

Women in STEM Decadal Plan

DISCUSSION PAPER

The future is science, technology, engineering and mathematics

Automation and globalisation will fundamentally change the Australian workforce, meaning Australia needs to develop people with the skills needed for the future, not only today's job market¹.

Science, technology, engineering and mathematics (STEM) underpin the innovation and creativity needed to develop technologies and understand and find solutions to current and future problems, changing the way we live in years to come.

Even now, there is a huge array of career paths available to people who study STEM. STEM skills underpin jobs in every field, including accounting, logistics, policy development, education, policing and market research², among many others. STEM-based industries are among the fastest growing in Australia³, where even a 1% increase in people choosing a STEM career could contribute over \$57 billion to the economy over 20 years⁴.

Diversity drives productivity

Workplace diversity is crucial to optimise performance and power the innovation and invention needed to drive a knowledge economy⁵. Research shows that diverse teams are more effective and innovative⁶, benefiting from a range of perspectives and approaches. For example, companies with higher numbers of women in leadership positions yield better economic performance and outcomes⁷.

Once female representation in leadership exceeds 30%, the gains are seen irrespective of company size⁸. The 2017 World Economic Forum Gender Gap report estimates the world could add US\$5.3 trillion to global GDP by 2025 by closing the gender gap in economic participation by 25% in the same timeframe⁹.

A diverse STEM workforce is an economic necessity, and a crucial investment in Australia's future national development¹⁰.

The challenge

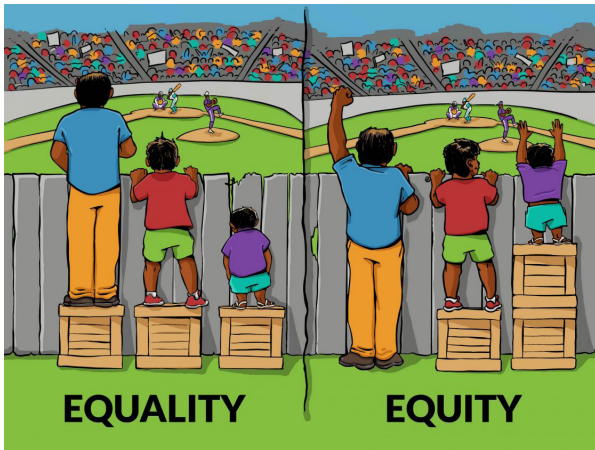
Women are lost at every stage of the professional ladder in STEM fields, due to a range of factors including stereotypes, discrimination, and workplace culture and structure¹¹, some of which manifest from early school years. The challenge of improving participation and retention of women in STEM is complex and multifaceted. At the request of the Australian Government, the Australian Academy of Science is working with the Australian Academy of Technology and Engineering on a Women in STEM Decadal Plan that will help Australia meet this challenge.

The decadal plan will provide a roadmap for achieving sustained increases in women's STEM participation and retention from early school years through to retirement over the next 10 years. To support its uptake across all sectors, the plan will be developed through a broad process of consultation with individuals and organisations throughout Australia.

This discussion paper briefly describes the enablers and barriers that affect participation, retention and success of women (by women we include girls) in STEM education and STEM-underpinned employment. These key areas will be explored in more depth in the development of the plan and will shape the questions for broad consultation with stakeholders.

Terminology

STEM—STEM in this paper refers to science, technology, engineering and mathematics, and is used as an umbrella term for scientific and technical fields. STEM skills are those taught and used in STEM disciplines, but the term is used more broadly to encompass the



Credit: Interaction Institute for Social Change, Artist: Angus Maguire. Adapted from the original image by Craig Froehle.

creativity and ways of thinking necessary to promote innovation and problem solving in any discipline or industry.

Women—The term women (including girls for minors) encompasses cisgender (personal gender identity corresponds with sex assigned at birth), transgender, non-binary and intersex persons who identify as women (girls).

Equity—Equity is fairness of treatment, regardless of gender, according to respective needs. This may include equal treatment or treatment that is different but

considered equivalent in terms of rights, benefits, obligations and opportunities¹². Through gender equity, gender equality is possible¹³.

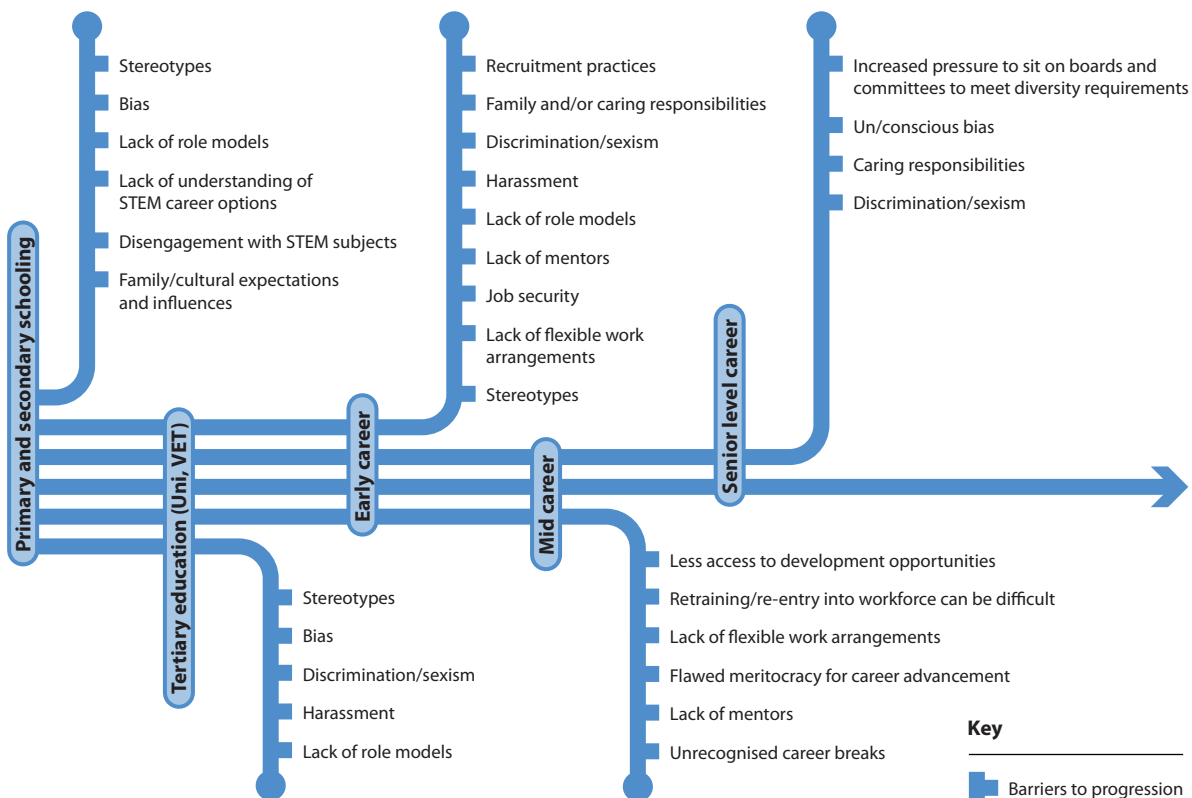
The current career path of a woman in STEM

Primary and secondary schooling—Industry demand for STEM graduates is increasing. The National STEM School Education Strategy 2016–2026 focuses on equipping students with strong foundational knowledge in STEM and inspiring them to pursue STEM careers¹⁴. However, student outcomes and engagement in STEM subjects are declining, particularly among girls. The challenge of attracting students to study STEM starts at primary school; a problem in many developed countries, not just Australia.

Disengagement with STEM occurs in all genders¹⁵ and the number of students choosing to study STEM subjects decreases as they progress through the education system¹⁶. Families are critical in facilitating student engagement with STEM¹⁷ and in either reinforcing or changing stereotypes associated with subject and career choice.

When asked to draw a scientist, children around the world invariably draw a man. Studies have consistently

Figure 1: The current career path for a woman in STEM faces barriers at each stage



shown STEM jobs are perceived as ‘things- and male-oriented’ and incompatible with femininity or work–life balance¹⁸. One dominant stereotype is boys are better at maths and science, which is not true in general. Continued exposure to such stereotypes with expectations of underperformance can create in girls a loss of interest and career aspirations in these fields¹⁹.

These inaccurate perceptions can be consciously, and unconsciously, reinforced. Girls and women, especially those from minoritised groups and disadvantaged backgrounds, face multiple barriers to STEM participation due to a lack of encouragement, unconscious biases and inequitable practices from peers, parents, teachers and workplaces²⁰. Media worldwide have traditionally under-represented women in STEM, and where they were represented the focus tended to be on their appearance or their feminine roles as wives and mothers²¹.

Tertiary education—While women are outpacing men in attaining tertiary degrees in Australia²², women are still under-represented in STEM higher education, particularly in certain subject areas. Fewer than one in five students enrolled in degrees in engineering, physics, mathematical sciences or information and communications technology (ICT) in Australia are women²³.

Vocational Education and Training (VET) systems are crucial components of the STEM education sector in Australia. VET qualified workers make up 68% of the total STEM workforce²⁴. Unfortunately, the gender gap in STEM is greater for VET qualified workers (9% females vs 91% males) than university qualified workers (29% females vs 71% males) in Australia²⁴. Current efforts and funding to support women in STEM post-secondary education are focused on universities, however women in STEM VET systems need assistance too.

Early to senior career— Around 77% of all STEM graduates work in the private sector. Many use their STEM training directly in their work in traditional STEM sectors. For example the majority of STEM graduates in the private sector have engineering qualifications²⁴, of which women comprise well under 25%²⁵. Many other STEM graduates use the skills, and way of thinking that their STEM training has taught them, across other areas of the private sector. It is more difficult to quantify this latter group and to determine its gender breakdown. About 50% of Australian STEM PhD students are women²⁶, however few remain in academia long enough to become senior professors²⁷.

Success rates for women were very similar to, or higher than, those for men in most STEM disciplines in Australian Research Council (ARC) funding rounds in 2017²⁸. In health and medical science research there is a higher proportion of women (58.5%) to men (41.5%)²⁷. Despite this, in the National Health and Medical Research Council (NHMRC) funding outcomes in 2015, there were more men applying for grants, and men were funded at a higher rate in six out of eight funding schemes²⁹. This suggests that there are additional barriers preventing women from applying for research funding.

The processes and measures that are typically used to determine success, and thus allow a STEM professional to rise to a senior level, may put some members of the STEM community—not just women—at a disadvantage³⁰. In the research community, women can be at an additional disadvantage due to the emphasis placed on research quantity in the definition of merit.

Merit has become synonymous with fairness but can be highly discriminatory. Merit is hard to quantify and is often defined and measured inaccurately. Merit tends to be defined by deeply held beliefs based on characteristics innately familiar to those evaluating the merit³¹. Therefore, diversity is not encouraged and the status quo is protected, limiting the positive impact diversity has on performance and economic outcomes^{6,7}.

Women who do reach senior levels are more frequently asked to be members of boards and committees, which places an additional burden on their time³² and limits their capacity to participate in other activities, such as research and professional societies, in comparison to their male colleagues³³.

The pay gap between genders persists and remains largely unchanged since 2001³⁴.

The professional, scientific and technical services industry has the fifth highest gender pay gap in Australia at 22.6%³⁵.

Initiatives such as Science in Australia Gender Equity (SAGE) are working to improve gender equity in the higher education and research sector. Similarly many private enterprise, government, and community organisations have implemented strategies to increase the number of women in STEM roles³⁶. However the understanding of what initiatives are effective, and why,

is incomplete. Women within the STEM private sector are more likely to intend to leave their careers within the next five years (75%) than those in public sector (31% of 432 respondents) with the lack of career advancement opportunities the most common influencing factor³⁷.

STEM workplaces are historically typically male-dominated³⁸. This often results in workplace structures and cultures that unconsciously or consciously discriminate against women and are not in line with the expectations or requirements of modern workers of all genders.

There is no large independent survey in Australia about sexual harassment rates in STEM, although a national inquiry into sexual harassment in the workplace is underway which may provide insight. However a publication from the National Academies of Sciences, Engineering and Medicine in the United States says that women subjected to sexual harassment can question the value in pursuing a career in STEM and reconsider working in these disciplines³⁸.

The barriers experienced by white, middle-class, cisgender women may be very different to those of women of another gender identity, sexuality, age, religion, ethnicity, socio-economic status or disability. Intersectionality is a framework that attempts to enable an understanding of these differences, and how these overlapping or intersecting social identities relate to participation and progression barriers. The influence of intersectionality on STEM participation is not yet well understood and warrants further exploration³⁹.

Societal issues not specific to STEM

Societal expectations of roles can also influence participation in STEM careers, and careers more generally. Data from the Australian Bureau of Statistics shows childcare remains the biggest barrier to women either entering the workforce or working more hours⁴⁰. This also derives from the traditional notion of the male breadwinner which has long underpinned childcare policies⁴¹. Although many workplaces are offering equal access to parental leave, rates of usage by fathers/partners are very low, which reduces the opportunity to break down gender stereotypes⁴².

The Australian Human Rights Commission (AHRC) found half of all mothers reported experiencing pregnancy or return to work discrimination in the workplace⁴³. Over a quarter (27%) of partners experienced discrimination related to parental leave and return to work despite taking only short periods of leave.

The AHRC found this discrimination had a tangible effect on women's workforce participation: 32% of women who experienced discrimination looked for another job or resigned. Additionally, 18% of mothers surveyed reported they were made redundant or their jobs were restructured, were dismissed, or their contract was not renewed during their pregnancy, when they requested or took parental leave, or when they returned to work⁴⁴. Women returning from parental leave also often receive reduced earnings compared to before their leave period⁴⁴. Women face other forms of discrimination, particularly in male-dominated workplaces. Taking career breaks or working part-time to accommodate caring responsibilities generates stereotypes and myths about women's lack of ability and career aspirations, which are then used to justify the actions of organisations that exclude women from recruitment and development activities³⁸.

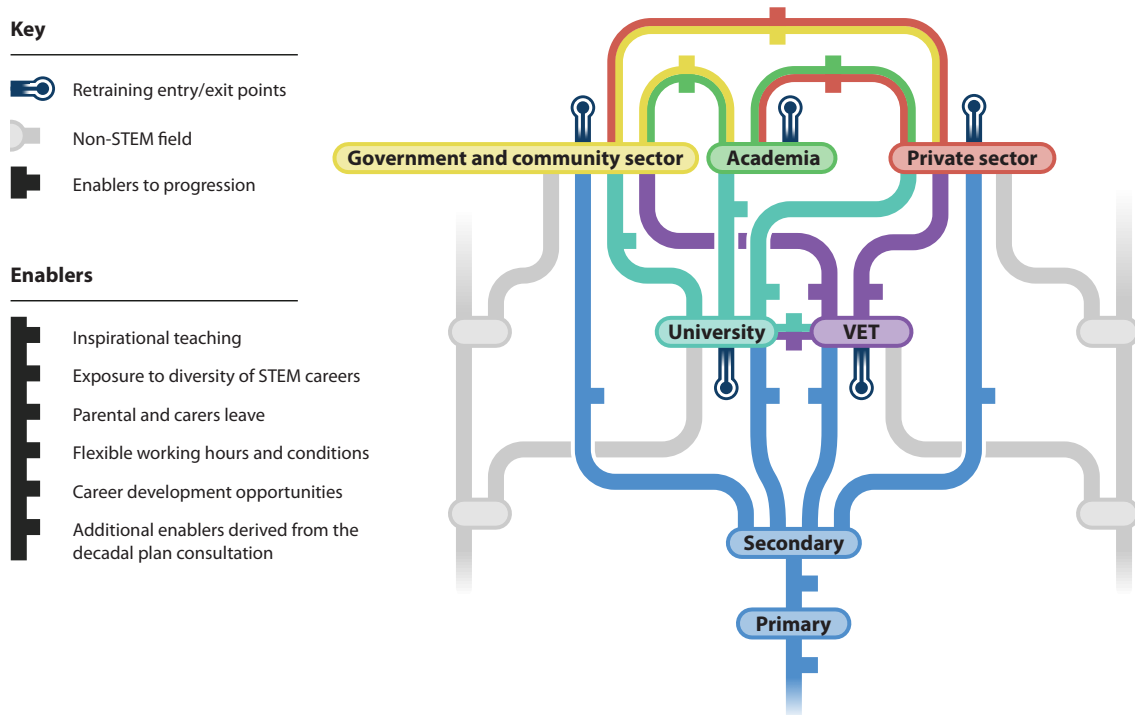
No evidence exists to show women are less committed to their careers⁴⁵, yet women who do choose to take career breaks and work part-time are likely to be disadvantaged by the traditional notion of an uninterrupted career to achieve progression⁴⁶.

In Australia in 2016, one in five university students (21%) were sexually harassed in a university setting⁴⁷. Women were three times as likely as men to have been sexually assaulted, and almost twice as likely as men to have been sexually harassed⁴⁸. Earlier research has also shown that most victims of sexual harassment include, but are not exclusively, young women, women on part-time or contract-based work and women in non-traditional jobs⁴⁸, all of which are common in STEM.

Women who start their own businesses (which may include STEM sector enterprises) face difficulties in gaining funding. According to Westpac data, 51.3% of women faced gender bias when starting or running a small business, compared to 18% of men⁴⁹. Women are also more likely (57.3%) to face financial restraints than men (33.3%).

Australia has made some progress towards gender equity, however at the leadership level that progress has stalled or, in some areas, regressed⁹. For progress to be made and momentum regained, everyone needs to be involved. However implementing efforts to create a more inclusive organisation or community can be complex, and occasionally meet resistance and backlash⁵⁰. This negative reaction could be caused by a lack of understanding, change fatigue, industry and/or cultural norms, or a fear of 'losing' opportunities as a result of the change in diversity⁵¹. Until gender equity is seen as a

Figure 2: A model of equitable career paths allowing flexibility, mobility and career progression



benefit for all, progress will remain slow and Australia will not reap the economic and societal benefits.

Creating a new, equitable career path

The Women in STEM Decadal Plan aims to develop recommendations and pathways to remove barriers to women’s participation and progression in STEM at every stage—from primary school through to senior leadership. This may mean returning to the STEM workforce after a period of absence or retraining at a later career stage to join it for the first time. It may mean flexibility and mobility between sectors or allowing lateral movement within the same sector.

Flexibility, part-time work and meaningful employment are key drivers for current job seekers⁵². Over 75% of respondents to a 2011 survey of the Australian business community, both women and men, were interested in having workplace flexibility⁵³; a trend likely to continue as Generation Z enters the workforce. A 2014 study found that Millennial STEM students are less interested in working in traditional ‘work-focused’ laboratory settings, preferring labs or other workplaces with more work–life interaction⁵⁴.

These are drivers pertinent to everyone in the STEM sector, not just women. Involving men and women is also a more inclusive means of addressing gender equity, as

typified through initiatives such as Male Champions of Change.

Enablers

Facilitating women’s participation in STEM requires a cohesive, holistic and sustained approach. Positive outcomes will not result from addressing a single factor alone, but rather from the interactions between factors at the individual, family, school and societal levels⁵⁵.

A mapping exercise conducted during the development of this discussion paper found more than 330 different initiatives are employed nationwide to foster the participation of girls and women in STEM, supported by institutions from within academia, government and industry, as well as community groups and philanthropy. These range from camps, competitions and workshops for primary and secondary students, over 120 scholarships to support individuals at different levels of tertiary education, through to programs, networks, mentoring and online resources for women working in STEM.

A person’s decision to study STEM and pursue a career that requires STEM training can be influenced by a variety of factors, with the strongest influences identified as personal interest, perceptions of being good at STEM, and a curiosity about the world⁵⁶. School STEM subjects, teachers and out of school activities were also positive

influences. School STEM subjects in particular are more appealing to girls if curricula content is contextualised and relevant to real-world situations⁵⁶. Family has a significant influence on interest and engagement with STEM, particularly if a parent or elder sibling is employed in a STEM-related role⁵⁷.

Role models can be used to both attract and retain women in STEM. Using women as role models has been found to be more effective in retaining women in STEM, while using both men and women as role models is effective for recruitment⁵⁸. Mentoring is often used as a means of supporting women in STEM careers, within academia as well as industry. Mentors can be an important mechanism to develop and support existing talent in the workforce. Peer mentoring programs can contribute to the retention and advancement of women, as well as influence institutional reform⁵⁹, and increase the STEM self-efficacy beliefs of undergraduate students⁶⁰.

Industry recognises the paucity of women in STEM-based careers, and many individual companies have implemented strategies to increase the number of women in STEM roles³⁷. There has been a concerted push by the Australian Institute of Company Directors to achieve a level of 30% female board membership within high performing companies, including those within the STEM sector. Female representation on boards within ASX 200 companies has increased to 27.7% in 2018; a substantial increase from 8% representation in 2008⁶¹.

Organisations such as Chief Executive Women and Male Champions of Change are important contributors. These Australian initiatives are comprised of leaders spanning public and private sectors, including STEM, who use their individual and collective leadership to change gender inequity in the sectors they lead^{62,63}. These initiatives have been important in elevating gender equity as an issue of national social and economic importance.

The Science in Australia Gender Equity (SAGE) initiative aims to raise awareness of gender equity and diversity issues and establish benchmarks for actions to improve gender equity in STEM institutions in the higher education and research sector⁶⁴. It receives high levels of support across Australia and is currently being piloted in 45 institutions.

But what else can be done?

Consultation questions

1. What changes need to occur to enable more girls and women to participate in STEM education at any level (primary, secondary or tertiary)?
2. What are the most effective things we can do to change inaccurate stereotypes about STEM professionals and the range of STEM careers?
3. What measures should we be using to determine eligibility for career recognition and progression?
4. Australia has more than 330 different initiatives to foster the participation of girls and women in STEM. What type of initiatives are demonstrating the most impact in your area of interest?
5. What societal and regulatory issues (i.e. not STEM-specific) will have the greatest impact on women in STEM, and how should we address those that are barriers?
6. Progress towards gender equity in STEM will require changes. How do we address the challenge of backlash and resistance to these changes?
7. If Australia is to take a strategic approach to improving the participation of girls and women in STEM, where would effort best be placed?
8. Is there anything else you have not yet covered in your response which could improve gender equity in STEM?

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