported to lead work increasing recognition and respect of First Nations Knowledges as a valid and valuable knowledge paradigm.
- Researchers are supported by research leaders and administrators to collaborate with First Nations people and communities and value their Knowledges. For example, by ensuring research funding timeframes, publishing metrics, intellectual property, and funding expectations

are suited to respectful and genuine partnership with Aboriginal and Torres Strait Islanders with cultural authority.

More work is required to address research gaps around First Nations engagement in STEM, as well as on the effectiveness of policies and programs to increase this engagement. This work should be led by First Nations academics and communities.

Why we recommend this

STEM is usually thought of as its components: science, technology, engineering and mathematics. It was not until the beginning of the 19th century that the term ‘science’ was used in the way that it is used today.[214] The origins of modern science are commonly located in Western Europe, particularly Britain and France, during the 19th and 20th centuries.[215] Examples of STEM knowledge and practices are overwhelmingly drawn from Western Europe and North America in the past 500 years. They are usually concerned with the spread of Western-style science beyond the West.[216]

However, the term ‘science’ existed before the 19th century. It was applied to a broad range of disciplines that concerned the natural world, including theology. Today, disciplines such as theology would not qualify as science. This different application of the term 'science' shows that, for thousands of years, European people considered studying the natural world was not science, but other disciplines such as 'natural history', 'mixed mathematics' or 'natural philosophy'.[217]

This focus on science as being recent and Western may reinforce the ongoing exclusion of other knowledge systems. These knowledge systems have existed (and continue to exist) across the world and through time.[218]

The *Big Mob: STEM it Up research report* suggests that most teaching approaches in science work to assimilate First Nations Knowledges. This could position First Nations Knowledges as ‘inferior’ to Western knowledge, which devalues First Nations Knowledges within science thinking.[219] There is an opportunity to instead tease out multiple, simultaneous histories. This will highlight other ways of understanding the world, which are contingent on culture, place and values.

STEM is one set of practices and tools that people can use to solve problems and improve their lives. But STEM is not the only way to do this. Moreover, STEM disciplines (chemistry, electrical engineering, algebra, etc) are not the only STEM practices. And, while not everything is STEM, STEM can also inform other ways of thinking to contribute to community and society.

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[214] Cunningham, A., & Williams, P. (1993). De-centring the ‘big picture’: The origins of modern science and the modern origins of science. *The British Journal for the History of Science*, 26(4), 407-432

[215] Orthia, L. (2020). Strategies for including communication of non-Western and Indigenous Knowledges in science communication histories. *Journal of Science Communication*, 19(2) 1-17

[216] Ibid.

[217] Cunningham, A., & Williams, P. (1993). De-centring the ‘big picture’: The origins of modern science and the modern origins of science. *The British Journal for the History of Science*, 26(4), 407-432

[218] Orthia, L. (2020). Strategies for including communication of non-Western and Indigenous Knowledges in science communication histories. *Journal of Science Communication*, 19(2) 1-17

[219] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

First Nations Knowledges as STEM

‘Our people have been observing, hypothesising, and developing legitimate understandings of reality/ies for millennia. Science is not just a part of “Traditional knowledge” as Ancestral wisdom, but also integrated into Indigenous ways of thinking and knowing today.

The connection is that STEM is the building block of ancient Aboriginal culture. Aboriginal culture was able to use science to live off the land, collect natural medicines and protect native animals. Aboriginal culture was able to create technology like hunting tools, weapons, clothing and instruments. Aboriginal culture was able to thrive through environmental engineering. Aboriginal culture was able to use maths to ensure that no natural resource was wasted or overused.

Our culture is built on mathematical genius (like the kinship system) and feats of engineering and science. We are the original STEM culture, we just never needed to or need to separate it from culture and Country and life.’[220] – Survey respondent, *Big Mob: STEM it Up research report*

First Nations people have managed, maintained, transmitted, applied and traded knowledge through well-established and sophisticated systems for tens of thousands of years. This included surviving natural disasters, pandemics, the ongoing impacts of colonisation, and forced disruption of language and culture and links to Country. This strength and resilience make up the impressive first chapter of Australia’s STEM history.

First Nations Knowledges and knowledge systems need to be celebrated and acknowledged for their unique, intrinsic value. These systems can stand apart from STEM, as well as work with and complement STEM. A properly calibrated relationship between First Nations people and Knowledge and STEM is critically important to achieving greater social, scientific, technological and economic outcomes. This work must be intentional, ongoing and First Nations-led.

It is now almost universally accepted that the world’s environmental problems are multidimensional and complex. It is also accepted that existing technological solutions are not sufficient. To achieve

[220] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

a more social-ecological transformation, the broadest possible range of ideas, knowledge, and insights, including those of First Nations people, is necessary. First Nations approaches to STEM apply a broader lens and see everything as interconnected.

‘Western science is very objective. It’s a question and then an answer… First Nations people see it all very differently. We see the whole picture. So, it’s like we see the question, the answer, but also all the grey in between.’[221] – Associate Professor Corey Tutt OAM.

The Learned Academies have a key role to play in changing perceptions and practices around the recognition of diverse knowledges within STEM. As standard-setters and upholders of scientific and research excellence, they should lead by example and work with First Nations people to work towards this shift. They should do this in a way that resources and supports First Nations people to weave their Knowledges into science and research systems where appropriate, and recognise First Nations control over their Knowledge.

Funding streams to allow preferencing First Nations researchers and scientists

Through interviews, the panel heard that applications for government grant funding in STEM often include a desire to engage First Nations communities. The panel heard that this was perceived to increase the likelihood of receiving funding. This demonstrates that funding considerations drive some grant applications rather than a genuine intention for First Nations co-designed and led research.

Grant funding administered by the government should therefore:

- promote awareness of funding opportunities among First Nations communities, organisations and people
- engage and encourage First Nations applicants to apply
- preference First Nations scientists and research applicants. This is because these applicants are most closely connected to the communities their research impacts. They also better understand local priorities, needs and research sensitivities. This preferencing should occur when First Nations researchers:
    - lead research where it involves First Nations people or Knowledges
    - determine what kinds of questions are asked and have control over how their knowledge is represented in academic and other outputs.

[221] Associate Professor Corey Tutt OAM, interview with Mikaela Jade.

‘I think a lot of the time as mob, we don't have the luxury of being objective too, because our voices have been excluded for so long that how can we do systematic reviews of science when we're not in the conversation to begin with.’[222] – Coen Hird, *Big Mob: STEM it Up research project podcast*

People-focused STEM research cannot be undertaken without the perspectives, consent and control of the people being written about. The *Big Mob: STEM it Up research report* revealed existing literature regarding First Nations participation in STEM in Australia and the representation of First Nations Knowledges in STEM literature was undertaken by mostly non-First Nations authors.

Supporting First Nations researchers and communities is central to worthwhile collaborations. Non-First Nations researchers should approach partnerships with First Nations communities with awareness of the limits of their training and knowledge. By embracing a mindset of intellectual humility, conditions for more meaningful First Nations leadership will more likely be created. Taking time to develop trust and understanding is essential for successful First Nations-led research outcomes.[223]

Elevating and integrating the importance of First Nations Knowledges

Education institutions, the Learned Academies, and organisations employing STEM workers all have the responsibility to recognise First Nations Knowledges as valid and valuable. They can do this by working with communities to elevate First Nations Knowledges. Moko-Painting and McAllister argue that decolonising science and science education is a necessary step before we can indigenise science.

The process of decolonisation involves challenging and critiquing the disciplines of Western science. It focuses on histories, structures and institutions that act as barriers to First Nations involvement in STEM.[224] These structures and institutions have contributed to First Nations people being treated as subjects for study and exploitation. Instead, First Nations people should be making decisions about research and science that affect them and their communities, and maintaining control over if, and how, their Knowledge is used. In an interview with the panel, Felicity Chapman stated ‘I think one of the biggest challenges…especially for younger mob coming up is, that they want to participate in STEM but…there’s an internal conflict of is it Western STEM?

[222] Interview with Coen Hird, Big Mob, STEM it up Project Podcast.

[223] McAllister, T., Macinnes-Ng, C., & Hikuroa, D. (31 March 2023). Indigenous Knowledge offers solutions, but its use must be based on meaningful collaboration with Indigenous communities. *The Conversation*. https://theconversation.com/indigenous-knowledge-offers-solutions-but-its-use-must-be-based-on-meaningful-collaboration-with-indigenous-communities-201670

[224] Moko-Painting, T., & McAllister, T. (15 June 2023). Indigenous Knowledge is increasingly valued, but to fully respect it we need to decolonise science – here’s how. *The Conversation.* https://theconversation.com/indigenous-knowledge-is-increasingly-valued-but-to-fully-respect-it-we-need-to-decolonise-science-heres-how-205097

Or is it culturally appropriate?'.[225] Including First Nations Knowledges within school or university science curricula means changing the current systems and structures.

Government and the Learned Academies also need to take material steps to ensure a large number of influential, remunerated, and continuing positions are genuinely accessible to First Nations students and staff.[226]

First Nations Knowledges and intellectual property rights and protections

Copyright and other intellectual property rights protect scholarly and creative works generally. But these protections have emerged from a Western idea of 'knowledge outputs' and are inadequate for protecting First Nations Knowledges.[227] For example, copyright does not cover cultural skills and practices, and First Nations Knowledges are frequently misappropriated and inappropriately commercialised.[228]

IP Australia has done work on First Nations Knowledge initiatives. Deepening the intersections between contemporary science and research methods and First Nations Knowledge systems should build on this work. It includes looking at potential changes to the Australian intellectual property system, including by developing standalone legislation to protect that Knowledge, to allow First Nations communities to determine who can use First Nations Knowledges.[229] This will stop the unauthorised use of First Nations Knowledges and develop recognition of First Nations people as rightfully owning their Knowledges.

Initiatives should also adhere to the UNESCO Indigenous Declaration and the UN Declaration on the Rights of Indigenous Peoples. The Australian Government endorsed these in 2009. The declarations are based on the fundamental rights to:

- self-determination
- participation in decision-making
- respect for and protection of culture
- equality
- non-discrimination.[230]

Research should also follow the:

- AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research
- Indigenous Knowledge Institute's Charter for Research with Indigenous Knowledge Holders
- where relevant, the National Health and Medical Research Council Ethical Guidelines for Research with Aboriginal and Torres Strait Islander Peoples.

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[225] Felicity Chapman, interview with Mikaela Jade.

[226] Orthia, L. (2020). Strategies for including communication of non-Western and Indigenous Knowledges in science communication histories. *Journal of Science Communication*, 19(2) 1-17

[227] University of Melbourne. (2003). *Indigenous Knowledges Research.* https://unimelb.libguides.com/c.php?g=932536&p=6741081

[228] Ibid.

[229] Intellectual Property Australia. (4 July 2023). *Scoping study on standalone legislation to protect and commercialise Indigenous Knowledge.* Australian Government. https://www.ipaustralia.gov.au/tools-and-research/professional-resources/data-research-and-reports/publications-and-reports/2023/07/03/05/26/scoping-study-on-standalone-ik-legislation

[230] Australian Human Rights Commission. *About Aboriginal and Torres Strait Islander social justice.* https://humanrights.gov.au/our-work/aboriginal-and-torres-strait-islander-social-justice/about-aboriginal-and-torres-strait

First Nations Knowledges and STEM

Modern STEM has frequently treated non-European and non-Western people as belonging to the past and unchanged through history. The word 'traditional' is often used to describe the concept of First Nations Knowledges. But this concept should recognise that First Nations Knowledges continues to develop, evolve and contribute to providing solutions to modern problems.[231]

First Nations Knowledges in bushfire management

Bushfire management in Australia is an example of how authorities are blending First Nations Knowledges with other STEM methods. Doing so enables them to respond to natural hazards and environment problems more effectively.

European settlers who arrived in Australia deemed the continent to be wild and unfamiliar. But the landscape had been very consciously and deliberately shaped by First Nations peoples' use of fire.[232]

For more than 65,000 years, First Nations people have used cultural burning to manage the land, maintain ecosystems and mitigate the risks posed by bushfires. First Nations people have a reciprocal relationship with the land – if the land is cared for, the land will take care of the people. Fire is a central element to living with and respecting Country.

Small patches of land were burned regularly and controllably at cooler temperatures in a 'mosaic' pattern. This limited the incidence and severity of wildfires across Australia by reducing the amount of flammable vegetation. It also promoted drought-shielding grasses and shrubs and distributed plants, grasses and trees to promote and protect animals, birds and insects.[233]

Burning was done in accordance with the seasonal calendars of local areas, which don't align with the European idea of the 4 seasons. Cooler mosaic burning helped sustain the life of First Nations communities across Australia for thousands of years by:

- providing access to food
- providing the ability to travel through Country and conduct ceremony
- protecting cultural sites
- providing refuge for animals.

European settlement and urbanisation disrupted these practices. However, Native Title acknowledgement and the bushfires of 2019–2020 sparked programs and multiple bodies of research into First Nations peoples' cultural practices and Knowledges with fire. This provides a better understanding of how to manage bushfires.

The Darwin Centre for Bushfire Research, located at Charles Darwin University, has worked with First Nations communities and rangers in northern Australia for 25 years to find more effective

[231] Intellectual Property Australia. (2023). *Indigenous Knowledge initiatives.* Australian Government. https://www.ipaustralia.gov.au/about-us/our-agency/our-research/indigenous-knowledge-initiatives

[232] The University of Melbourne Indigenous Knowledge Institute. (2023). *Fire.* https://indigenousknowledge.unimelb.edu.au/curriculum/themes/fire

[233] Western Sydney University. (2023). *A cool approach to land management.* https://www.westernsydney.edu.au/future-makers/issue-four/a-cool-approach-to-land-management

ways to manage bushfires.[234] Use of fire in this way is nuanced, complex and requires detailed and local knowledge of the land.

These collaborations have led to blending First Nations land management practices with modern scientific knowledge. This reduces fuel load through small, low intensity burns earlier in the fire season when greenhouse gas emissions are lower.[235]

Firesticks Alliance Indigenous Corporation is a not-for-profit organisation that aims to enhance the cultural and natural values of people and Country through conservation, cultural fire and land management practices. Firesticks was formed to support communities in the sharing of Traditional Knowledge to reimplement traditional cultural fire knowledge practices in Australia.[236]

Firesticks is leading the development of certification and assessment frameworks that will recognise and enhance First Nations practices in cultural fire across 14 country types. Co-founder of Firesticks Victor Steffenson has said 'it's about getting people onto Country and using Good Fire to heal the land. Because we know when we improve the health of the landscapes, we improve its resilience against wildfires'[237]

Mick Smith, Awabakal, Biripi and Worimi man and Associate Indigenous Fire Practitioner in the Hunter Region echoed the significance and recognition the Firesticks program brings to his community by saying 'we are finally getting the recognition that the old ways are the right way. This is how we used to do it for thousands of years, and we know it works'.[238]

[234] Charles Darwin University. (2023). *Darwin Centre for Bushfire Research.* https://bushfireresearch.org.au/#:~:text=Who%20are%20we%3F,NAFI)%20web%2Dbased%20portal

[235] Sangha, K., Edwards, A., & Rioli, W. Sr. (25 February 2021). Indigenous expertise is reducing bushfires in northern Australia. It's time to consider similar approaches for other disasters. *The Conversation.* https://theconversation.com/indigenous-expertise-is-reducing-bushfires-in-northern-australia-its-time-to-consider-similar-approaches-for-other-disasters-155361

[236] Firesticks. (2023). *About us*. https://www.firesticks.org.au/about/

[237] Suncorp (11 October 2021). *Supporting the next generation of Indigenous Fire Practitioners.* https://www.suncorpgroup.com.au/news/news/suncorp-announces-firesticks-community-partnership

[238] Ibid.

Vision Mātauranga

Vision Mātauranga is an international example of government policy that weaves First Nations Knowledges into science and research. It demonstrates the value of First Nations Knowledges in responding to environmental problems. It integrates and elevates First Nations Knowledges and ensures this is accompanied by work to protect against the commodification and exploitation of First Nations Knowledges and questions over its scientific value.

Mātauranga Māori is a modern term for the combined knowledge and understanding of Polynesian ancestors and the experiences of Māori living in Aotearoa/New Zealand. It is a government policy that:

- uses the science and innovation potential of Māori knowledge, resources and people for the environmental, economic, social and cultural benefit of New Zealand
- recognises Māori as important partners in science and innovation
- builds the capability of Māori individuals, businesses and incorporations to engage with science and innovation.[239]

Under Vision Mātauranga, individual scientists are working more closely with Māori communities and incorporating Mātauranga Māori within their scientific research. Māori communities benefit because these strong relationships enable science research to develop from the experiences or needs of the people.[240]

Progress of Vision Mātauranga has not been straightforward, with some publicly questioning the scientific value of Mātauranga. Others claim the purpose of the policy is to commodify Māori knowledge and Māori-owned natural resources to produce goods for international markets.[241]

The 'Understanding STEM' section of this report has addressed the importance of taking a broader approach to defining what STEM is. The above also explains how different ways of understanding the world have existed simultaneously throughout history. They are also heavily informed by language, culture, place and values. Only in more recent times has the 'Western' conceptualisation of science been privileged above other knowledge systems and ways of understanding the world.

First Nations people have been recognised as Australia's first scientists and innovators. The stars are used as a guide for hunting in Nations across Australia. For example, the Yolnu people use the Arcturus star as a sign to collect rakay to make baskets and fish traps. Torres Strait Islanders know that the rising of the 'yam star' signals the time to harvest yams. The first innovators bound tools together with what we now know as glue, created from different grasses, sand, ash and bark.[242]

[239] Ministry of Business, Innovation & Employment. (2023). *Vision Mātauranga.* New Zealand Government. https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/vision-mataurangа-policy

[240] Science Learning Hub - Pokapū Akoranga Pūtaiao. (2023). *Mātauranga Māori and science.* https://www.sciencelearn.org.nz/resources/2545-matauranga-maori-and-science

[241] Barber, K. (2022). Science, Indigenous Knowledge and the politics of academic research. *Arena Quarterly,* No. 11. https://arena.org.au/vision-matauranga-commodifying-maori-knowledge

[242] Tutt, C. (2021). *The First Scientists: Deadly inventions and innovations from Australia's First Peoples*. Hardie Grant Explore.

These examples demonstrate that despite technological advances, the voices and designs of the first scientists still remain. They are passed from generation to generation, complementing other knowledge systems and overlapping with 'Western' understandings of scientific methods.[243]

Initiatives that aim to elevate First Nations Knowledges must avoid isolating these knowledges from their cultures, languages, places and peoples and damaging their integrity. Instead, engaging with the voices of First Nations people, communities and leaders in a respectful way could broaden which people, cultures, knowledge, ideas and practices can contribute to and practice science.[244] Key to this is ensuring policy and legislative supports are established to protect these Knowledges from misappropriation by non-Indigenous people.[245]

To avoid the commodification or perceived commodification of First Nations Knowledges for economic gain, we must respect the self-determination of First Nations people. First Nations people must be supported to lead decision-making on how their knowledge can be used to benefit their communities and Australia. The work of IP Australia and other organisations looking to improve the legal protections provided to First Nations Knowledges will be key to this.

[243] Barber, K. (2022). Science, Indigenous Knowledge and the politics of academic research. *Arena Quarterly,* No. 11. https://arena.org.au/vision-matauranga-commodifying-maori-knowledge

[244] Orthia, L. (2020). Strategies for including communication of non-Western and Indigenous Knowledges in science communication histories. *Journal of Science Communication*, 19(2) 1-17.

[245] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

The Australian Government must increase the national profile of diversity in all areas of STEM, particularly through representation in Australian media.

Recommendation 11

The panel recommends the Australian Government develop a communication and outreach strategy to increase awareness, visibility and importance of diversity in STEM. This should emphasise the opportunities and potential for careers in STEM.

Key considerations for this recommendation

This strategy should focus on shifting broader community perceptions of STEM, STEM education and STEM careers through authentic, trusted sources.

It should:

- tailor initiatives for different cohorts, sectors and locations
- identify innovative ways to reach key groups including children, young people, their parents and carers, people considering a change of career, and people approaching key transition points through schooling and higher education
- draw on and incorporate diverse representation, highlighting the benefits of diversity in STEM to organisations and Australia's economy
- include a national, measurable media campaign to build awareness of the breadth of STEM skills, types of jobs in STEM sectors and pathways available
- draw on existing Australian Government programs and platforms such as the Inspiring Australia program. For example:
    - promoting STEM and STEM pathways to parents/carers and young people could leverage the Your Career platform tools and the National Careers Institute resources
    - reaching diverse cohorts through community outreach programs and organisations such as multicultural support services
    - tailoring outreach in remote and rural areas by working with Regional Development Australia and Questacon
    - building on resources and approaches developed in gender diversity programs to target other diversity cohorts
- seek opportunities to partner with industry, peak bodies, tertiary institutions and schools to promote STEM education and career opportunities
- promote opportunities for adults to reskill and upskill to participate in the STEM workforce
- broaden perceptions of STEM and the value of diverse scientific knowledge systems, including the role and value of First Nations Knowledges

Why we recommend this

Perceptions and stereotypes of what STEM is, what STEM jobs are, and who works in them, are shaped early in life. These stereotypes persist. For example, surveys in OECD countries found students view people in science and technology as doing 'boring, uninteresting work in unpleasant surroundings, cut off from other people', that STEM jobs are less people-oriented and less creative.[246]

STEM jobs can be creative and caring, they have the potential to change people's lives – such as finding ways to increase food security, or creative ways to help wildlife conservation and address climate change.

The 'Understanding STEM' section of the report aims to create a more inclusive definition of STEM. Ongoing strategic efforts are needed to shift the narrative and imagery of people doing and working in STEM. This expanded understanding will help address the persistent perception that STEM education and careers:

- is only for particular kinds of people
- only relates to particular kinds of activities
- is only attainable through particular grades and education pathways.

Education and work settings have an important role in changing these perceptions. Just as important are the influences in the community and the home – for example through parents or carers, media and community settings.

The Australian Government can take a leading role in shaping these perceptions using current and new platforms to engage with the public. The dedicated advisory council, proposed in Recommendation 1, should work with peak bodies, media organisations and education institutions at all levels to ensure they realise the importance of diverse representation. The communication and outreach strategy should form the basis of this work, building on existing efforts to shift perceptions of STEM.

[246] Luo, T., So, W., Wan, Z.H., & Li, W.C. (2021). STEM stereotypes predict student's STEM career interest via self-efficacy and outcome expectations. *International Journal of STEM Education*,36(8). https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-021-00295-y

Diverse representation and role models in STEM

Contributors to the review highlighted that 'you can't be what you can't see'. Young people across Australia are interested in STEM, but they may be reluctant to pursue a career because they don't have role models to support them. How diversity is represented in STEM education and jobs has an impact on choices to pursue study or careers in STEM.[247]

> Diverse role models are important at all education and career stages, from primary school right through to the workplace. Stereotypes that often begin in the early years of school – that maths is hard, science is for people in white lab coats – must be addressed through showing children, students and their parents that STEM is for everyone.'[248]

Opportunities for more diverse representation in STEM in school and tertiary education are highlighted in the 'Lifelong learning' section of this report. Government and non-government organisations must take deliberate action outside education settings to change how people perceive STEM careers. This includes through their:

- media and public relations outputs
- outreach initiatives
- hiring practices for STEM-related roles.

Existing government initiatives have set a foundation for shifting perceptions of STEM jobs. For example, Future You has built resources that show STEM pathways and traits of different diverse STEM professionals. Another example is Superstars of STEM, which provides mentorship and media training to increase representation of women and non-binary STEM experts in the Australian media. Another example is STEM Professionals in Schools, which is a national volunteer program that facilitates partnerships between schools and industry to bring real STEM into the classroom. Lessons from these initiatives can be used to inform the communication and outreach strategy to shift representation and perceptions of different people in different STEM occupations.

Industry is also taking a lead in shifting perceptions, as highlighted in the below case study.

[247] Submissions to the Pathway to Diversity in STEM Review from Australian Computer Society, Engineers Australia, the Department of Defence, iSTEM Co., Sydney Quantum Academy, The University of Melbourne, WILD for STEM, and others.

[248] Submission to the Pathway to Diversity in STEM review from Science and Technology Australia.

L'Oréal–UNESCO For Women in Science Program

The L'Oréal Groupe is an example of an organisation leading work globally to increase representations of women in science.

L'Oréal recognised that despite women leading on ground-breaking research throughout the world they aren't being recognised for these efforts. For example:

- women represent just 33% of researchers globally
- less than 4% of Nobel Prizes have been awarded to women
- only 11% of senior research roles in Europe are held by women.[249]

The L'Oréal Groupe and UNESCO have been working together on the For Women in Science Program (FWIS) for 25 years. FWIS operates internationally, including in Australia and New Zealand.

The program aims to empower, recognise and encourage more women to enter and progress in scientific and research careers through:

- media training
- elevating the platforms of female scientists to showcase their research more widely
- outreach to high school girls.

The L'Oréal-UNESCO Women in Science Australia and New Zealand Fellowships were launched in 2007. Each year the program celebrates 5 women in science for their scientific excellence and supports them to continue their research. Each Fellow receives $25,000 and is provided with media training and a platform to showcase their cutting-edge research.

As of 2023, the fellowship program has recognised 69 women scientists. Of these, 96% have stayed in research since being awarded a fellowship. These fellowships have helped elevate the public profile of the recipients, supporting them to drive cultural change and challenge perceptions about science.

L'Oréal-UNESCO For Women in Science Ceremony, 2023 Fellows: Dr Renata Borovica-Gajic, Dr Georgia Grant, Dr Lucia Romani, Dr Anna Trigos, Dr Deborah Burnett

Photo credit: L'Oréal-*UNESCO For Women in Science.*

[249] United Nations Educational, Scientific and Cultural Organisation. (November 2023). *UNESCO science report: Towards 2030*. https://unesdoc.unesco.org/ark:/48223/pf0000235406

Awards and recognition for achievement in STEM provide an additional opportunity to showcase diversity, for example, the Prime Minister's Prizes for Science and the Queensland Young Tall Poppy Science Awards.

Government outreach programs and rewards could increase diversity and help more Australians see themselves and people like them reflected in excellence in STEM. This could be done by:

- recognising the achievements in STEM of people from diverse backgrounds
- expanding the pool from which awardees are drawn to include the achievements of those from alternative STEM education and career pathways
- naming awards after diverse people.

Promoting diverse STEM career pathways

Research shows that many children's ideas about careers are already in place by the time they finish primary school.[250] These perceptions are influenced by the media, families and schools.

> 'Changing perceptions about STEM requires efforts in all of these areas to combat misconceptions in STEM and to build community and confidence around participating in STEM study and careers.'[251]
> – Careers with STEM

Most careers education programs begin in grade 9 or 10. The National Youth Commission Australia's Inquiry into Employment and Transitions suggests this is too late and limits young people from understanding available work opportunities. Instead, careers education should begin earlier.[252]

Recommendation 7 outlines improving supports for educators, schools and career advisers to provide current information about different STEM career pathways.

Educators and career advisers have large workloads and don't always have adequate time to ensure students get the information, advice and support they need to make decisions about their futures.[253] For example, research conducted in 2018 by Refraction Media and the University of Adelaide found there can be as few as one career adviser for every 1500 students.[254]

Parents and families are another key influence on perceptions and bias around STEM that can positively influence children and family members to pursue study or work in STEM. A 2021 survey

[250] Submission to the Pathway to Diversity in STEM Review from Careers with STEM.

[251] Ibid.

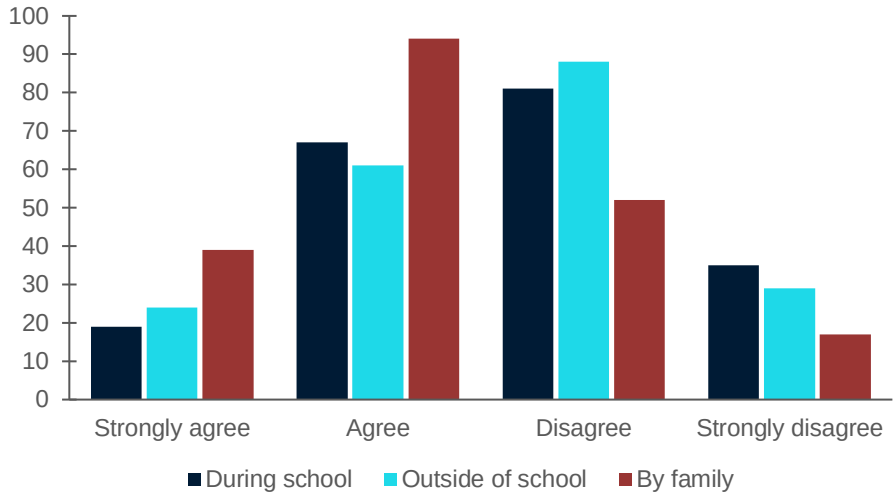
[252] National Youth Commission Australia. (2021). *You can't be what you can't see: The careers advice problem in Australia*. https://nycinquiry.org.au/the-careers-advice-problem-in-australia

[253] Ibid.

[254] Ibid.

by Joblist found that 52% of people in the job market work in careers that their parents wanted for them. Almost 40% felt pressured to follow their parents' career advice.[255] The *Big Mob: STEM it Up research report* also found that family is the most influential factor behind choices of First Nations students in relation to study and career.[256]

Figure 6: Participant levels of agreement to whether their interest in STEM was supported (a) during school, (b) outside of school, or (c) by family on a 4-point scale ranging from 'Strongly agree' to 'Strongly disagree'. Source: *Big Mob: STEM it Up research report* (2023).



The communication and outreach strategy should identify biases, myths and assumptions that individuals, parents and educators hold about STEM skills, careers and education in Australia. It should find innovative ways to educate children and young people, and those influential in their career and subject choices, about:

- pathways and opportunities
- industry and higher education provider networks
- connection to diversity in STEM stories and examples.

Key principles for the communication and outreach strategy

People understand what STEM is in different ways, based on their values and experiences. Stereotypes, attitudes and perceptions can be deeply engrained and take time to adjust. The communication and outreach strategy must be designed in a way that allows for continued and tailored messaging through multiple channels.

Key principles for designing communication and outreach activities include:

- tailoring messaging and channels based on an understanding of what influences decisions by different groups of people (for example, their trusted sources, location and aspirations)
- long-term approaches that allow time for cultural change

[255] Joblist. (2021). *The impact of parental influence: Career edition.* https://www.joblist.com/trends/the-impact-of-parental-influence-career-edition

[256] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z., Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

- a focus on diverse STEM careers and education pathways, for example through VET or industry training
- embedding evaluation to monitor success of strategies
- leveraging and aligning with existing campaigns or platforms (for example, Inspiring Australia and the Your Career platform.

Inspiration can be taken from previous successful government-run media campaigns. These include 'Maths Multiplies Your Choices' and 'Slip Slop Slap'. A key lesson from these campaigns is the need for long-term funding and support. For example, the Australian Government funded Slip Slop Slap campaign has been running since 1981, resulting in a dramatic shift in sun protection behaviour and decreased rates of skin cancer.

Maths Multiplies Your Choices

Maths Multiplies Your Choices (MMYC) is an example of a successful media campaign influencing behavioural choices of girls selecting subjects at school – and the importance of continued messaging. The Victorian Government ran MMYC between July and early November of 1989. The campaign targeted girls aged 13-15 and their parents to encourage enrolment in maths and science subjects in school. The campaign slogan was 'don't pigeon-hole your daughters'.[257] The campaign coincided with timing of subject selection for the following year.

MMYC campaign included a number of strategies, such as:

- television commercials shown during "family viewing time"
- radio advertisements on stations predominantly listened to by young girls
- tram panels aimed at parents and commuting students
- letters to parents of all girls in Year 10 explaining the messaging behind the campaign
- information booklets for parents.[258]

A survey of parents and Year 10 girls found the campaign increased rates of enrolment in maths and science subjects. After initial success, funding was discontinued. Following termination of the campaign, the rates girls enrolled in the maths and science subjects decreased to where they had been prior to MMYC.[259]

The strategy should be developed and progressed across government, informed by advice of the advisory council. It will take time and need to be well resourced.

Leveraging the Australian Science Communicators Network will be valuable to this process. So will advice and support from media groups such as SBS, the Advertising Council of Australia, and the Association for Data-driven Marketing and Advertising. The Australian Science Media Centre (AusSMC), which aims to enhance the media's coverage of science, could also provide advice.

[257] Department of Labour. (1989). *How maths multiplies your daughter's choices*. Victorian Government.

[258] Department of Labour (Women's Employment Branch). (1990). *Maths multiplies your choices.* Victorian Government.

[259] McAnalley, K. (1991). Encouraging parents to stop pigeon-holing their daughters: The 'Maths Multiplies Your Choices' campaign. *Victorian Institute of Educational Research Bulletin*, 66.

The AusSMC works to support and improve the diversity of expert voices in the media by supporting specific initiatives for women, First Nations scientists and CALD experts.[260]

Organisations providing specific advice on diversity in the media could also be leveraged. For example, Shift20, which aims to change perceptions and stereotypes of people living with a disability through the media.

A holistic communication plan should be developed alongside the strategy. This could include a variety of communication pathways in addition to media and advertising campaigns. For example:

- participating in relevant national and local events to promote the advisory council and the importance of diversity in STEM
- ensuring that council members have consistent exposure to press
- ensuring that council members are well supported to act as key advocates and trusted sources for change, with proactive and personalised communications support.

Photo credit: DeadlyScience.

[260] Australian Science Media Centre. (2023). *About Us*. https://smc.org.au/about-us

Diversity in STEM Program Strategy

The Diversity in STEM Program Strategy outlines an approach to designing and delivering programs to increase diversity in STEM. The Pathways to Diversity in STEM Review identified gaps and duplication in current programs funded by the Australian Government. It also identified opportunities to improve future program focus and design to attract and retain more diverse people along STEM pathways.

The strategy has 3 key elements. They set a foundation for the proposed dedicated advisory council and the department supporting it (as outlined in Recommendations 1 and 2 of this report) to take forward.

The elements are:

- Embed best-practice program design in all programs to increase diversity in STEM. This will ensure they are impactful and lead to long-term change.
- Change the existing suite of women in STEM programs to address findings of the review and ensure they align with best-practice program design.
- Design new programs to fill gaps in support for all underrepresented cohorts.

Element 1: Embed best-practice program design in all diversity in STEM programs

The below guide is based on best-practice design elements identified through the *Pathway to Diversity in STEM Review*. They will ensure government programs create impact and drive holistic change. These characteristics are detailed further in the sections below.

Long-term (flexible) funding models

The government provides long-term funding to programs to drive sustained, long-term impact.

Design and deliver in partnership

The government works in partnership with community and industry stakeholders to build new programs and improve impact and longer-term outcomes.

Increase diversity through grant processes

Grant processes should ensure applicants from diverse backgrounds and experience can be competitive for funding.

Enhance data collection

Data collection should be consistent across all programs to easily measure effectiveness across programs. Collection of data to develop longitudinal datasets should also be considered to measure program impact.

Better evaluation

A monitoring and evaluation framework should be developed, including metrics or KPIs, to inform program development, data collection and evaluation. This will help monitor program success against desired outcomes.

Evaluations should be completed in line with best practice, including evaluation that is independent of the program delivery partner. Evaluations should be published to demonstrate best practices, share knowledge of what works, and drive systemic change.

Collaboration and relationship building

Support to undertake relationship management activities is important to drive cohesion across programs and increase community buy-in.

Long-term (flexible) funding models

Longer-term funding should be provided to enable programs to demonstrate impact and adjust approaches based on monitoring and evaluation.

The evaluation of the Women in STEM program suite, funded through the Australian Government Department of Industry, Science and Resources, found the short funding timeframes, and approach to monitoring and evaluation, made it difficult to understand the impact of programs on participants' longer-term STEM education and careers.

Research in the education sector, for example, identified that a new program typically takes 2 to 4 years to become embedded in a school.[261] Currently, programs are funded for approximately 2 years on average, cutting short the potential for them to show success.

Longer-term funding provides certainty for delivery partners to adjust approaches to maximise impact based on what is working and what isn't. It also reduces administrative burden on program delivery partners in applying and renewing funding agreements, which impacts capacity to deliver on program objectives.

An example funding model is the Cultural Transformation in the Geoscience Community program, referenced in the 'Government leadership and coordination' section of this report. This program funds projects for up to 5 years. Organisations can seek funds for existing activities for an additional 5 years if the organisation:

- clearly demonstrates the effectiveness of current activities
- identifies gaps that would be addressed if additional funding resources were available.

Based on this model, a future approach to diversity in STEM programs could support providers for up to 10 years, split over 5-year contracts. 'Gateways' to receive additional funding after the first 5 years should be contingent on the program demonstrating impact (aligned with evaluation reporting as below). The approach could allow for the provision of additional funds for different or new initiatives, milestone variations or the termination of under-performing programs.

[261] Scott, K. (23 June 2023). *How ready is your school for change? Considerations when introducing new initiatives, programs and models to your school community.* https://www.edresearch.edu.au/articles/ready-school-change-considerations

Design and deliver in partnership

Formal mechanisms should be built into program design and evaluation to enable partnership with people and communities they will support. To deliver on the principle of 'nothing about us without us', includes working with target communities to co-design new initiatives, and ensure the program is continuing to meet their needs. This will allow programs to be culturally safe, effective and accessible.

This includes research and consultation with communities across Australia to understand how diverse cohorts are inspired to pursue and remain in STEM. To support this engagement and design process, people should be adequately compensated to engage. National programs may need to adjust for 'place-based' and iterative design to ensure programs are designed to fit communities and adapt to changing needs.

The advisory council can provide guidance and advice to ensure programs are appropriately developed in partnership.

Increase diversity through grant processes

Grant processes should maximise opportunities for programs to be delivered by diverse cohorts. They should also ensure funded organisations are taking meaningful action to increase diversity and inclusion.

The advisory council should consider a pilot to understand leading practice in delivering changes in government investment in equity and diversity through grant guidelines and agreements. These changes could build on existing work underway in the Department of Industry, Science and Resources, or across other government agencies, including by:

- specifically targeting or preferencing applications from diverse applicants
- making applications as accessible to diverse applicants as possible. For example, making it a one-stage process, producing grant information in multiple languages, and promoting grant opportunities through channels to reach diverse audiences
- outlining diversity and inclusion references and expectations in program objectives
- setting requirements for diversity and inclusion action plans. These requirements can be tailored proportionally to type of applicants
- updating assessment criteria to have organisations show how they are progressing equity and inclusion in the workplace
- reporting requirements related to progress updates on diversity and inclusion action plans that are proportional to the size and length of the grant. Reporting can also include data collection to understand which cohorts participate in the program because of the grant
- outlining specific expectations or requirements about diversity of committees for grant opportunities that involve merit assessment.

Enhance data collection

Data collection must be strengthened to better understand the intended and actual impacts of programs over time and inform decisions to change, continue or expand programs.

Data collection needs to be carefully designed so it can show progress over time and how programs impact individual career and education pathways. Elements that will strengthen data collection include:

- longer-term program funding to provide a large sample of data to analyse if, and how, the program is making impact
- application of impact assessment frameworks
- consistency in data collection metrics across all programs
- making data collection mechanisms inclusive and diverse to improve understanding of the benefits of programs on different diverse cohorts. For example, updating demographic related questions, allowing for different data collection methods or developing customised KPIs to assess against different data sources or proxies
- collection at regular periods and beyond 'personal satisfaction' or awareness metrics, such as 'are you more aware of STEM jobs after this workshop?'. These metrics, and questions like this, provide limited data to identify whether programs are creating cultural and behavioural change
- collecting data throughout and beyond participation in a program to build longitudinal data sets. This will identify if participants still engage in STEM several years after engaging in a program
- further metrics to support understanding of education or workplace outcomes over time, such as web analytics, engagement and user research (potentially qualitative data)
- capacity building in data collection, data literacy and evaluation skills within funded organisations to enhance evaluation and program improvement.

Better evaluation

A monitoring and evaluation framework should be developed for the program suite, including a program logic, and theory of change and impact assessment as part of program design. This should help track program implementation against program objectives for both individual programs and the whole diversity in STEM program suite (including KPIs or metrics). This should be aligned to the work of the Australian Centre for Evaluation and the Commonwealth Evaluation Policy.

Programs (regardless of whether they are funded by government or not) should be regularly evaluated by a party independent of the program delivery partner. Evaluation costs should be included in funding agreements.

Regularly evaluating programs across delivery can improve understanding of:

- how the program is meeting participant needs
- future outcomes
- impacts across economic, social and environmental outcomes
- broader impact of diversity in STEM education and jobs.

This can help program funders make evidence-informed decisions about how to continue or improve programs. For example:

- providing additional funding to expand or increase the scope of successful initiatives
- improving programs to meet desired objectives.

Evaluations should be accessible to other organisations or government agencies. This will help program funders or organisations delivering programs to better understand what works. This could include moving Australia's Women in STEM Ambassador resources to an Australian Government website and adding evaluations of other programs.

Collaboration and relationship building

Program funding should include support for organisations to undertake collaboration and relationship management activities with other organisations or stakeholders.

Providing support for these activities would enable program delivery partners to ensure related programs are connected. This will smooth transitions between programs with a different focus on the STEM pathway, as well as avoid duplicative efforts. It can also help funded organisations develop more sustainable, long-term funding models through private partnerships or philanthropy.

Element 2: Modify Women in STEM programs based on key learnings

Changes to the current suite of Women in STEM programs is needed to:

- address findings of the review
- ensure they are creating cultural change and supporting diverse cohorts across the pathway to STEM careers.

Any changes or further investment to existing programs would occur in stages aligned with the timeframes of existing program contracts. This is shown in Figure 7 below.

Recommended changes to government Women in STEM programs

Women in STEM Ambassador

- The work of the Ambassador program should form the foundation of the work of the dedicated advisory council and Australian Government department proposed in Recommendation 1.
- The advisory council should continue the advocacy and awareness-raising work of the Ambassador and identify research needed. It would advise senior decision makers across government, industry, education, and the broader community on implementation of reforms and further opportunities.
- Spreading this work across multiple council members representing different diverse cohorts, as opposed to one Ambassador, could reduce the key person capacity risk and broaden the scope of advice.
- The existing research, implementation and evaluation resources should transition to a government-hosted online resource repository.
- With this new expanded model, the current Women in STEM Ambassador program should not be extended.

Science in Australia Gender Equity (SAGE)

- Further funding should be provided to support SAGE to develop and deliver a sustainable model for driving cultural change in higher education and research organisations.

Women in STEM and Entrepreneurship grants

- The funding model should be changed to fund long-term projects.
- The projects should continue to demonstrate evaluation requirements but must also demonstrate how they will address lasting and/or systemic change.
- The program should consider the oversubscription of grant applications and how to address this through the eligibility and assessment criteria.

Girls in STEM Toolkit (GiST)

- GiST resources should be better integrated with other existing supports for teachers to teach STEM skills and subjects. This includes as part of work underway across governments to improve curriculum resources (see Recommendation 8).

- Opportunities should be identified for the GiST to be effectively adapted to support different stages of STEM education, or to support other underrepresented cohorts in STEM education.

Future You

- The national awareness raising work component of this program should be undertaken by the advisory council in delivering the communication and outreach strategy proposed in Recommendation 11.
- With this new model, Future You should not be extended.

Superstars of STEM (Superstars)

- Superstars should continue in its current form, with a continued focus on developing media visibility and capability as well as professional communication skills.
- Data collection metrics should be expanded to inform any future adjustments to the program. This should include data to understand whether superstars remain in the STEM workforce, including promotions, and the impact of superstars' school visits.

Elevate: Boosting Women in STEM (Elevate)

- Elevate should continue work to support greater diversity through the intersectional cohorts currently targeted.
- Subject to more data, Elevate may be expanded to other cohorts.

STEM Equity Monitor

- The STEM Equity Monitor should be expanded as follows:
    - Include broader diversity data, particularly on the participation and engagement in STEM of First Nations peoples, culturally and linguistically diverse people, and people with a disability.
    - Source (or develop) additional longitudinal data sets showing outcomes over time, entries and exits to and from the STEM workforce, and leadership and career progression.
    - Where possible, source (or develop) wellbeing-based data regarding people's experiences of workplaces
    - Provide data and trend analysis services.

Note: The Male Champions of Change - STEM group program was included in the Women in STEM initiatives evaluation that informed this review. The contract with the Australian Government Department of Industry Science and Resources ceased in 2019. Since then, the initiative has expanded to include non-STEM organisations and now known as the Champions of Change Coalition. It is therefore not included in these recommendations.

Photo credit: CSIRO.

Timeframe for Women in STEM program changes

The proposed modifications to programs should be made to existing contracts wherever possible. New contracts should be developed in line with the best practice program design principles outlined in Element 1 and any changes recommended in Element 2.

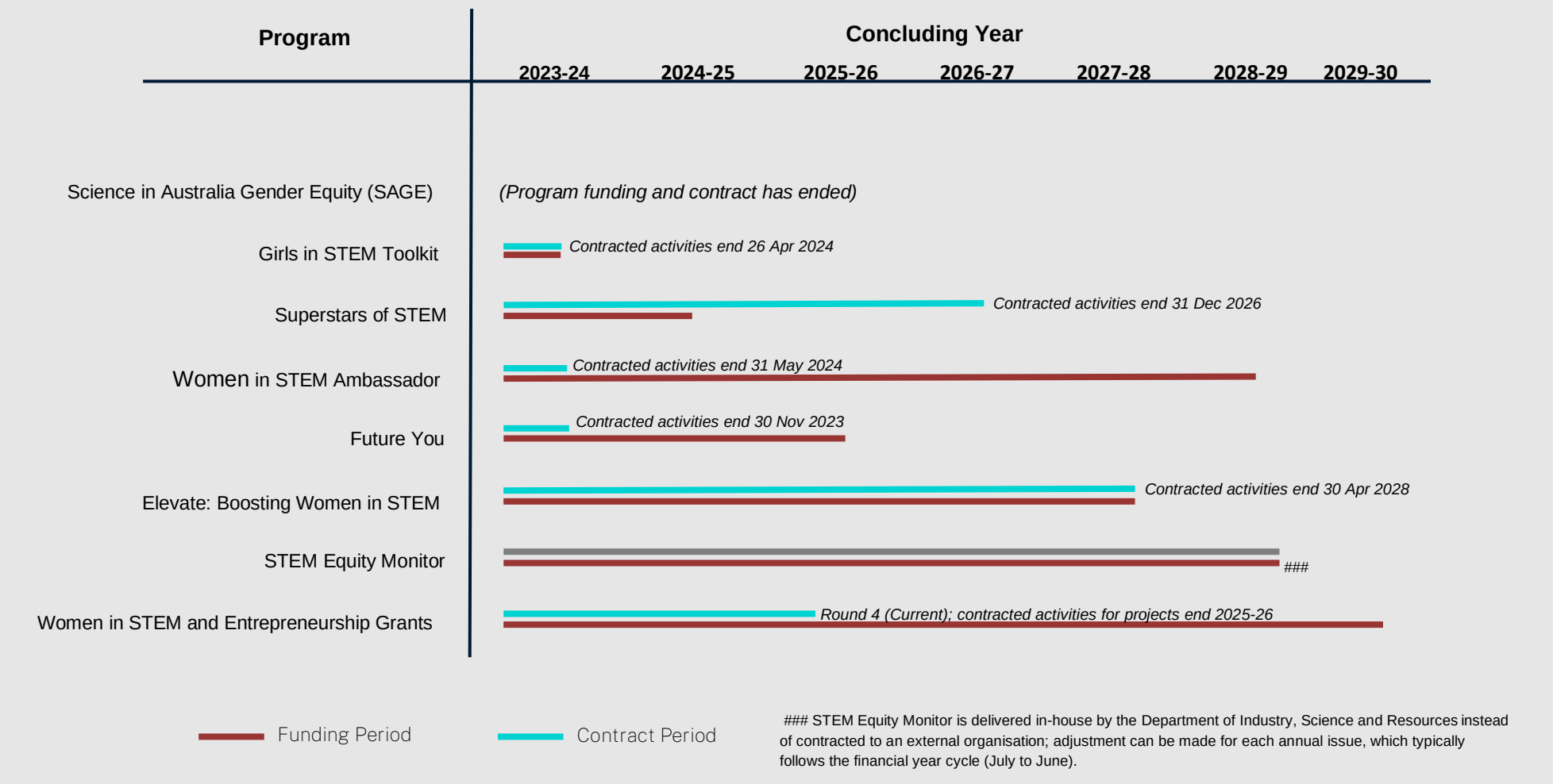


Figure 7: Timeline for existing contracts

Element 3: Develop new programs to address gaps

The review identified 3 areas that would benefit from programmatic support as a priority. They can be explored in more detail by the advisory council. The areas are:

- elevating First Nations Knowledges
- tailoring and connecting supports for underrepresented cohorts along the STEM pathway
- upskilling and re-skilling into and within STEM careers.

Additional gaps have been identified for further consideration. These include:

- increasing diversity in the VET-qualified workforce
- connecting STEM trained migrants to jobs
- supporting organisations to become safer and more inclusive
- increasing outreach in regional and remote areas (including underserved outer metropolitan areas with less access to STEM programs).

The advisory council, supported by the government, should further analyse the existing government program landscape. It should advise on the design of new programs outlined in this section, ensuring they do not duplicate government or non-government programs.

Priority program areas

1. Elevate First Nations Knowledges

A program could be developed to the reciprocal benefit of First Nations Australians and the broader Australian public through elevating First Nations Knowledges. The *Big Mob: STEM it Up research report* identified the importance of recognising, valuing and advancing First Nations Knowledges.

The program solution should be developed in partnership with First Nations experts to design ways of sharing and increasing understanding of the importance and value of First Nations Knowledges outside existing STEM frameworks. First Nations leadership in this work would be critical to ensure First Nations Knowledges are communicated and incorporated appropriately, respectfully and in a way that benefits their communities.

This program could include ways of:

- valuing and drawing on First Nations Knowledges in STEM education, research and practice
- supporting education institutions and workplaces to understand and work with First Nations peoples to draw on their Knowledges
- ensuring culturally respectful presentation of First Nations Knowledge in media
- recognising the diversity of knowledge across Australia and providing a platform for the communication and celebration of varying, place-based local knowledges.

The *Big Mob: STEM it Up research report* suggested a 'clearinghouse' of trusted sources for educators (school and university-based) as one way of embedding Indigenous STEM Knowledge in curricula.[262]

The experience of entities such as Questacon and CSIRO in partnering with First Nations people and communities in program design could help inform the approach to designing the program in partnership. Particularly, through leveraging their national networks, existing First Nations program connections and experience delivering STEM outreach with regional, remote, low-SES and other underserved communities.

This should be developed to complement, and not duplicate existing related initiatives. This includes initiatives across government and the community sector, for example, the Young Indigenous Women's STEM Academy, 8 Aboriginal Ways of Learning, DeadlyScience, the National Aboriginal and Torres Strait Islander Curricula Project, and Narragunnawali.

2. Tailored and connected supports for underrepresented cohorts along the STEM pathway

A program could be developed that focuses on supporting underrepresented cohorts along the STEM pathway. This should have a focus on the key development or transitional sections of the STEM pathway – for example, early childhood education, or when moving from high school to tertiary education or a job. It could initially support an intersectional cohort of trans and gender-diverse people, neurodivergent people, and people with disability (given the review found a gap in support for these cohorts). The program could then scale over time if successful.

The program could provide relevant supports over a long time, rather than during one phase, such as high school or university. These supports could include networking, mentoring and championing workplace experience from industry partners. Social support should be used as an enabler, as well as advocacy from leaders within organisations. This program could draw on lessons from the Young Indigenous Women's STEM Academy, referenced in the 'Government leadership and coordination' section of this report.

A secondary outcome for the program would be tracking longitudinal data and the impact of the program on people's progression along the STEM pathway. Currently, it is difficult to measure or track data on trans and gender diverse people or people with disability in STEM.

3. Upskilling and re-skilling into and within STEM careers

A program could be developed to improve the participation of diverse cohorts in STEM pathways throughout their whole life. This includes for people who either:

- are interested in moving into a STEM career but don't know how
- have lost a connection with their career
- need to update their skills after a break.

The program could include a focus on supporting prospective STEM workers who are older, First Nations, have a disability or who are returning from a period of care giving. These people can gain placement experience and become more competitive in the job market.

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[262] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z, Harvey-Smith, L., & Williams, L. (2023). *Big Mob: STEM it Up research report*. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

The program should be designed with industry to address skills shortages. It should aim to get prospective STEM workers into the workforce through paid internships and placements where they can re-skill and network within the industry. This can include providing financial incentives to organisations to accept interns (particularly organisations who do not have the financial capacity to pay interns). Additionally, this program should consider horizon scanning to map out potential future skills shortages and prepare accordingly. It would need to consider any focus on formal educational experiences, noting the barrier this presents to First Nations people. This includes looking at other forms of education and the STEM skills First Nations people use in their family or through their cultural knowledge or community.[263]

Areas for further consideration in program development

Increase the diversity of the VET-qualified STEM workforce

A program could be developed to increase the participation of diverse cohorts in STEM VET training courses. This may include supporting students to undertake VET while at high school. It could have a specific focus on First Nations people, girls and people living with a disability.

To understand how to best design and implement the program, it would be developed in consultation with:

- relevant Australian Government agencies
- different state and territory departments
- teachers and school leaders.

Support STEM qualified migrants to obtain employment in Australia

A program could be developed to encourage organisations to employ skilled migrants in STEM areas with workforce shortages.

Engineers Australia is piloting the Global Engineering Talent Program to address this challenge. This includes a 12-week paid internship at an engineering firm, providing migrant engineers with local experience, references and networks. The outcomes of this pilot will show whether program support of this nature can be provided to complement regulatory and systemic changes worked through in government.

Safety and discrimination in STEM workplaces

There is opportunity to develop a program that supports smaller businesses to undergo a review of their workplace strategies to build transformational workplace change and amplify what works. To avoid duplication, development would need to consider existing workplace programs such as SAGE, and the work of agencies such as the Workplace Gender Equality Agency.

STEM in regional and remote Australia

Accessibility to STEM education and workplaces is more limited in regional and remote Australia. There is opportunity to bridge the gap between city and country. Access to the internet is an impediment, so alternative methods of communications are required.

[263] Shay, M., Miller, J., Thomson, A., Cole, A., Hameed, S., Perkins, R., Rashidi, P., Hurley, A., Ockerby, Z, Harvey-Smith, L., & Williams, L. (2023). Big Mob: STEM it Up research report. The University of Queensland. https://espace.library.uq.edu.au/view/UQ:9fddf34

To help bridge this gap, there is opportunity to either build a program, or sponsor and work with existing organisations who deliver STEM engagement to these areas. For example through Questacon, the Science and Engineering Challenge, and regional STEM providers to expand and coordinate stronger regional and remote delivery.

This would complement broader work across government to increase access to services, education and employment in regional and remote Australia.

Address challenges with existing programs in engineering, mathematics, and technology

There is opportunity to develop a program to support increased engagement of underrepresented cohorts in engineering, technology and higher levels of mathematics. This could have an initial focus on First Nations Australians, as the *Big Mob: STEM it Up research report* identified there is need for urgent investment in First Nations people to participate in technology, engineering and mathematics.

Further cohorts would be considered, as an analysis of current programs to support women in STEM indicates there are limited supports for women and girls to build confidence and engagement in mathematics. The STEM Equity Monitor demonstrates less girls enrol in engineering, technology and higher mathematics subjects in year 12.

The advisory council, supported by the Australian Government department, could undertake further mapping and analysis of diversity in STEM programs. It would identify gaps and successful approaches to engage underrepresented cohorts in specific STEM disciplines along their education pathway. It would also consult with relevant groups to develop this program.

Appendices

Online supplements

We have provided links to the following further reading resources:

Initiatives for workplace equity and inclusion research report

https://osf.io/preprints/osf/zmvjn

Women in STEM initiatives: evaluation report

industry.gov.au/publications/women-stem-initiatives-evaluation-report

Big Mob: STEM it Up research report

espace.library.uq.edu.au/view/UQ:9fddf34

Additional diversity in STEM program review report

industry.gov.au/publications/additional-diversity-stem-programs-review-report

Pathway to Diversity in STEM Review terms of reference

industry.gov.au/science-technology-and-innovation/diversity-stem-review/terms-reference

Dialogue Starter published submissions

consult.industry.gov.au/diversityinstem1/dialogue-starter/list

Let's Talk Solutions published submissions

consult.industry.gov.au/diversityinstem1/submission/list

Draft Recommendations published submissions

consult.industry.gov.au/diversityinstem2/submission/list

STEM career pathways report

chiefscientist.gov.au/stem-careerpathways

Research assessment in Australia: Evidence for modernisation report

acola.org/research-assessment

Acknowledgements from the panel

We did not do this alone.

Hundreds of people participated in this review: they are the storytellers, knowledge holders, researchers, and collaborators who helped shaped this report.

It is with gratitude that we acknowledge the following contributors, whose perspectives provided us with valuable insights and a greater understanding of how change can be made across the STEM system.

The panel thanks:

Leaders in the STEM sector who participated in interviews and shared their experiences of the STEM system.

Groups working to encourage underrepresented cohorts in STEM, who participated in virtual workshops on the themes of: Primary and Secondary Education, Youth and Community, First Nations, Career and Employment, Workplace Leadership, and VET and University Education.

Teachers, staff, students, and community members who shared their innovative approaches and experiences in STEM education and hosted in-person workshops at: Joseph Banks Secondary School, Batchelor Institute of Indigenous Tertiary Education, and TAFE NSW Albury Campus.

Respondents to the public consultations who joined the conversation, sharing the barriers and challenges they face in STEM, what's working and what can be changed, and feedback on the draft recommendations.

Subjects of the lighthouse case studies used throughout this report, whose examples can help guide others to increase diversity in STEM.

Neville Narmarnyilk and Bindi Isis and their ancestors, whose artwork and dreamtime story have been passed down through generations and which we have the immense privilege of recognising in this report.

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ACIL Allen, who evaluated the government's current suite of Women in STEM programs.

The delivery teams for the Women in STEM and Entrepreneurship Grants, Champions of Change Coalition - STEM Group, Science in Australia Gender Equity, Superstars of STEM, Girls in STEM Toolkit, Women in STEM Ambassador, STEM Equity Monitor, Future You, and Elevate: Boosting Women in STEM.

Members and representatives of the government's interdepartmental committee, who ensured these recommendations were informed by other relevant activities occurring across government.

Our ex-officio colleague, Helen Wilson, and Janean Richards, who contributed their knowledge and experience of designing and delivering government policies and programs.

The taskforce that was established within government to support the panel and the review: Hayley Arbaut-Zaalen, Adrian Rule, Ben Scandrett, Jessica McDonald, Thea McKenzie, Steph McLennan, Kim Woodland, Brett von Špulák, Kim Lau, Sophie Morrow, Brooke Deak-Rogers, Isabelle King, Rachel Moore, Jaynell Vila, Hannah Farrell, and Monique Langridge.

And finally, to the people who shared their stories anonymously because they did not feel safe to share them publicly – we hope you feel heard.