GOVERNMENT OF
WESTERN AUSTRALIA

Future jobs, future skills

Driving STEM skills in Western Australia

Contents

Minister's foreword

Preparing ourselves for future jobs and growing new jobs in developing sectors is a priority for this Government. We need to ensure that Western Australians are equipped with the right skills to grow the State's economy and participate in our future workforce.

As our world becomes more technologically advanced and automation becomes more extensive, the nature of work continues to change. The jobs of the future are difficult to predict but there is evidence that particular skills are crucial for our future workforce to ensure we are globally competitive and able to address the social and environmental challenges we face in Western Australia.

As Minister for Science, and Innovation and ICT, I have the privilege of seeing firsthand how critical science, technology, engineering and mathematics, or STEM, are for bettering all of our lives. Most of the fastest growing occupations require STEM knowledge and skills. In all fields we need people with digital and enterprise skills who can think critically and take an innovative approach to addressing challenges.

Western Australia's first State STEM skills strategy aims to ensure that everyone can develop the skills to embrace a technological future. We need to encourage young people to study STEM disciplines and create a strong STEM culture in our schools and the wider community. It is also crucial that opportunities to develop STEM skills are available to our current workforce so that Western Australians at all stages of life can be active participants in a work environment that responds to technological change.

The statistics are stark. Females, students from low socioeconomic areas and Aboriginal people are less likely to study STEM subjects at school. These groups are also underrepresented in the STEM workforce. Addressing the current lack of diversity in STEM related study and employment is at the heart of the strategy. We want all Western Australians to be empowered to take part in a STEM-enabled future regardless of their gender, cultural background or postcode. No one should be left behind.

This strategy builds on a number of existing commitments by this Government around STEM, such as our investment of $17 million to boost science in primary schools, $4 million to support real-world problem solving in the classroom and $2 million to support integrating coding into the curriculum. We have also frozen TAFE fees over the next four years to ensure equity of access for all Western Australians to vocational sector skills that we know will be critical. To kick-start this strategy, the Government has invested $3.3 million in professional development for more than 1,000 teachers in lower socioeconomic public schools, STEM communication, mentoring programs, and digital and technology programs.

STEM skills underpin a number of the Western Australian Government's priorities and are integral to strengthening the economy, improving our environment, Aboriginal wellbeing and regional prosperity, and ensuring our kids have a bright future. The McGowan Government has set a target to increase STEM participation in schools – by 2024 we want 85 per cent of year 12 students completing two or more STEM courses.

I would like to offer my sincere thanks to all STEM Advisory Panel members from the school education, industry, university, vocational education and training, and informal and community engagement sectors. I am delighted by the panel's collaborative approach, which has produced a collaborative strategy in which each sector plays a vital role in delivering the strategy's goals. Together we can capitalise on STEM opportunities and build everyone's skills for the jobs of the future.

Hon Dave Kelly MLA
Minister for Science; Innovation and ICT

STEM Advisory Panel

The STEM Advisory Panel recognises that technological and scientific advances are rapidly changing our world and offer enormous benefits to Western Australia. We must seize this opportunity to grow our capability and prepare for the future. This is not the time to be complacent.

STEM skills are more important than ever, with industry increasingly looking for workers who are problem solvers, innovators and critical thinkers, and able to use and create technologies.

The State STEM skills strategy we have developed as a panel is aspirational, seeking to increase young people's uptake of STEM studies and careers and reskill current workers for the jobs of the future. It is based on our common goals across sectors.

Government wants people to have jobs. Industry wants people with the right skills. Universities and training providers are educating, skilling and reskilling our citizens for jobs and life. Schools are preparing the next generation for the future. And informal engagement throughout the community is shaping public attitudes and culture.

Getting the strategy's implementation right requires all of us to be involved. We commit now to work together and invite others across these sectors to work with us to achieve the strategy's goals.

This is by no means ground zero. A host of fantastic STEM skills initiatives are going on right now across the State. This strategy aims to build on their success to provide greater benefit to more Western Australians.

We recognise similar efforts from a range of stakeholders in other jurisdictions. Our strategy aligns with Commonwealth and Western Australian initiatives around STEM skills to ensure that we are maximising impact.

We thank Minister Kelly for the opportunity to develop this whole-of-State STEM skills strategy and look forward to driving its implementation to effect positive change for Western Australia.

Professor Peter Klinken AC
Chief Scientist of Western Australia
STEM Advisory Panel Chair

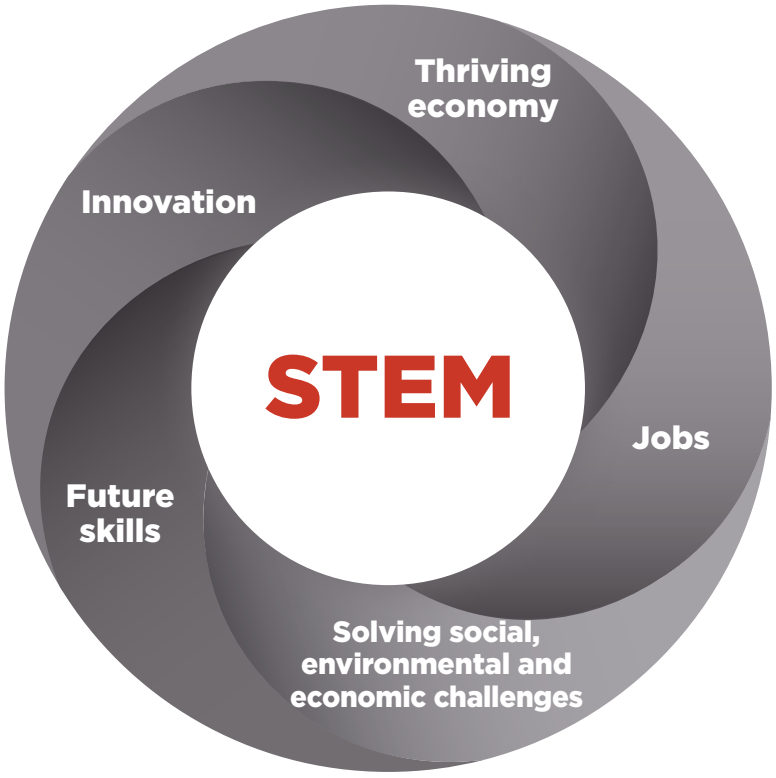
STEM Advisory Panel members

The STEM Advisory Panel comprises representatives from across industry, community engagement, vocational education and training, school education and the universities:

- Chief Scientist of Western Australia (Chair)
- Department of Education (Deputy Chair)
- Australian Information Industry Association
- Chamber of Commerce and Industry of Western Australia
- Chamber of Minerals and Energy of Western Australia
- StartupWA
- Rio Tinto
- Woodside
- Engineers Australia
- UnionsWA
- Western Australian Museum
- Scitech
- State Training Board
- Department of Training and Workforce Development
- Department of Jobs, Tourism, Science and Innovation
- Association of Independent Schools of Western Australia
- Catholic Education Western Australia
- School Curriculum and Standards Authority
- Science Teachers' Association of Western Australia
- Curtin University
- University of Western Australia (representing Curtin University, Edith Cowan University, Murdoch University, the University of Notre Dame and the University of Western Australia)
- Independent experts in STEM education, indigenous culture, innovation and technology.

Introduction

In an increasingly technology-rich and innovative economy, the nature of work is rapidly changing. Our future workforce needs the right skills to ensure Western Australia's global competitiveness and to enable our State to address social and environmental challenges such as securing food and water supplies and addressing climate change and disease.



Future skills

There is strong evidence that skills and understanding in science, technology, engineering and mathematics (STEM) enable us to innovate and drive economic growth, thereby unlocking the jobs of the future. Sixty-five percent of Australia's economic growth per capita in the past 50 years can be attributed to improvements in the use of capital, labour and technological innovation made possible in large part by STEM capability.[1]

STEM refers not just to the disciplines of science, technology, engineering and mathematics but also to a cross-disciplinary approach to them. The ability to apply concepts from multiple disciplines is essential to solving many of today's global problems.

As highlighted in the table of definitions relating to STEM on page 7, STEM education provides the opportunity to develop knowledge and technical skills fundamental to specific disciplines, as well as a framework for the development of higher order skills and capabilities that cut across all disciplines. This includes in the arts and areas such visual arts and game development.

Higher order skills developed in STEM disciplines such as critical thinking and creative problem solving are relevant in all roles and are essential to ensure a future workforce that is adaptable, flexible and innovative. Automation, globalisation and technology are transforming the tasks and activities people perform in their occupations, often reshaping jobs rather than removing them altogether. It is predicted that, on average, most workers will spend more time completing non-routine cognitive tasks, as these are the least susceptible to automation.[2] By 2030, workers are expected to spend double the amount of time solving problems and 77 percent more time using science and mathematics skills.[3]

Skills for a thriving economy

Technological change, automation and a diversifying economy mean that everyone needs some level of STEM skills, not just workers in STEM related jobs. The benefits and transferability of STEM skills across careers enable individuals to lead productive and rewarding working lives. Furthermore, a basic level of STEM literacy empowers and enables people to participate in an increasingly technological world and to make informed decisions based on knowledge, skills and a positive attitude towards STEM, including an understanding of its benefits to society.

The economic gains of ensuring Australia's future workers are equipped with the right skills to work in an increasingly automated world have been estimated at $600 billion from 2015 to 2030.[2] STEM skills will equip young Western Australians for jobs of the future and prepare them for a lifetime of unfolding career opportunities that cannot be accurately predicted today.

Similarly, the economic gains from transitioning Australian workers at high risk of being displaced by automation to new areas in the workforce have been estimated at $400 billion from 2015 to 2030.[2] Through training, members of the current workforce can embrace future job opportunities.

Skills for all

Women, people from low socioeconomic backgrounds, disadvantaged groups, Aboriginal people, and culturally and linguistically diverse communities are under-represented in the STEM disciplines in the education and career pipeline. This lack of diversity stretches from school through post-secondary education, including vocational education and training (VET) and university, to work. Increasing diverse participation in STEM opens opportunities for under-represented groups to be active contributors to the future economy and maximise Western Australia's talent pool for innovation and economic growth. A diverse, well-trained workforce is an innovative workforce.

What is STEM?

There is a range of different terms used to describe 'STEM' and the sorts of skills people need for future jobs. This strategy adopts the following terms and definitions.

STEM

A term used to refer collectively to the disciplines of science, technology, engineering and mathematics

STEM discipline

A specific field within science, technology, engineering or mathematics

STEM education

A term used to refer collectively to the teaching of STEM disciplines, which often includes an integrated cross-disciplinary approach to them. STEM is not a new subject or discipline that needs to be taught separately.

STEM skills

Knowledge, skills and capabilities developed through the study of STEM disciplines, including:

higher order skills

Also known as 21st century skills, core competencies, enterprise or job-capable skills. Higher order skills is a generic term encompassing general capabilities, personal attributes and employability skills developed across disciplines.
For example:

- problem solving, higher order thinking, critical thinking, creativity and entrepreneurship
- communication, interpersonal and teamwork skills and ethical understanding

digital skills

- information and communications technology (ICT) skills
  Also known as digital literacy, these are fundamental skills needed to navigate the technological world. This assists with the use of digital platforms and programs to manage, find and communicate information, perform transactions and solve problems
- digital technologies skills
  Deeper skills needed to design and create digital solutions that solve problems. This includes knowledge of the underlying concepts of information systems, data, and computer science, and skills such as coding, networks, robotics, cybersecurity, data analytics, and algorithmic and computational thinking

STEM discipline skills

Deep knowledge of the concepts and practical skills that make up one or more STEM disciplines

STEM culture

A culture in which people are aware of and value STEM and see its relevance to their everyday lives and future careers

STEM literacy

The knowledge, skills and attributes a person needs to understand STEM concepts and make informed decisions in relation to STEM aspects of any matter

STEM qualification

A university or VET qualification in a field of education that is classified by the Australian Bureau of Statistics as Natural and Physical Sciences, Informational Technology, Engineering and Related Technologies, or Agriculture, Environment and Related Studies. Some definitions also include fields classified as Health, such as medicine and dentistry, known as 'STEMM'.

STEM workforce

The population with STEM qualifications, noting that all workers require STEM skills to some degree

STEM related jobs

Jobs for which a STEM qualification is required or jobs in an industry in which STEM qualifications are often required

About this strategy

Vision

A globally competitive and innovative workforce with the skills to drive Western Australia's technological future and create new job opportunities

Goals

1. Ensure students have STEM skills for the jobs of the future
2. Reskill the current workforce with the STEM skills required to embrace a technological future
3. Break down barriers and ensure that everyone has the opportunity to participate in a STEM future

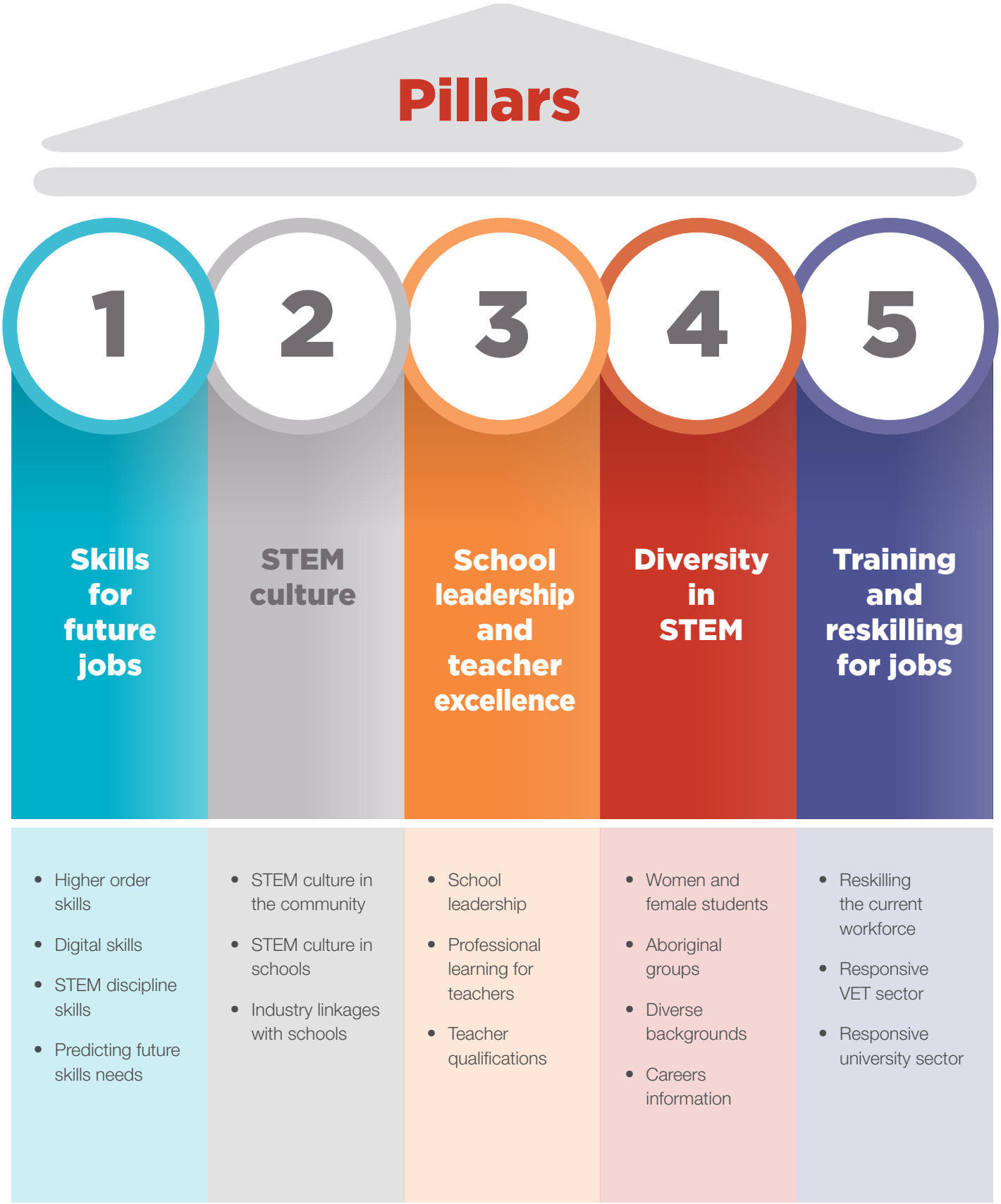
Sectors

Achieving the above goals requires commitment from a range of stakeholders in several sectors to work together:

These sectors are collectively responsible for implementing this whole-of-State strategy.

Structure

This strategy has five pillars and 17 themes.



Pillar 1 **Skills for future jobs**

Higher order skills

Providing opportunities for students to develop higher order skills and capabilities such as problem solving and creative thinking

The skills and capabilities school students need for their future participation in the workforce are evolving, with estimates indicating that today's students will on average have 17 jobs across five different careers.[4] Higher order skills that cut across specific discipline areas provide students with a strong foundation to secure jobs that may not yet exist. These include problem solving, critical thinking, digital and enterprise skills, as well as the confidence and flexibility to apply these skills to new problems.

STEM subjects provide an excellent framework for developing these skills, particularly where the curriculum is based on students undertaking hands-on inquiries and solving real-world problems. For example, high quality teaching of mathematics through a focus on mathematics proficiencies, including problem solving and reasoning, can develop higher order thinking. Balancing course content with developing higher order skills through examples directly relevant to students' lives and to real industry applications is likely to enthuse and engage students. Industry partnerships with schools are an important facet of this approach.

Entrepreneurial skills are also essential to drive innovation, productivity and job creation. Programs that enable their development are currently being trialled in some schools.

Our strategy

- Strongly emphasise higher order skills in school curriculum documents and assessment
- Develop professional learning and curriculum resources to implement and assess higher order skills in the curriculum
- Consider the benefits of a new project-based learning course in Years 11 and 12
- Explore opportunities for entrepreneurship teaching in schools
- Encourage real-world problem solving competitions aimed at secondary and tertiary students

The general capabilities that assist students to live and work successfully in the 21st century are captured in the Western Australian Curriculum. Highlighting these skills is essential to allow for their practice and authentic assessment. This is consistent with national recommendations to strengthen the development of general capabilities and raise their status within curriculum delivery.[5] For example, the STEM Learning Project is delivering a range of innovative STEM teaching resources and professional learning workshops encouraging collaborative thinking to solve real-world problems that are interdisciplinary and open ended.

The School Curriculum and Standards Authority has begun an initiative to create opportunities for upper secondary school students to undertake deep project work that will develop their higher order skills and capabilities. Competitions and hackathons are also effective in engaging young people to develop solutions to real-world problems.

Digital skills

Providing opportunities for people to develop digital skills

In the 21st century digital skills are as important as literacy and numeracy for both students and workers. Basic ICT skills – such as using digital platforms and programs to manage, find and communicate information, perform transactions and solve problems – will underpin successful engagement in the future job market and facilitate simple daily tasks and effective participation as a citizen.

Our State's international competitiveness in the emerging innovation economy relies on talented workers able to innovate using digital technologies, as well as highly skilled professionals with advanced skills in developing digital technologies and solutions. This includes coding, data science and analytics, networks, cybersecurity, robotics, and algorithmic and computational thinking.

Western Australia produces far fewer ICT graduates and postgraduates each year than are required to meet forecast needs.[6] Despite this shortfall, local ICT graduates experience a higher unemployment rate than graduates in many other STEM disciplines, as employers recruit ICT workers with the right skills from overseas.[7] This may indicate a need to better align Western Australian university and VET courses with the skills employers seek. It is also essential to ensure that the teaching and learning of digital skills keeps pace with the rapid rate of change.

Informal education and community organisations play an important role developing digital skills in workers and citizens. Coding clubs and boot camps are an increasingly popular way to enthuse students and provide opportunities to reskill adults.

Schools in Western Australia are developing digital skills from an early age. In 2018 coding and computational thinking became part of the digital technologies curriculum for Pre-primary to Year 10. The new curriculum aims to help students become confident developers of digital solutions and teachers are being supported in its implementation.

Our strategy

- Provide professional learning for teachers to support teaching of digital technologies
- Enhance access to informal digital and technology education programs across the State
- Encourage the school education, university and VET sectors to develop courses that address the ICT needs of industry

STEM discipline skills

Maximising all students' exposure to science, technology and mathematics subjects at advanced levels to develop deep knowledge of the concepts and practical techniques in STEM disciplines

Our strategy

- Explore the merit and feasibility of introducing compulsory mathematics, technology and science in Years 11 and 12
- Review and, where appropriate, provide incentives to encourage advanced mathematics, technology and science enrolments in Years 11 and 12, including ATAR scaling, university bonus points, scholarships and prerequisites

Western Australia needs high achievers in STEM disciplines to innovate and develop new techniques and products that will drive jobs and growth. Deep mathematics and science knowledge and capabilities are important for school students planning post-secondary STEM studies and specialisation. Research shows that students studying advanced mathematics at senior secondary level perform better in STEM discipline degrees at university,[8] opening up a wider range of career opportunities.

More broadly, all students stand to benefit from higher order skills, regardless of whether they pursue STEM careers such as in science, ICT or engineering. However, sections of the community including female and Aboriginal students, as well as people from low socioeconomic backgrounds and other disadvantaged groups, are not participating in science and mathematics at senior secondary level as much as other groups. We risk these students falling behind in the future economy and wider society unless greater participation is realised.

The Western Australian Government is committed to increasing the number of Year 12 students completing STEM courses, setting a whole-of-government target of, by 2024, 85 per cent of Year 12 students completing two or more STEM courses and/or STEM related vocational education and training (VET) qualifications.

The STEM requirements of the Western Australian Certificate of Education are some of the most stringent in the country. They include a minimum numeracy standard and a breadth requirement that all students choose a mathematics, science or technology-based subject at Year 12 level. However, there may be merit in further requiring all students to complete a science course, a technology course and a mathematics course up to Year 12 to send a strong signal to students, parents and teachers about the importance of these subjects and to ensure all under-represented groups have equal access to STEM. There are several countries that have compulsory mathematics and science until the end of high school[9] and the implications of such a proposal for Western Australia should be fully considered.

There is also concern that many high achieving students elect to study less challenging subjects in Years 11 and 12, in some cases to maximise their ranking for university entry. While there has been a recent increase in enrolments by Western Australian students in the most challenging mathematics courses, enrolments in these courses declined over the past decade.[10] Moreover, the lower a school's Index of Community Socio Educational Advantage (ICSEA), the fewer students elect to study high level mathematics, physics and chemistry.[10]

The 10 percent Australian Tertiary Admission Rank (ATAR) bonus for students undertaking Mathematical Methods and Mathematics Specialist subjects from 2017 exemplifies Western Australian universities working together to send a strong signal to students and parents about the importance of studying challenging STEM subjects. Further work is required to analyse and determine the effectiveness of this and other incentives.

Predicting future skills needs

Developing a detailed understanding of future STEM skills needs

Understanding how new technologies will affect workforce requirements is critical to Western Australia's future. Automation, digital disruption and globalisation are leading to substantial changes in the way we work, with STEM skills fundamental to future work. Recent data show there is a lower unemployment rate for Western Australians with a STEM qualification compared with those with other qualifications or none at all.[11] The data also show that university and VET STEM graduates tend to be in higher income brackets than non-STEM graduates.

There is some data available about the broad sectors in which jobs are likely to be created in Western Australia over the next decade.[12] Further work is required to make detailed predictions about workforce requirements in new and emerging STEM related industries with the potential for growth. Industries that are likely to be at the forefront in Western Australia for STEM related skills include defence, space and maritime technologies, cybersecurity, medical technologies, mining equipment, technology and services and oil and gas equipment, and big data and data analytics.

Our strategy

- Conduct STEM workforce analysis and forecast future STEM skills requirements, sharing findings across all sectors
- Support research on the impact of technologies on future workforce requirements in sectors important to the Western Australian economy

Detailed data on workforce changes and trends in job growth are required to inform future investment in skills and training, as well as teacher education and curricula. We need to identify STEM related growth industries and understand the impact of technologies on work and resulting skills requirements. There is a need to improve data sharing across industries, sectors and portfolios to support decision-making.

Pillar 2 **STEM culture**

STEM culture in the community

Strengthening STEM culture in the community through STEM education and outreach

In a strong STEM culture people are aware of, and value, STEM. They see its relevance to their everyday lives and support family and friends to participate in STEM studies and careers. Scientists are celebrated, emerging technologies are of interest rather than feared and families engage with STEM ideas in the home. STEM literacy enables people to make informed decisions and participate in community debate within an informed democracy. This is increasingly important as innovations rapidly change the world we live in.

Science communicators and the informal and community engagement sector play a significant role in developing Western Australia's STEM culture. There are many outreach, engagement, citizen science programs and events conducted by government agencies, not-for-profit organisations, industry providers, universities, TAFEs, research institutes and community groups. These provide opportunities for everyday Australians to engage with STEM as a leisure activity through to external STEM education providers seeking to complement school and post-secondary STEM education.

Our strategy

- Maximise opportunities from the new Scitech to enhance STEM experiences across all age groups
- Maximise opportunities from the new Museum with a strong STEM focus on community engagement and learning
- Promote a range of ongoing effective outreach and citizen science programs
- Increase coordination across the informal and community STEM engagement sector

Every year Scitech, the State's dedicated science discovery centre, engages and inspires around 500,000 Western Australians with STEM programs in Perth and the regions. Scitech aims to continue inspiring people of all ages through its plans for a new centre, extended community reach, an informed public voice and connected STEM community. Likewise, the new Museum project will revamp one of the State's oldest scientific institutions, providing new opportunities for the public to engage with STEM matters.

With a vast array of formal and informal STEM education service providers enriching education and community life, there is an opportunity to enhance coordination and impact across the State. Initiatives such as Scitech's STEM Providers Network and the national STARportal directory are improving public access to STEM engagement and building connections within the STEM engagement community.

STEM culture in schools

Strengthening STEM culture in schools, particularly in the early childhood and primary school years

Schools are crucial for developing STEM culture in Western Australia. In a whole-of-school approach to developing a STEM culture the importance of STEM learning is embraced by the school principal, leadership team and teachers with a resulting positive impact on students, parents and the community. Students participate in interdisciplinary STEM activities integrated across learning areas, and teachers are supported to collaborate, innovate and teach STEM skills in an engaging way. There are numerous examples where this has been successful in Western Australia, based on strong leadership shown by school principals and leaders.

Mentoring and peer-to-peer learning ensure best practice and sharing of resources among schools, systems and sectors. Examples of where this has been successful include the Department of Education's STEM Innovation Partnerships and Teacher Development Schools and finalists from all education sectors in the Governor's School STEM Awards. The schools involved in these programs continue to lead and share their innovative practices in STEM education.

Our strategy

- Encourage principals to promote a whole-of-school STEM culture
- Provide opportunities for teachers, principals and schools with a strong STEM culture to mentor others
- Enhance access to science laboratories and laboratory equipment in primary schools

Perceptions of STEM and career aspirations are shaped from a young age. Enhancing STEM education must start in early childhood and primary school years, fostering children's natural curiosity and igniting their interest in the world around them, as well as informing and engaging parents and teachers. Improved STEM education in the early years can help to increase the number of students choosing STEM subjects in upper secondary school and beyond. The State Government's $17 million investment to convert existing classrooms into science laboratories and provide associated resources in government primary schools will contribute to building STEM culture within primary schools and igniting an interest in science from a young age.

Industry linkages with schools

Enhancing the impact of industry-schools linkages to develop student abilities and career aspirations in STEM related areas

Industry is already playing a vital role in engaging with students, teachers, parents and the community about the skills relevant for future jobs as well as the importance of STEM to Western Australia's future prosperity.[13,14] This engagement can clearly be enhanced.

There are numerous programs in which industry helps to bring the STEM classroom to life with real-world applications, for example through teacher professional learning, classroom resources, site visits and work experience. Many industry professionals are also dedicating time to inspire young people to pursue STEM professions, including speaking about their experiences at schools and careers events and acting as role models in careers campaigns and case studies. Successful partnerships align with the curriculum and highlight the higher order skills developed in STEM subjects.

There is an opportunity to encourage further activities through a central connection point for schools and industry. Scitech, as part of its role in developing a connected STEM community, will play a leading role in coordinating and maximising the impact of industry-schools partnerships in Western Australia, helping school and industry parties to connect and identify shared objectives. It will map the reach of current programs offered by industry, universities, research institutes, not-for-profit organisations and government and others across the State. This information will assist it in identifying high priority schools for industry connections, such as those in low ICSEA and regional areas, leveraging off its State-wide program and other STEM education service providers.

Our strategy

- Encourage effective industry engagement with schools to enhance teacher professional learning, real-world problem solving experiences and STEM careers awareness
- Coordinate and maximise the impact of industry-schools linkages through Scitech

Pillar 3 **School leadership and teacher excellence**

School leadership

Building STEM education leadership in schools

School principals and leadership teams play a critical role in developing their schools' STEM education programs. Excellent school leaders understand why STEM education is important to the future of individual students and the State as a whole, and inspire teachers and students accordingly.

STEM education leaders in schools implement a vision that sees all students and teachers engaged in and enthused about STEM learning. They establish a whole-of-school STEM culture, in which STEM education is integrated across learning areas. Importantly, they ensure resources are judiciously allocated to STEM education within the school and encourage and empower teachers to collaboratively embrace STEM learning. They deliver high quality outcomes and use qualitative and quantitative data to plan and evaluate STEM learning.

High quality school leadership and teaching is recognised through programs such as the WA Education Awards and the Governor's School STEM Awards.

Our strategy

- Support school leaders to lead STEM initiatives in their schools
- Encourage school leadership to strongly embrace STEM education

Professional learning for teachers

Building capacity for teaching STEM and STEM disciplines within the existing teaching workforce

Our strategy

- Support teachers in schools to undertake professional development in STEM and STEM disciplines

Western Australia's teachers play a central role in the participation and achievement of school students in STEM. Teachers spark curiosity, ignite passion, develop students' skills, knowledge and confidence, and influence subject and career choices.

It is vital that teachers stay abreast of how STEM disciplines and skills are being used in the real world. It is also important that teachers are able to engage students and prepare them with the STEM skills they will need for an economy increasingly dependent on new technologies and focused on knowledge-based services and products.

The school education sector is committed to strengthening STEM teaching capability by disseminating the best possible teaching practices and continuing support for teachers attending a range of professional learning programs. Examples include Little Scientists Australia, Science by Doing, Primary Connections and the Association of Independent Schools WA's STEM in Practice program.

Best practice in the teaching and learning of mathematics is being explored through programs such as the Mathematical Association of Western Australia's Out-of-Field Secondary Teachers Pilot Program and the Scitech Alcoa Maths Enrichment Program. These programs aim to ensure that teachers have the capacity and confidence to facilitate deep learning of mathematical concepts.

This strategy builds on this work by providing greater access to professional learning in specific STEM disciplines, cross-curricular pedagogies, real-world problem-based learning, future careers and industry requirements. Efforts will be targeted at low-ICSEA schools and those in regional and remote areas, as well as out-of-field teachers, and will utilise mentoring, peer-to-peer learning and sharing of practice between schools to maximise impact.

Teacher qualifications

Ensuring a strong supply of qualified STEM teachers

A deep understanding of one or more STEM disciplines, combined with passion and relevant skills, enables teachers to inspire students and demonstrate the importance of STEM to everyday life and future careers. A strong supply of qualified STEM teachers is essential to the effectiveness of STEM education and quality student learning.

Primary school teachers need to be adequately prepared through their teacher education to teach science, mathematics and technology as well as integrated STEM across learning disciplines. All teacher education courses in Western Australia include some science and mathematics, but enhanced content could be achieved through collaboration between science, engineering and education faculties at universities, as well as with involvement from the VET sector and industry. There is also an opportunity to ensure teachers are supported and prepared to teach digital technologies and can embed ICT skills in their teaching and learning programs.

In secondary schools, some teachers are required to teach out of field, particularly in science, mathematics and technology. This is most common in regional and remote schools and schools with a lower ICSEA.[15] To understand the extent of the challenge, plan for the future and track the impact of strategies to build teacher capacity, there is a need to collect information about the qualifications of those currently teaching secondary science, technology and mathematics as well as those entering the profession. One way this could be achieved is through the teacher registration process.

Our strategy

- Recruit more STEM qualified people to become teachers
- Ensure STEM features strongly in pre-service teacher education courses
- Explore how to best gather STEM teacher qualification data

Pillar 4 **Diversity in STEM**

Women and female students

Enhancing women and female students' participation in STEM education and careers

Women are significantly under-represented in STEM disciplines. Only 16 percent of STEM-qualified Australians are female,[11] with the numbers as low as 13 percent in fields such as engineering.[16] This gender gap inhibits productivity and growth through under-utilisation of minds and the rich diversity of ideas and experiences that can be achieved with a diverse workforce to tackle the world's challenges. It also negatively affects women's future job prospects in a world where STEM skills are essential in the workplace and STEM qualifications often attract higher salaries.

The reasons for the gap are varied and occur from an early age, with conscious and unconscious gender bias, cultural stereotypes and self-perception playing a role.[17-19] It is essential that we ensure that female students are offered opportunities to develop skills that will enable them to participate in the workforce of the future and are not excluded because of their gender.

A cross-sectoral approach is required to initiate change from early childhood, through primary school, secondary school and higher learning and into the workplace. There is a range of outreach, careers, role model, mentoring and scholarship programs undertaken by all sectors aimed at increasing uptake of STEM discipline studies and careers by women. Impact can be enhanced by greater collaboration and coordination across sectors, including industry and industry bodies. Careers education and engagement is needed through multiple channels to break down gender stereotypes and communicate the importance of STEM knowledge and skills to female students and their parents, teachers, careers advisors, peers and the community.

Our strategy

- Emphasise women and female students' participation in STEM in all relevant initiatives in this strategy
- Encourage workplaces to reduce barriers to women in STEM roles
- Promote and encourage effective STEM outreach programs, partnerships, scholarships and awards that target female students and women
- Encourage all sectors to commit to increasing women and female students' participation in STEM

It is equally important to address the barriers experienced by women who take up post-secondary STEM studies and careers if we are to increase the number of women in STEM leadership positions. There are numerous examples of good practice throughout the tertiary education and industry sectors, such as the participation of WA's four public universities in the Science in Australia Gender Equity (SAGE) pilot and the setting of gender diversity targets by many leading organisations. Commitment is required across all sectors to encourage workplaces to eliminate gender bias and create opportunities to enhance the participation of women and female students in STEM.

Aboriginal people

Enhancing the participation of Aboriginal people in STEM education and careers

Aboriginal people are significantly under-represented in STEM education and careers. For instance, Aboriginal people represent less than one percent of higher education engineering and science students.[20] The resources sector is one example of how a commitment by industry can lead to enhanced participation and reduced workplace bias, with indigenous employees now representing four percent of the resources workforce in Western Australia.[21] However, a high proportion of these indigenous employees are in jobs, such as machine operation, at risk of displacement by technology. We need to provide opportunities for Aboriginal people to strengthen their STEM skills, better positioning them for future work in a rapidly changing economy.

Research shows that the gap between indigenous and non-indigenous Australian students starts at an early age in education, with mean scores for literacy and numeracy already measurably lower for Aboriginal students by Year 3.[22] By age fifteen, the gap in scientific literacy is equivalent to around two-and-a-half years of schooling.[23]

Our strategy

- Emphasise supporting Aboriginal students in all relevant initiatives in this strategy
- Encourage workplaces to reduce barriers to Aboriginal people in STEM roles
- Promote and encourage effective, culturally relevant STEM outreach programs, partnerships, scholarships and awards that target Aboriginal students
- Encourage all sectors to commit to increasing Aboriginal people's participation in STEM

Role models and culturally relevant education initiatives that support school education and communities are critical to enhancing participation of Aboriginal students in STEM. Programs such as Scitech's Aboriginal Education Program, Edith Cowan University's Old Ways, New Ways program and the CSIRO's Indigenous STEM Education Project cater for Aboriginal students as they progress through primary, secondary and tertiary education into employment.

A network of schools in the remote northern goldfields region is working together to create STEM learning experiences that connect country, culture and community to engage their Aboriginal students in deep, authentic STEM learning. The Department of Education is working with these schools to further explore opportunities to engage with Elders and senior community members, integrate digital technologies, strengthen VET opportunities and utilise project-based learning. Non-government schools are also engaging Aboriginal students and communities with STEM, for example through the award-winning program at Coolgardie Christian Aboriginal Parent Directed School.

Diverse backgrounds

Enhancing the participation of people from all backgrounds in STEM education and careers

All groups under-represented in the STEM pipeline are a valuable untapped resource. They need greater access and achievement throughout the STEM education and careers pipeline stretching from school, through VET and university, to work. This includes people from low socioeconomic backgrounds, people with disabilities and people from culturally and linguistically diverse backgrounds.

We have a responsibility to ensure that all Western Australians can participate in the rapidly evolving economy, particularly those most vulnerable. With intervention now, under-represented groups will be better placed to actively participate in the future economy and the State will benefit from increased diversity in workplaces.

Ensuring people from all backgrounds have access to STEM education is central to this strategy. For example, in implementing the 2017 election commitment to provide $17 million for laboratories and resources in government primary schools, ICSEA was a strong consideration in the selection of the schools in order to prioritise access to appropriate facilities for these students.

Qualified secondary science and mathematics teachers are particularly sought after in rural, remote and low socioeconomic areas. Teachers in such schools need STEM capability, teaching aptitude and appropriate support to address specific challenges. Building on existing programs, further incentives would attract STEM-qualified graduates to teach in high priority schools and provide support to STEM teachers who are not STEM-qualified.

It is also imperative that individuals from all segments of society understand the career opportunities STEM can provide. There is a range of existing STEM outreach programs, partnerships, scholarships and awards targeted at under-represented groups. Further achievement in this area will require a consolidated approach from all sectors.

Our strategy

- Emphasise supporting schools in low socioeconomic areas and other disadvantaged groups in relevant initiatives in this strategy
- Explore incentives for STEM graduates to teach in schools located in low socioeconomic, rural and remote areas
- Encourage workplaces to reduce barriers to people from diverse backgrounds in STEM roles
- Promote and encourage effective STEM outreach programs, partnerships, scholarships and awards that increase participation of under-represented groups
- Support disengaged students to undertake VET STEM courses
- Encourage all sectors to commit to increasing participation by under-represented groups in STEM

Careers information

Improving careers information to encourage participation in STEM

The careers landscape is rapidly changing, with 65 percent of children entering primary school today expected to take up jobs that do not yet exist.[24] Research nonetheless indicates that all future jobs will require higher order skills such as problem solving, critical thinking and digital skills and 75 percent of the fastest growing occupations require skills and knowledge in specific STEM disciplines.[25]

To encourage students to choose STEM pathways, access to careers information and quality advice from a range of influencers is vital. Research shows that students' career aspirations start early in life and are largely affected by their parents, teachers and peers.[17] There is a need to break down barriers to STEM and showcase role models, including women and Aboriginal people, undertaking rewarding jobs and solving social and environmental challenges.

Provision of STEM careers information must begin early and can be incorporated into everyday STEM related learning from the start of primary school with links to role models, case studies and industry. This will enable students to begin to see how their classroom learning, passions and interests relate to the world of work, including in STEM disciplines.

Informed careers advice and work experience opportunities are crucial in Years 9 and 10 as students prepare to make course selections for Years 11 and 12. Students and parents need current and accurate information about the variety of STEM-related pathways they can take from school into the VET and university sectors and into the workforce. Relevant information is also required for tertiary students and throughout workers' careers.

Our strategy

- Develop a new State-wide STEM campaign featuring diverse role models in a variety of STEM careers
- Raise awareness of the value of STEM skills among students, parents, teachers, careers advisers and the community, including through an enhanced role for Scitech
- Promote and encourage effective outreach programs, events and awards that encourage pursuit of STEM studies and careers, including those targeting primary school students and families
- Identify, implement and communicate a variety of new and existing STEM pathways through school, VET and university
- Ensure schools, teachers and careers advisors have access to up-to-date information regarding existing and future workforce requirements relating to STEM skills

Pillar 5 **Training and reskilling for jobs**

Reskilling the current workforce

Reskilling the current workforce with relevant STEM skills to be active participants in a work environment that responds to technological change

Our strategy

- Encourage industries to commit to reskilling workers likely to be affected by technological change
- Encourage the involvement of unions in building the STEM capability of workers

Automation and globalisation are changing the nature of work, with research predicting that up to 40 percent of current jobs may disappear over the next 10 to 20 years.[26,27] It is predicted that all jobs will be affected in some way. For many workers, this will mean more time spent on non-routine, cognitive tasks, resulting in increased safety and productivity. People whose jobs focus on non-cognitive, repetitive tasks, may find that their jobs may change substantially or in some cases disappear. It is vital that early intervention provides training to reskill existing workers who may be affected by automation.

Large corporations recognise these challenges and are actively preparing for the future of work. For example, Rio Tinto has committed $2 million to partner with South Metropolitan TAFE to develop a new curriculum focused on jobs around automation and technological advancements for the mining industry. This has led to the establishment of the WA VET Collaboration which broadens the partnership model to include additional industry, government and education partners and other industries affected by automation and technology.

Further proactive approaches across industry can assist in empowering existing workers to embrace technological change and the opportunities it offers, including working more closely with unions. Unions can support their members to access lifelong learning and on-the-job training, ensuring that their skills remain relevant.

Responsive VET sector

Continuing to build an adaptive VET sector that is responsive to emerging workforce needs in STEM related areas

A skilled, well-trained workforce that can adapt to changing industry needs is essential for a vibrant and diversified economy. The TAFE and private registered training organisations that comprise the VET sector play an important role in providing STEM training, with VET qualifications making up more than two thirds of all STEM qualifications in Australia. As STEM jobs grow, VET funding should be prioritised, as appropriate, for STEM-related training and STEM skills must be further embedded in courses.

Flexible approaches such as short courses and in-house training will be necessary to encourage reskilling and lifelong learning in an environment where innovation and digital disruption are rapidly transforming the workforce landscape, as well as the tasks and technical skills required of workers.

Effective collaborations, partnerships and communication between industry and the VET sector are vital for ensuring courses provide relevant skills for current and future jobs. Industry partnerships and reference groups allow the sector to embed specific workforce requirements into training courses and provide hands-on experiences in real-life industry environments like the Australian Centre for Energy and Process Training at South Metropolitan TAFE. They also enable teachers and trainers to maintain currency in their specific area through training courses, industry placements, networking and site visits.

Our strategy

- Establish one-stop-shop Jobs and Skills Centres at TAFEs
- Encourage greater collaboration, partnerships and communication between industry and the VET sector, in particular to address the skills needs of workers affected by new technologies and automation
- Work with industry to support trainer development including rotating between industry jobs and training
- Include STEM related training as a VET funding priority

Industry engagement around future workforce needs and career, training and employment assistance for workers will also be an important part of the new Jobs and Skills Centres being established at TAFEs.

Responsive university sector

Continuing to encourage a strong and flexible university sector that builds Western Australia's STEM capacity and capability

Western Australia's universities play a vital role in preparing a future workforce that can respond to a rapidly changing technological future. STEM graduates should be equipped with deep STEM understanding and skills that enable cutting edge discoveries to address global environmental and social problems and drive new industries, as well as enterprise skills that will equip them for the workforce.

Lifelong learning and reskilling throughout a working life are becoming the norm and enable individuals to respond to emerging opportunities, changing technologies and society's needs. Universities are increasingly offering flexible courses that enable reskilling, such as short courses and micro-credentials.

Universities are also working closely with industry to improve alignment between graduate skills and industry needs. In addition to developing specific STEM discipline skills needed by industry, this is providing greater opportunities for students to develop core competencies. University courses, like secondary school subjects, are increasingly emphasising higher order skills as they are being taught. Initiatives such as internships, work integrated learning, field work and industry mentoring programs enable students to understand the portability of their skills and the array of career opportunities available.

Only 30 percent of Australian researchers are employed in the business sector, a relatively low proportion compared with other advanced economies.[28,29] The McGowan Government's Science Industry Fellowship Program and the iPREP WA program are providing STEM research students with the opportunity to engage with industry during their studies.

Our strategy

- Encourage universities to develop courses that are flexible and enable reskilling, lifelong learning and continuing professional development
- Encourage collaboration and partnerships between the industry and university sectors for course development and work integrated learning
- Encourage universities to offer industry and teaching internships for credit, work integrated learning and industry mentoring programs
- Encourage universities to embed core competencies across professions into courses
- Provide opportunities for research students to engage with industry
- Develop appropriate graduate career readiness credentials in universities in consultation with industry

Measuring success

The *Future jobs, future skills* strategy provides a framework for building Western Australia's STEM skills to address the needs of our future workforce and capitalise on the creation of job opportunities. The strategy is ambitious and will be implemented over the next four or more years.

Performance measures will be determined by the responsible agencies and organisations to track the implementation of funded and new initiatives. Programs will be reviewed and adapted to build on successes and maximise impact. Preparing Western Australians for the future workforce is a long term investment. As such, long term tracking of metrics and data will be established to measure the effectiveness of the initiatives in achieving the overall goals of the strategy. The measures will also align to the Western Australian Government's target, as part of the Our Priorities program, to increase STEM participation in schools. The STEM Advisory Panel will oversee development of appropriate metrics to measure success against the following goals.

Indicative high level measures under each of the three goals are provided below.

GOALS

1

Ensure students have STEM skills for the jobs of the future

- Increased number of qualified science, mathematics and digital technologies teachers
- Increased performance of school students in STEM subjects
- Increased participation of school students in STEM subjects, including advanced subjects, in Years 11 and 12
- Increased university and VET enrolments in STEM subjects
- Increased career readiness of university STEM graduates
- Increased industry involvement in developing STEM courses

2

Reskill the current workforce with the STEM skills required to embrace a technological future

- Increased number of workers being trained for technological change
- Increased number of businesses preparing workers for technological change

3

Break down barriers and ensure that everyone has the opportunity to participate in a STEM future

- Increased participation of under-represented groups in advanced mathematics, physics, chemistry and ICT in Years 11 and 12
- Increased university and VET enrolments in STEM subjects by under-represented groups
- Increased participation in the STEM workforce by under-represented groups

References

1. Office of the Chief Scientist, 2014. *Science, Technology, Engineering and Mathematics: Australia's Future*, Australian Government: Canberra

2. AlphaBeta, 2017. *The Automation Advantage – How Australians can seize a $2 trillion opportunity from automation and create millions of safer, more meaningful and more valuable jobs*, AlphaBeta: Sydney

3. The Foundation for Young Australians, 2017. *The New Work Smarts – Thriving in the New Work Order*, AlphaBeta: Sydney

4. McCrindle, 2015. Analysis of ABS (Australian Bureau of Statistics), 2014. Australian Labour market Statistics, July 2014, cat no. 6105.0 in The McCrindle Blog: Job Mobility in Australia, http://mccrindle.com.au/the-mccrindle-blog/job-mobility-in-australia

5. The Department of Education and Training, 2018. *Through Growth to Achievement: The Report of the Review to Achieve Educational Excellence in Australian Schools*, Australian Government: Canberra

6. JMG Marketing, 2008. *A Review of the ICT Skills Supply and Demand in Western Australia*, WA Department of Industry and Resources: Perth

7. Norton, A., and Cakitaki, B., 2016. *Mapping Australian Higher Education 2016*, Grattan Institute: Victoria

8. Nicolas, J, Poladian, L, Mack, J & Wilson, R, 2015. *Mathematics preparation for university: entry, pathways and impact on performance in first year science and mathematics subjects*, International journal of Innovation in Science and Mathematics Education, vol. 23, no. 1, p. 39

9. Hodgen, J., Pepper, D., Sturman, L. and Ruddock, G., 2010. *Is the UK an outlier? An international comparison of upper secondary mathematics education*, Nuffield Foundation: London

10. School Curriculum and Standards Authority, 2017. *STEM Education in Western Australian Schools: 2016 Update*, SCSA: Cannington

11. Office of the Chief Scientist, 2016. *Australia's STEM Workforce: Science, Technology, Engineering and Mathematics*, Australian Government: Canberra

12. See, for example, joboutlook.gov.au or www.dtwd.wa.gov.au/workforce-development

13. Office of the Chief Scientist, 2017. *STEM Partnerships Forum Communiqué: First Meeting – Business partners with schools on Science, Technology, Engineering and Mathematics*, Australian Government: Canberra

14. Education Services Australia, 2018. *Optimising STEM Industry-school partnerships: Inspiring Australia's Next Generation Final Report*, STEM Partnerships Forum, Education Council: Victoria

15. Australian Council for Educational Research, 2016. *Out-of-field teaching in Australian secondary schools*, Policy Insights, Issue #6, June 2016

16. Engineers Australia, 2017. *The Engineering Profession – A Statistical Overview,* Thirteenth Edition, Institution of Engineers Australia: Barton

17. Hobbs, L., Jakab, C., Millar, V., Prain, V., Redman, C., Spelewinde, C., Tytler, R., & van Driel, J., 2017. The Invergowrie Foundation, 2017. *Girls' Future – Our Future: The Invergowrie Foundation STEM Report*, Invergowrie Foundation: Melbourne

18. Chapman, S. & Vivian, R., 2017. *Engaging the future of STEM: A study of international best practice for promoting the participation of young people, particularly girls, in science, technology, engineering and maths (STEM),* Chief Executive Women: Sydney

19. Li, N. & Koch, I., 2017. *Choose Maths Gender Report: Participation, Performance, and Attitudes Towards Mathematics*, Australian Mathematical Sciences Institute: Melbourne

20. Department of Education and Training, 2015. *ATSIHEAC Background Paper: Indigenous Science, Technology, Engineering, and Mathematics (STEM),* Australian Government: Canberra

21. Chamber of Minerals and Energy of Western Australia, 2017. *Diversity in the Western Australian Resources Sector*, CME: Perth

22. Australian Curriculum, Assessment and Reporting Authority, 2015. *NAPLAN achievement in reading, persuasive writing, language conventions and numeracy: National Report for 2015*, ACARA: Sydney

23. Australian Council for Educational Research, 2017. *PISA 2015: Reporting Australia's results*, ACER: Camberwell, Victoria

24. World Economic Forum, 2016. *The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*, World Economic Forum: Geneva

25. PricewaterhouseCoopers, 2015. *A smart move: Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths (STEM),* PwC: Australia

26. Committee for Economic Development of Australia, 2015. *Australia's Future Workforce?* CEDA: Melbourne

27. Bankwest Curtin Economics Centre, 2018. *Future of Work in Australia: Preparing for tomorrow's world*, Bankwest Curtin Economics Centre, Focus on the States Series, Issue #6, April 2018

28. Office of the Chief Scientist, 2012. *Future of Australian Science, Technology and Innovation*, Prime Minister's Science Engineering and Innovation Council (PMSEIC) Meeting 24, Australia

29. Australian Council of Learned Academies, 2016. *Review of Australia's Research Training System*, Project 13, Final Report, ACOLA: Melbourne

www.jtsi.wa.gov.au