



NATIONAL STEM SCHOOL EDUCATION STRATEGY

A COMPREHENSIVE PLAN FOR SCIENCE, TECHNOLOGY,
ENGINEERING AND MATHEMATICS EDUCATION IN AUSTRALIA

DECEMBER 2015



This strategy was endorsed by Australian Education Ministers on 11 December 2015.

National STEM school education strategy 2016 – 2026

Introduction

When Australian Education Ministers signed up to the *Melbourne Declaration on Educational Goals for Young Australians* in 2008, they identified literacy and numeracy and knowledge of key disciplines as the cornerstone of schooling for young Australians. They also recognised that schooling should support the development of skills in cross-disciplinary, critical and creative thinking, problem solving and digital technologies, which are essential in all 21st century occupations.

These objectives lie at the core of the national science, technology, engineering and mathematics (STEM) school education strategy.

All governments are investing in improving STEM education. There is significant activity underway across the country in schools and education systems, by industry and universities, to lift student engagement and attainment in STEM and to support teachers to improve student outcomes.

The Chief Scientist's report *Science, Technology, Engineering and Mathematics: Australia's Future*, however, has provided fresh momentum for a national focus on STEM education.

The Chief Scientist's report highlighted the trends that all education systems are grappling with – the performance of Australian students against international benchmarks has stalled or declined as has participation in senior secondary science and advanced maths.

Reversing the trends in STEM performance will take time and effort across the community. Building young people's engagement in STEM is bigger than schools and what happens in the classroom. Education systems alone cannot overcome the pervading cultural norm that it is acceptable to be 'bad at maths' or 'not a numbers person'.

There are many factors that affect student engagement in STEM. Underlying this are the views of the broader community – and parents in particular – about the relevance of STEM, and the approach to the teaching and learning of STEM from the early years and continuing throughout schooling. Connected to this is the way industry articulates the importance of STEM related-skills that extend beyond traditional STEM occupations. University admissions policies also have a strong influence on student choices in the senior secondary years.

The purpose of the strategy is to build on a range of reforms and activities already underway. It aims to better coordinate and target this effort and sharpen the focus on the key areas where collaborative action will deliver improvements to STEM education.



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THE CASE FOR CHANGE

Over the next five years, employment is predicted to increase in professional, scientific and technical services by 14 per cent and in health care by almost 20 per cent. The Australian Bureau of Statistics has estimated that some STEM-related jobs, such as ICT professionals and engineers, have grown at about 1.5 times the rate of other jobs in recent years. ¹

International research shows that building STEM capacity across the population is critical in helping to support innovation and productivity regardless of occupation or industry. Consistent with this research, industry surveys show that STEM literacy is increasingly becoming part of the core capabilities that Australian employers need. PricewaterhouseCoopers has estimated that changing 1 per cent of Australia's workforce into STEM-related roles would add \$57.4 billion to GDP. ²

Yet Australian data shows that inequities currently exist in STEM. Girls, students from low socio-economic status backgrounds, Aboriginal and Torres Strait Islander students, and students from non-metropolitan areas can be less likely to engage with STEM education and therefore have a higher risk of not developing high capabilities in STEM-related skills. These groups are more likely to miss out on the opportunities STEM-related occupations can offer.

This combines with an overall trend away from higher level STEM subject choices and the failure to keep pace with the highest performing countries on international tests of maths and science.

A renewed national focus on STEM in school education is critical to ensuring that all young Australians are equipped with the necessary STEM skills and knowledge that they will need to succeed.

1. Australian Government, *Industry Employment Projections 2015 Report*; ABS *Perspectives on Education and Training: Australian qualifications in STEM, 2010-11*, Cat. 4250.0.55.005.

2. PricewaterhouseCoopers (PWC), *A Smart Move: future-proofing Australia's workforce by growing skills in STEM* (2015).

STEM learning in schools

STEM education is a term used to refer collectively to the teaching of the disciplines within its umbrella – science, technology, engineering and mathematics – and also to a cross-disciplinary approach to teaching that increases student interest in STEM-related fields and improves students' problem solving and critical analysis skills.

STEM sits within a broader foundational knowledge base and the teaching of STEM is a part, albeit important, of a balanced program of learning.

The national strategy is focused on action that lifts foundational skills in STEM learning areas, develops mathematical, scientific and technological literacy, and promotes the development of the 21st century skills of problem solving, critical analysis and creative thinking. It recognises the importance of a focus on STEM in the early years and maintaining this focus throughout schooling.

Goals

Goal 1: Ensure all students finish school with strong foundational knowledge in STEM and related skills

Today's students need to acquire core subject knowledge as well as the skills of collaboration, critical thinking, creativity and problem solving – and STEM education has a crucial role in achieving this.

School systems have a responsibility to ensure that all young people have a fundamental level of STEM literacy that enables them to engage with, and succeed in, the world beyond the school gate. Building foundational STEM knowledge needs to start from early childhood and continue throughout primary and secondary schooling.

Schools have the opportunity to foster and nurture young people's curiosity towards STEM, and can use this to develop deeper engagement and learning. This requires renewed focus on achievement in the STEM 'building blocks', especially mathematics, as well as effective cross-disciplinary curriculum and pedagogical approaches that build student interest and performance in STEM education.

Goal 2: Ensure that students are inspired to take on more challenging STEM subjects

While the primary aim of the national strategy is to support all young people to become more STEM capable, a supplementary goal is to increase participation in challenging STEM subjects in the senior secondary years.

School systems have an important role to play, in partnership with the tertiary education sector and industry, to encourage students to develop higher level STEM capabilities, to build aspiration for STEM participation at tertiary levels and for STEM-related careers.

Five areas for national action

Schools form a critical part of a broader STEM education ecosystem which includes pre-schooling, vocational education and training, higher education and workplace training and development. The strategy has identified five key areas for national action through which school education has the greatest leverage.

1. Increasing student STEM ability, engagement, participation and aspiration
2. Increasing teacher capacity and STEM teaching quality
3. Supporting STEM education opportunities within school systems
4. Facilitating effective partnerships with tertiary education providers, business and industry
5. Building a strong evidence base

There is significant activity underway across the country – within schools, school systems, universities and business – to improve STEM education. The national STEM school education strategy seeks to build on this activity and provides a framework for collaborative effort.

The actions identified in this strategy focus on areas where national collaboration is most beneficial, drawing together some of the national curriculum and teaching reforms to drive improvements in STEM education.

The strategy supports a long-term change agenda. Some national actions are well advanced or can be implemented in the short term, but in setting the bar high, others are more aspirational and will take time to be realised.

In identifying areas for national collaborative effort and jurisdictional priority actions, it is recognised that jurisdictions have different starting points and that there will continue to be differences in strategic priorities across states and territories.

While the actions are largely focused on teaching and learning within the school environment, building and maintaining student interest and aspiration in STEM cannot be achieved by schools alone. Parents and the broader community, industry and the tertiary education sector are key STEM education partners.

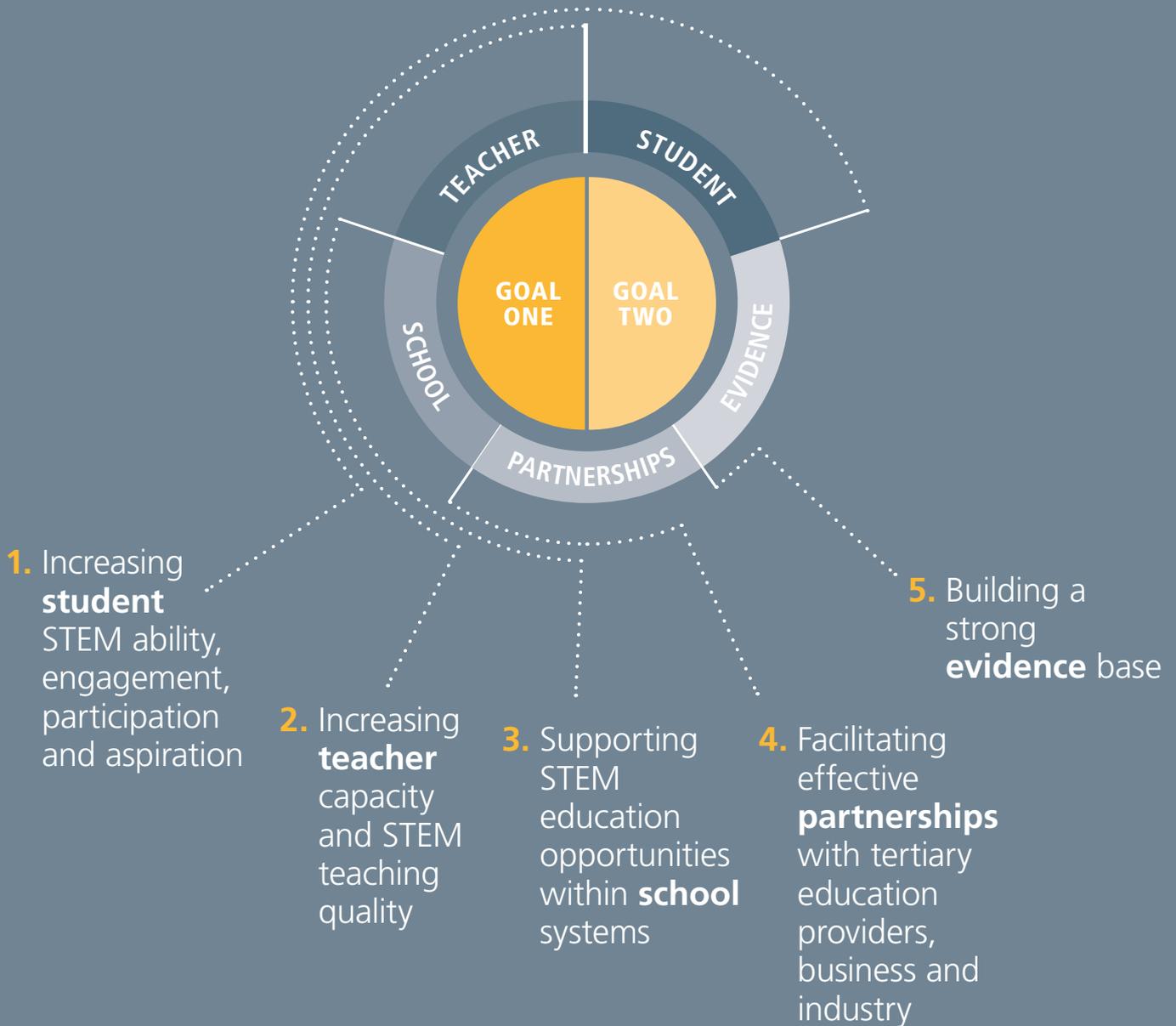
GOALS

Goal 1:

Ensure all students finish school with strong foundational knowledge in STEM and related skills

Goal 2:

Ensure that students are inspired to take on more challenging STEM subjects



FIVE AREAS FOR NATIONAL ACTION

1. Increasing student STEM ability, engagement, participation and aspiration

Students' early interest in STEM is not translating to ongoing engagement and participation in STEM education. While evidence shows students have a natural interest in science, they don't necessarily understand the relevance of STEM education, particularly maths. Research shows that there is an interrelationship between student aspirations towards STEM careers and engagement in STEM subjects. Mathematical thinking is a fundamental skill that underpins all STEM learning. The sequential nature of mathematical learning means that students who fall off the 'maths pathway' early can struggle to achieve sufficient levels of mathematical literacy.

National collaborative actions:

- Explore options for a **minimum level of numeracy attainment** for all students to demonstrate before leaving school, with a focus on proficiency levels over time.
- Increase the **recognition of the subject load of advanced STEM subjects** and encourage the uptake of advanced courses, for example, through university entrance bonus point schemes.

Jurisdictional priority actions:

- Supporting a focus on STEM in early childhood education to build on early curiosity for science and technology, and the importance of foundational numeracy skills.
- Recognising the primary and middle years as critical periods when students begin to cement their aspirations for, and confidence in, STEM.
- Supporting a focus on the development of higher order computational, problem solving and creative thinking skills through the rollout of the Australian curriculum on technologies, including a deep engagement with coding.
- Encouraging the uptake of online learning materials, linked to classroom practice, to support the development of students' problem solving and reasoning skills which are at the core of mathematical thinking, scientific literacy and a deep engagement with coding.

2. Increasing teacher capacity and STEM teaching quality

Quality teaching is the key to lifting student engagement and performance in STEM education. Teachers need to be equipped with the skills and confidence to support STEM learning. The rapidly changing nature of technology, and the importance of real world approaches to science education, makes this particularly challenging.

Evidence suggests that some primary school teachers lack confidence in teaching science and maths, particularly where they have limited expertise in these content areas. While there is significant activity already underway across jurisdictions to support STEM teaching, effort under the national strategy will focus on sharing best practice, implementing national initial teacher education standards and efforts to attract more STEM graduates into the profession.

National collaborative actions:

- Collect and develop **online exemplar teaching modules**, in partnership with university and industry, to assist in the delivery of best practice STEM teaching, including a focus on, for example:
 - Using coding to develop mathematical thinking and solve real world problems.
 - Addressing identified weaknesses in numeracy arising from NAPLAN performance.
 - Supporting the key progress points in the learning of maths and science.
 - Delivering project-based learning for STEM
 - Using engineering and technological challenges to provide real world context for projects.
 - Supporting the introduction of STEM concepts in the preschool years.
- Establish a **STEM professional learning exchange**, in partnership with universities and industry, to support schools and school systems by sharing best practice and identifying areas to help boost teacher confidence and capacity in the primary and secondary years, for example in STEM subject content, data analysis and programming.

- Lift the quality of **initial teacher education** to support teacher confidence and STEM content expertise, including through:
 - implementation of agreed national program standards, including mandatory content requirements in maths and science, and the national literacy and numeracy test for initial teacher education students.
 - consideration of enhancements to mandatory content requirements and the use of financial arrangements with the university sector to further lift the quality of initial teacher education over time.
- Work with universities to improve the **pathway for STEM graduates into teaching**, for example, through financial incentives and inclusion of teaching pedagogy components in STEM-related degrees linked to school/university partnerships.

Jurisdictional priority action:

- Continuing to support schools to access specialist teachers in maths, science and technology.

3. Supporting STEM education opportunities within school systems

Schools and education systems need to facilitate STEM engagement through effective curriculum, teaching approaches and assessment resources to improve learning outcomes in the classroom. While there are a wide range of curriculum resources available, effort under the national strategy will build on, and link to, the Australian curriculum and national assessments to support the attainment of core STEM subject knowledge and the underlying skills of problem solving and analytical thinking.

National collaborative actions:

- Extend the **national literacy and numeracy continuums** to better assist teachers to identify and address individual student needs according to the expected skills and growth in student learning at key progress points from the early years through high school, given the evidence of the spread of student achievement within any classroom.
- Develop **online formative assessment tools** that help teachers collect and use data about individual student learning needs, which builds on the continuum and utilises the nationally agreed and supported online assessment platform.
- Revise the scope and **extend the reach of the national science and ICT assessments** for Years 6 and 10, calibrating them against the best international standards to ensure high levels of scientific and digital literacy (jurisdictions to opt-in to full cohort testing).

Jurisdictional priority actions:

- Improving the integration of statistical concepts, data analysis and problem solving skills into school programs, consistent with the Australian curriculum and in recognition of the impact of technology and big data on the types of STEM literacy today's students require.
- Extending student performance in STEM through initiatives such as virtual classrooms, extension courses and early access to university courses.

4. Facilitating effective partnerships with tertiary education providers, business and industry

National effort is required to raise community understanding of the critical role STEM skills play in a knowledge based economy and the range of careers that require STEM capabilities. There are a significant number of partnerships and programs in place that bring together schools, industry and universities to support STEM engagement. However, more needs to be done to improve the coordination and reach of these arrangements, particularly for under-represented students, and to identify best practice.

National collaborative action:

- Establish a **STEM Partnerships Forum** to facilitate more efficient and effective partnerships between schools, industry and the tertiary education sector that support teachers and develop the aspiration and capabilities of students, particularly for under-represented groups. This may include consideration of:
 - developing guidance and support materials for **best practice models** of partnerships, including mentoring and outreach activities, that are relevant, engaging and support STEM learning outcomes.
 - **increasing industry involvement** in effective school-based partnerships.
 - ensuring greater alignment of **initiatives to raise awareness** of the importance of STEM education for all.
 - advising on the best approach to **careers advice** on the importance and relevance of STEM skills, particularly for primary students and their parents.
 - facilitating greater engagement between industry and STEM teachers, for example, **industry work placements** and programs for pre-service teachers.

Jurisdictional priority action:

- Work with the tertiary education sector to improve **communication to secondary students** about the level of school STEM study needed to successfully complete STEM-related courses at university and in vocational education and training.

5. Building a strong evidence base

There are multiple approaches to partnership programs and to the integrated and project-based teaching of STEM that aim to improve student aspiration, engagement and performance. Better guidance is needed for schools and teachers to determine which approaches work best for different purposes and student cohorts. Effort under the national strategy will focus on establishing a stronger data and evidence base over time to track national trends and improve our understanding of what works in Australian contexts.

National collaborative actions:

- **National reports** to chart national change in a range of STEM data indicators, for example, STEM participation and attainment (including a focus on girls, low SES, Aboriginal students), university commencements and graduate outcomes, and employment outcomes.
- **Share and synthesise research and evaluation** findings to identify successful STEM interventions and inform school practice.

Jurisdictional priority action:

- Establishing a **culture of evaluating** programs and initiatives to help build an evidence base for what works to improve STEM outcomes in Australian contexts and for particular sub-groups (in particular girls, low SES and Aboriginal students).

NATIONAL STEM SCHOOL EDUCATION STRATEGY

GUIDING PRINCIPLES FOR SCHOOLS TO SUPPORT STEM EDUCATION

These high-level principles have been developed to help guide school leaders in improving the focus on, and bringing about change in, STEM within the school environment.

1. Create a school culture where the importance of STEM is recognised and valued, and there are high expectations for all students to engage with STEM education opportunities.
2. Expose students (and their teachers) to a wide range of career options and information early to help increase STEM aspirations and engagement, ideally in primary school and continuing throughout high school, and involving parents and school communities where possible.
3. Build on students' curiosity and connect STEM learning to solving real world problems, including through collaborative and individual learning experiences that are hands-on and inquiry-based and support the achievement of deep knowledge.
4. Recognise that STEM education approaches work best when supported by a whole-of-school collaborative effort.
5. Encourage teachers to prioritise STEM content knowledge when determining their professional learning needs, given the rapidly changing nature of science and technology.
6. Use school demographic data and the local context to guide choices about partnership and outreach programs, and consider how best to target student cohorts less likely to do STEM subjects or see the relevance of STEM-related skills.
7. Consider how to evaluate new partnerships and learning approaches as part of program design, to determine whether change has occurred in student attitudes to STEM, and whether this translates into greater STEM achievement.



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