Thank you. I’d first like to acknowledge the traditional custodians of the land, the Ngunnawal people, and pay my respects to Elders past, present and emerging.

I grew up in a small village in rural Essex, around 60km north of London. The skies were pretty dark and at night, my Dad and I would go into the garden and look at the stars together.

In 1986 – when I was six years’ old - Halley’s Comet came to visit. Some of you might remember seeing it.

Halley’s Comet is an ice-covered rock, about 5km across, that is whizzing through space. As its orbit takes it close to the Sun, every 76 years or so, it begins to heat up. The ice on the surface of the comet turns into gas and that gas is blown away from the Sun into a gigantic tail by the energetic particles that stream away from our star. It looks magnificent. Or so I’m told.

Because, I never actually got to see Halley’s Comet. The English clouds got the better of me.

But NOT seeing Halley’s Comet turned out to be a pivotal point in my life. This exciting event (or non-event in my case) got me hooked on astronomy. By the age of 12, I was looking at the stars almost every clear night. My parents encouraged me to join my local astronomical society – and I loved it, despite being the only person under 50. I’ll paint you a picture. Imagine a 12-year-old girl and a bunch of retired engineers wearing grey cardigans, and you’ve pretty much got it.

But who says you can’t be what you can’t see? Because these guys were fantastic! So friendly and keen to help. They lent me books and telescopes – took me to the London Planetarium and egged me on to take my astronomy exams. These men were important role models.

My parents too, gave me tremendous a gift by cultivating my interest in astronomy. My Dad stood beside me in a freezing cold farmer’s field as I took photo after photo of the moon. My mum, after long days at work, drove me to observatories in the middle of the Essex countryside. Their support meant the world to me.
As adults, our time and encouragement are the most precious commodities we can offer to children. To help a young person cultivate their sense of wonder and curiosity about the world is an amazing gift that we can give.

But sadly, the numbers of young people studying Science, Technology, Engineering and Mathematics (or STEM) subjects are stagnating. We’ve got some serious work to do, if we want to enable more ‘STEM love-stories’ like mine.

Women make up only 17% of the STEM-qualified population in Australia. At the same time, STEM skills are becoming vital in the jobs market. This mismatch is storing up a catastrophic future for millions of young Australians, who risk missing out on employment opportunities and economic independence.

Diversifying our STEM-qualified workforce is important for several reasons. First is the fact that technological solutions designed in a monoculture are seldom fit for purpose.

There is growing evidence that gender and racial bias in society is magnified by artificial intelligence, or AI. When used in facial recognition, self-driving cars and police databases these AI systems can sometimes spell the difference between life and death. The vast majority of people designing AI systems around the world are white men. Many case studies of AI show evidence of bias, with crime-predicting software showing bias against black men, making them targets of law enforcement operations and giving them longer jail terms.

Some facial recognition technology – increasingly used in law enforcement and in war zones - works 99% of the time for white men, but just 35% for black women. That can put people at great risk. There is also evidence for loss of employment opportunities, with some online advertising algorithms showing high-income job adverts preferentially to men.

There’s also an economic imperative for cultivating a diverse STEM workforce. Advanced physical and mathematical sciences contribute $145 billion a year to the Australian economy, about 11% of GDP. Upskilling just 1% of the Australian workforce into STEM roles would add $57 billion to our GDP over the next 20 years.

Imagine the difference that equipping equal numbers of girls with STEM skills could make to the economy.
Despite more than 300 targeted Women in STEM programs across the country – including robotics, drones, coding camps and more - we’re barely moving forward in the numbers of girls taking up further study in engineering, IT and physical sciences. In 2006 women made up 15% of the STEM-qualified population in Australia. Now, more than ten years later, this figure has risen to just 17%.

Fortunately, the Australian government is coordinating a suite of actions that will tackle these issues and we hope, will shift the dial on gender equity in STEM.

Last year the federal government commissioned the decadal plan for Women in STEM, a ten-year plan developed by the Australian Academy of Science in partnership with the Australian Academy of Technology and Engineering. The decadal plan sets the direction for the STEM sector to take action on gender equity.

The Federal Government also released the Advancing Women in STEM Strategy, which sets out the government’s commitment to action on gender equity in STEM. It outlines the Government’s leadership role and support in three key areas: enabling STEM potential through education; supporting women in STEM careers; and making women in STEM visible.

**Then there is my work as the Australian Government’s Women in STEM Ambassador.**

My role is to work across all disciplines of STEM, with government, the research and education sector and industry, to drive gender equity. To find out what works and to accelerate the pace of change. And to bring these changes to all Australians, from regional and remote areas to the big cities.

My team and I are focusing on two important areas. The first is education; to highlight pathways to employment and reduce gender bias at home and in the classroom. The second area is to break down structural and systemic barriers to women’s retention and career advancement in STEM careers – and transform workplaces for the better.

I’ll start with education.

The kids of this generation find themselves in an increasingly STEM-driven job market. They will need to be ready to find solutions for global challenges like climate change, automation, the ethical development of AI and providing clean water and food for our growing population. These solutions will only be created by
assembling teams with a diverse range of skills and by combining expertise in technology, computing, creativity and collaboration.

So how do we get our kids ready for this future job market?

**Well the good news is, we can all contribute through our interactions with younger members of the family.**

Maths and counting are crucial skills, with many jobs requiring a good level of numerical ability. This includes a vast range of jobs in the retail, scientific, technological, medical, business, IT, trades and teaching professions. To avoid excluding girls from these occupations, **it is vital we start talking to them about numbers at the earliest possible opportunity.**

Why girls in particular?

There is a psychological condition called ‘maths anxiety’, which is highly contagious! Parents and teachers can easily transmit their dislike or lack of confidence in mathematics, and it tends to affect girls more acutely than boys. Maths anxiety is a self-fulfilling prophesy, and a lack of confidence in maths actually causes poorer outcomes in standardised tests.

Luckily, we can help alleviate maths anxiety by approaching numbers with a sense of open-mindedness and positivity. **AND, by talking about numbers and counting with girls as often as we do with boys.**

But, surely we are already doing this?

Well, sadly no – we’re not. Researchers in the US found that parents of two year-olds talk about numbers or counting - for example ‘how many flowers can you see?’ - three times more often with boys than they do with girls. **By being aware of these potential biases, we can make sure we don’t perpetuate these behaviours.**

**What we read to children also has an impact.** When the market research company Nielsen analysed the 100 most popular children’s books of 2017, they found most to be dominated by male characters. Male characters were twice as likely to have speaking roles than female characters and had far more lines when they did speak.
So it’s no coincidence that the cover illustration of my Children’s book ‘Under the Stars: Astrophysics for Bedtime’ shows a girl and her wombat, looking up at the stars.

Choosing educational books with women in leading roles is a great way to support your child’s education. If you are thinking about gifts over the summer holidays, you might consider some STEM-related books that will help them flourish.

There are also some brilliant resources to help you discuss STEM careers with children. The Girls in STEM Toolkit is a fun and engaging website funded by the Federal Government. It has resources, activities and a career quiz to empower girls to see a future for themselves in STEM. You can find this by typing ‘Girls in STEM toolkit’ into any search engine. I also recommend the Careers with STEM magazines and the STEM Careers Guide, which is also available online.

Of course, it’s not just the home environment that influences your children. In schools too, teachers can help to teach STEM in a way that engages all children.

Using modern technologies makes STEM relevant to students’ lives and to helps them acquire better learning, problem-solving and thinking skills. Collaborative approaches rather than individual ones are more likely to engage girls - especially in STEM classrooms. And mixed methods of assessment – including exams, group work and practical skills better determine a student’s overall grasp of STEM. Many teachers are already implementing these methods, but greater adoption of integrated STEM teaching must be the goal.

As educators we can do more to remove biases from STEM classrooms, by gaining an awareness of our own beliefs and attitudes about girls’ engagement with STEM.

Examples of classroom bias are not hard to find. Educational researchers in the US reviewed hours of video footage from science classes and observed interactions between students and teachers. The results were startling.

• 70% of the teacher’s time was spent focused on the boys. They were asked significantly more questions and given more feedback on their work.
• When girls were called upon, they received less wait-time for answers
• Boys were more likely to shout out and were allowed to speak over girls
• And boys were more likely to be called on to do science demonstrations
Girls, on the other hand, were more likely to be praised for the appearance of their work – then shoehorned into clerical roles in class.

Treating people equitably in educational settings is vital. To enable young people to receive the education they deserve, we should incorporate case studies like these into teacher training and encourage regular classroom audits to eliminate such biases.

**Connecting students with diverse STEM role models in schools** can make a big difference too.

When I was growing up, I didn’t know any real-life scientists or engineers. But through my local astronomical society, I was lucky enough to come into contact with professional astronomers whose generosity in sharing their expertise put me on a path that I could barely have imagined when I was 14.

Since then I’ve had an amazingly fulfilling career. I’ve **peered inside the birthplaces of stars** using giant radio telescopes on four continents. I’ve **mapped out the structure of gas in the Milky Way**, using a 305-metre radio telescope in the Puerto Rican jungle. I’ve **weighed a supermassive black hole** using the Australian Square Kilometre Array Pathfinder telescope in the outback of Western Australia. Thanks to the guidance of role models, my life has been enriched with the possibilities that a career in STEM can bring.

To give back, I try to be a role model for the next generation. A few years ago, I set up a partnership with my local public school through the STEM Professionals in Schools program. This gives students and teachers access to local STEM role models right across Australia. It helps break down preconceptions about who belongs in STEM – and boost students’ sense of belonging. I love seeing the children light up as we **explore the universe together**, learn physics using **food colouring and messy play** or **design a mission to mars**. It is incredible to watch children’s imaginations run riot as their affinity for STEM blossoms.

I highly recommend getting STEM role models into your local school. If you can’t find a local match through the STEM Professionals in Schools program, the ‘STEM Women’ database, at STEMwomen.org.au, is another avenue to try. It’s a list of more than 2000 STEM women around Australia who are open to speaking opportunities. If you’re lucky, you might find one who is willing to visit your local school and talk about what they do.
With all this work to encourage girls into STEM careers - are we making it a place they want to stay?

Well sadly, the data say no. Women are leaving STEM careers at much higher rates than men.

It’s not too much to ask for workplaces to function well, treat people with respect and actively manage employees’ physical and mental health. Our jobs should be flexible enough to accommodate our other responsibilities in life, including family commitments and social activities that boost our wellbeing. We all want to work in an environment that is free from discrimination and bias.

But women still face significant discrimination and bias at work. According to a survey by Male Champions of Change, two thirds of women have had their voices devalued at work, and around half see a lack of diversity in senior leadership as a barrier to their career progression.

A lack of support for men’s parental leave also has negative consequences. Currently, 53% of fathers feel that their workplace does not support them to take parental leave. 27% of fathers have experienced discrimination at work related to their parental leave, ranging from negative attitudes to threats of dismissal. At the same time, more men than ever want to take leave or work flexibly in order to care for children. Until men and women are equal at home - and sharing the unpaid work - equality in the workplace will never be achieved.

In a recent survey by Science and Technology Australia, half of Australian women and 1 in 10 men in STEM have experienced sexual harassment. 70% of respondents choose not to report this behaviour due to fear of reprisals and a lack of confidence in institutional policies.

To me, these are not just statistics. Far too often, I hear deeply troubling personal stories from women in the field about the harassment they have faced. Women who love their work, but are forced out due to powerful men who act with impunity and face minimal, or no consequences. Perpetrators who continue in senior roles whilst their students and colleagues live in fear or ignorance. Organisations that scramble to protect their reputations whilst another woman with talent, skill and passion is pushed away.

I welcome the fact that the Australian Human Rights Commission is holding a national inquiry into sexual harassment in Australian workplaces. I’ll be looking
forward with keen interest to hearing its recommendations - and to working with leaders across the sector to implement them.

When we look at this tangled mess of barriers to women’s progression, it becomes clear why so many women leave in the middle of their STEM careers and so rarely reach senior positions. Solutions are simple to identify, but not easy to implement. They include removing discrimination and bias from workplace practices, enabling equal carers leave and encouraging men to take it up, enforcing proper workplace behaviour, identifying targets for women’s career progression, and taking steps to eliminate pay gaps.

To be successful, these actions must be deliberate, strategic and system-wide. For change to take root, senior leaders and managers must commit to specific, tailored and measurable actions to remove structural barriers in workplaces. If you are not already tackling these issues in an organised and strategic way, the question must be ‘why not?’.

To give you some ideas and inspiration for actions you can take in your workplaces, I want to mention three case studies.

The first is a project my team has just launched, which will address the effects of unconscious bias on career progression.

Removing names and gender pronouns from applications works well to combat gendered bias. NASA recently trialled a process of anonymising application materials for observing time on the Hubble Space Telescope. They adopted a system where the names of reviewers and scientists were made known to each other only after the review was complete. For the first time in the 18 years, proposals with female leads had a slightly higher success rate than those led by men.

My office is keen to adopt this methodology in Australia – and several Australian research organisations and funding bodies have agreed to take part in a national trial. This will provide important data on the effectiveness of anonymised review and provide a strong evidence base for the STEM sector to take action on more equitable processes in future.

The second success story I want to tell you about is a targeted intervention conducted by the Federal Department of Industry, Innovation and Science in the nomination and assessment stages of the Prime Minister’s Prizes for Science.
The Prime Minister’s Prizes are Australia’s most prestigious science prizes. They recognise transformational scientific research, innovation and science teaching - with awards totalling $750,000.

In 2018, a lot of people (including myself) expressed concern that only one of the seven available prizes was awarded to a woman. This followed several years of consistently low representation of women amongst prize recipients.

So, the Department developed a plan to do something about it, based on evidence and best practice.

Through the use of a strategic communications plan, they encouraged nominations from diverse groups, including women, Indigenous and LGBTQI+ communities, using social media campaigns. They also reached out directly to STEM leaders, encouraging them to nominate outstanding members of their teams.

Language was removed such as “distinguished” and “exemplary” that can create barriers to participation - because women are less likely to identify with these terms. Selection committee members were shown material about how to mitigate unconscious bias before the meetings where shortlists were decided.

By taking these deliberate and strategic measures, nominations of women increased from 32% in the previous year to 42% in 2019. The outcomes were different too – we saw the highest number of women recognised in the prizes history, with five of seven prizes awarded to women. That’s not a bad result for a straightforward set of strategic actions.

Finally in ‘what works’, I wanted to talk about Science in Australia Gender Equity, or SAGE, which is an accreditation for institutional best practice, supported by the Australian government.

Through this program, 44 universities and research organisations have been guided through a journey of self-reflection, change and evaluation to improve gender equity and inclusion in their workplaces. SAGE participants have put in place fairer parental leave processes, support for LGBTQI+ ally programs, indigenous traineeships, parents rooms at work and many more initiatives designed to make workplaces more people-friendly.
SAGE is an attempt to embed workplace inclusion into an organisation’s business-as-usual. This, I think, is a model that organisations across the sector should seek to adopt. To be sustainable though, this work should always be led from the top, with the burden of driving change on the organisation, not on marginalised individuals themselves.

WRAP-UP

According to the World Economic Forum, the gender pay gap will take more than 200 years to close, at our current rate of progress.

My team and I are committed to taking action that will accelerate the pace of change and enable all Australians to thrive in the workplaces of the future.

We are planning a national awareness-raising initiative that will communicate the social and environmental good that can be achieved through STEM careers, leading to greater engagement in STEM education and showing all Australians that STEM is much more than just scientific research.

We are working on how to allocate resources more fairly in the higher education and research sector by bypassing unconscious bias.

We are facilitating more diverse STEM role models in schools and in the media.

But we will need your help.

Parents and families can make maths part of everyday life and help break the cycle of damaging stereotypes that prevent girls from reaching their full potential. Don’t ask girls ‘what colour are the flowers?’. Ask them ‘how many flowers can you see?’. Give them science books with female lead characters and talk to them about the natural world.

Teachers can help by adopting student-centred STEM learning, talking about STEM careers with young people and filling their classrooms with diverse role models.

And leaders in business, institutions and government. We can research, plan and commit to actions that break down systemic barriers to women’s progression in STEM careers. We must hold ourselves and our teams accountable for making meaningful, permanent changes to the systems and structures that are holding too many great people back.
And I’ll say it again – if you are not taking action in this way – the question has to be “why not?”.

We all want to live in a world where our achievements are defined by our skills and attributes, not our gender. Where a child’s vocation is a result of their interests and abilities, not the expectations of society.

Where a woman who might one day find a cure for cancer can follow her dreams without impediment – never to be bullied, harassed or marginalised from her chosen path.

This change will not happen on its own. And it won’t even happen in our lifetimes unless we greatly pick up the pace.

Let’s set our alarm clocks for 28th July 2061 – when Halley’s Comet next visits the sun.

On that night, maybe I will talk to my great grand-niece and reminisce about my life and work in astronomy and gender equity. And hopefully, she will look at me with a puzzled expression and ask: “why did we need a Women in STEM Ambassador?”.

I look forward to working with you all - to make this vision a reality.

Thank you.

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