SUBMISSION

TO THE AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY

The Australian Curriculum Review

ATSE Australian Academy of Technology & Engineering

ENGINEERS AUSTRALIA

ACED AUSTRALIAN COUNCIL OF ENGINEERING DEANS

THE AUSTRALIAN CURRICULUM REVIEW

The Australian Academy of Technology and Engineering (ATSE)[1], Engineers Australia[2] and the Australian Council of Engineering Deans (ACED)[3] are pleased to jointly contribute to the Australian Curriculum Review for Foundation to Year 10 students, being conducted by the Australian Curriculum, Assessment and Reporting Authority (ACARA).[4]

The world is undergoing a period of immense technological, social, economic, and environmental change, and this review of the Australian curriculum is a timely opportunity to bring Australia's education system into line with contemporary challenges and emerging knowledge in science, technology, engineering and maths (STEM), and school education. This review should also consider changes to make the Australian curriculum more inclusive to all students, and to provide equal opportunity to access high quality STEM education and careers. In particular, the review should seek to equip schools to build girls' capability and interest in STEM.

ATSE, Engineers Australia and ACED support the aim of the review, to ensure the curriculum continues to meet the needs of students and provides clear guidance for teachers. The curriculum reform must fundamentally strive for excellence and inclusion of all young people, and so it should seek to address key gaps in STEM education, including declining academic performance and engagement with STEM subjects.[5]

Recommendations:

The proposed changes outlined in the ACARA review are broadly positive, but there are areas where STEM Learning Areas could be further strengthened. ATSE, Engineers Australia and ACED recommend:

1. The Technologies Learning Area should be compulsory beyond year 8, and include more explicit references to 'engineering'.
2. Applied sciences, including engineering, should be explicitly included across the Science and Technologies Learning Areas at all year levels, to ensure the focus is on all STEM careers and learning, not just 'discovery' science.
3. Digital literacy and specific digital technology skills such as coding should be a key priority across all year levels.
4. Indigenous science, particularly areas which align with sustainability principles, should be explicitly included within the Science and Technologies Learning Areas.

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[1] The Australian Academy of Technology and Engineering is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.

[2] Engineers Australia is the peak member-based professional association for engineers with over 100,000 individual members. Founded in 1919 as the Institution of Engineers Australia, the organisation exists to advance the science and practice of engineering for the benefit of the community and has underpinned the progress of our nation for more than a century.

[3] The membership of the Australian Council of Engineering Deans (ACED)[3] is a senior academic leader of the 35 Australian universities that provide professional engineering degrees accredited by Engineers Australia. ACED's mission is to promote and advance engineering education, research and scholarship on behalf of Australia's higher education system.

[4] ACARA (2021) Australian Curriculum Review. https://www.acara.edu.au/curriculum/curriculum-review

[5] ACER (2018) Challenges for STEM Learning in Australian Schools. https://research.acer.edu.au/cgi/viewcontent.cgi?article=1028&context=policy_analysis_misc

Technologies Learning Area

As the global technology skills shortage grows, the inclusion of the Technologies Learning Area has significant potential to inspire Australian school students towards career pathways to meet growing national workforce and innovation needs. Australia's future and potential to succeed requires an understanding of science and technology, including digital literacy and design principles. There is also a growing imperative to create more value from advanced science and technology achievements through manufactured products and systems, driving an increasing demand for technologists and engineers.

It is a missed opportunity that the Technologies Learning Area is currently only compulsory to Year 8. States and territories should be strongly encouraged to develop and integrate subjects for Years 9-12 that will attract students into post-school study and work in these areas of critical national need. At the Foundation to Year 10 (F-10) stages, the curriculum for Technologies (with its components in Design & Technologies and Digital Technologies) can play a role in helping students understand the real-life applications of fundamental mathematics and science subjects, and an awareness of possible career paths using these skills

The Technologies Learning Area should also emphasise the broad and vital role that technology and its implementation plays in the world, and incorporate essential concepts that place technology in society, such as ethics, societal values, and knowledge about cognitive biases in technology development and application. Repositioning STEM education and learning within a social context is integral to articulating the roles of engineers in the community, and can improve engagement in STEM education by girls[6] and children from marginalised communities, including Aboriginal and Torres Strait Islander students.[7]

We are pleased that the core concept statement for the Technologies Learning Area captures much of the essence of engineering – a key application of technologies learning. The content emphasis on *forces*, however, creates a focus on one area of the science of engineering, rather than its purpose, to *make* useful and reliable products and systems for society.[8] Furthermore, we recommend that applied sciences, particularly engineering, should be explicitly included across both the Science and Technologies Learning Areas at all year levels. This will aid students to understand the significance of these aspects of the curriculum and relevance to future career pathways.

To strengthen the Technologies Learning Area curriculum, we make the following additional suggestions:

- Engineering principles are underrepresented in the content for years 9 and 10 and are absent nationally in years 11 and 12. To encourage engineering as a career for students entering university courses, it is essential that students engage with engineering principles at all year levels.
- Emphasising the subject's potential to link students with careers and serve as a clear pathway into technical Vocational Education and Training (VET).

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[6] Monash University (2019) Barriers to Participation in Engineering and the Value of Interventions to Improve Diversity, a report prepared for the Engineering for Australia Taskforce. p13. https://f8f.f75.myftpupload.com/wp-content/uploads/2021/01/Engineering-for-Australia-Taskforce-Report.pdf

[7] McKinley, E. (2017) STEM and Indigenous Students. Australian Centre for Educational Research. https://research.acer.edu.au/cgi/viewcontent.cgi?article=1290&context=research_conference

[8] Royal Academy of Engineering UK (2014) Thinking like an engineer: implications for the education system. https://www.stem.org.uk/elibrary/resource/35085#&gid=undefined&pid=2

- The frequent references to sustainability are welcome. We encourage more explicit references to sustainable energy and the shift to a circular economy.
- Strengthening the links between the Technologies, Science, and Mathematics Learning Areas may help to improve students' understanding of the dynamic relationships between these areas of STEM, which give rise to contemporary technology applications such as modelling.
- The Technologies Learning Area contains many engineering concepts, principles and methods and we are pleased with the breadth and depth to which these are reflected. However, there is limited reference to these concepts, principles and methods specifically as 'engineering' ideas. We recommend that the word 'engineering' is used more often throughout the Technologies Learning Area to ensure that teachers, students, parents/carers and careers advisers are better able to make the connection between these ideas and the engineering profession to make 'engineering' more tangible for students and increase awareness of engineering as a career path.

Generic capabilities - Digital literacy

Digital literacy is rapidly becoming one of the highest priority skills for our future workforce. Australian students must have strong digital technology skills to meet Australia's future workforce needs and support our growing digital economy.

If the Digital Technologies subject is compulsory through years 8 – 10, it is essential that all Learning Areas at these levels explicitly include relevant aspects of digital literacy and capability, including coding.

The inclusion of 'algorithms' described for years 1-2 in the Digital Technologies subject implies initial exposure to coding, as does the introduction of 'computational thinking' by Year 4, to be further developed during Years 5 – 6. The Achievement Goals for years 7 – 8 and 9 – 10 are excellent and should satisfy the Digital Literacy capabilities, assuming that digital skills are also used in other Learning Areas.

Science Learning Area

Overall, the changes outlined in the revised Science curricula are positive, and while content has been reduced for Foundation to year 4, there is a greater emphasis on learning outcomes. This emphasis on learning outcomes allows more opportunity in early years for teachers to embed fundamental science skills such as observation, which are essential for STEM education in later years.

Where "scientists" are described in the documentation, it would be more accurate – and encourage students to think more broadly about STEM career pathways – to describe "STEM professionals such as scientists, engineers and doctors".

Similarly, the applications of science could be more clearly articulated and strengthened. For years 7 – 10, the electrical and optics areas of physics could be strengthened to show the scientific underpinning of many contemporary applications, such as photonics, or the use of electronic devices as amplifiers and switches.

Finally, all changes to the science curriculum should ensure that practical application of the scientific method is maintained as an essential skill for children to develop in their interaction with the fast-evolving global environment. Students must learn critical skills such as empiricism and scepticism in order to navigate the complex social, environmental and economic challenges of the coming decades.

Mathematics Learning Area

Australia is falling behind international peers on basic mathematics skills and it is essential that changes to the Mathematics Learning Area give priority to improving basic mathematics skills to better enable higher level mathematical capability, leading to higher student engagement in tertiary STEM education. While refinement of the mathematics curriculum is necessary, the proposed changes lack a fundamental emphasis on the mastery of basic mathematics skills, which students need in order to develop further skills in problem-solving. These skills are critical to understanding and engaging with the world in later years.

We also consider that there is value in the increased focus on problem solving and modelling as this should enable more students to understand how mathematics is applied in science, technology and other areas, and may thereby encourage more students to take up mathematics subjects at higher levels.

Cross Curriculum Priorities

Aboriginal and Torres Strait Islander Histories and Cultures

Indigenous science refers to the process by which Indigenous peoples build empirical knowledge of the natural environment, as well as the practical application of theories of knowledge about the nature of the world.[9]

Indigenous science is an application of the scientific method, using observation and experimentation, to collect data about the natural world while being embedded in principles of custodianship of Country. Australia is in a unique position with over 60,000 years of Indigenous knowledge about the physical world, which can complement Australia's existing STEM curriculum and teach students about the importance of respecting and understanding deep connection to the land and environment.

We applaud the inclusion of Aboriginal and Torres Strait Islander Histories and Cultures as a cross-curriculum priority, and that elements of Indigenous science and engineering have been incorporated significantly into the Technologies Learning Area in the Design and Technologies subject. The inclusion of this cross-curriculum priority will allow investigation into role of Indigenous science in the development of knowledge about the physical world and how we interact with it, through observation and experimentation.

The inclusion of Indigenous science principles in the Curriculum will improve understanding and recognition of the importance of Indigenous science in Australia's history and future. To ensure students gain better understanding of the importance of Indigenous science and knowledge, the

[9] The Living Knowledge Project (2008). Indigenous knowledge in science education. Australian National University. https://livingknowledge.anu.edu.au/html/educators/02_questions.htm

curriculum should explicitly include a requirement for Indigenous science to be covered in the Science and Technologies Learning Areas.

We urge an emphasis on the sophistication of Indigenous science and engineering. In line with the sustainability cross-curriculum priority, students should also gain an understanding of the sustainability principles underpinning traditional Indigenous approaches to land and resource management.

Finally, many STEM teachers are unlikely to have prior experience in teaching the concepts of Indigenous science and knowledge. Professional development, support, and resources should be made available to teachers to ensure that these concepts are appropriately integrated into the existing STEM curriculum and associated frameworks.

Sustainability

As the world prepares to undergo immense change to mitigate and adapt to the challenges posed by climate change, and in order achieve the UN Sustainable Development Goals, it is essential that the Australian curriculum teaches students of the need for sustainability. The inclusion of sustainability as a cross-curriculum priority is welcomed, however this priority could be strengthened by the following suggestions:

- The ideas included under the Sustainability cross-curriculum priority are very high level and may obscure the urgency of addressing issues such as climate change, energy, resources, water and land use, and the shift to a circular economy. These challenges could be more explicitly outlined in the priority.
- Desired Sustainability outcomes and content should be mapped into all relevant curricula to clearly show the relevance of each subject area.
- The Sustainability cross-curriculum priority should indicate how applied science and engineering solutions can address sustainability issues.

STEM Career Pathways

To better prepare students for STEM careers, links to career pathways in applied sciences should be included across all years, as well as the upper secondary years. Several school programs focused on STEM education and career pathways are provided by ATSE and Engineers Australia and are discussed briefly below.

STELR

STELR (Science and Technology Education Leveraging Relevance) is a national initiative of ATSE. The STELR program is designed to improve participation rates in STEM subjects at the upper secondary school level and incorporates contemporary teaching and learning practices. Through the context of renewable energy technology, students learn about research, forming and testing hypotheses; planning and conducting robust investigations; collection and analysis of data and evaluation of scientific propositions as outlined in the Australian Curriculum. More than 800 schools across Australia and 30 internationally are using ATSE's STELR program in classrooms.

Computer Science in Schools

ATSE's CS in Schools is a free program that helps schools build robust digital technology capability in their students and aims to set the standard for computer science education nationally. Founded by Google Maps and eBay pioneer Hugh Williams, his partner and business executive Selina Williams, and education professional Kristy Kendall, it provides curriculum resources and matches computing professionals with teachers, helping them develop their coding skills in the classroom and providing innovative lesson materials.

This year, CS in School is working with 40 schools across Australia to build stronger DigiTech programmes and supporting over 150 teachers. Together, we are helping around 9,000 students learn how to code in Years 7 and 8 in 2021. CS in Schools prioritises girls and under-served communities and aims to be operating for free in all Australian Schools by 2027.

EA Junior Club

EA Junior Club (eajuniorclub.com.au) is designed to engage primary school students in engineering activities. The teachers' portal houses curriculum-aligned activities for the classroom and includes full teaching plans. The parents' portal houses fun activities that can be enjoyed at home.

STARportal

An Engineers Australia-owned property, the STARportal (STARportal.edu.au), was developed in collaboration with the Office of the Chief Scientist and is Australia's first centralised national database of STEM activities. This searchable database connects parents, students and teachers with STEM activities available in their local area and online, in real time.

These and a range of other programs and information can be found on the Engineers Australia website: https://www.engineersaustralia.org.au/For-Students-And-Educators

Teacher education

Teachers have an essential role in the formation of the next generation. While it is essential to renew and improve the Australian Curriculum content, it is important that Australian teachers are provided adequate opportunity to access professional development and education to improve their knowledge and understanding of new and updated information they are expected to teach. Teachers should have easy access to high-quality materials to support them to teach new or complex subject matter, and should have access to appropriate professional development, education and training to ensure they can meet students' needs and expectations to deliver the best learning outcomes for all students.

Teachers of STEM subjects are often generalists with limited experience in applied sciences, particularly engineering. This leaves teachers unprepared to deliver important concepts of engineering and design thinking, which are fundamental skills students need to meet the fast-evolving needs of society.

Introducing key principles of engineering, for example through the application of the Conceive, Design, Implement, Operate (CDIO) framework[10], may help to develop greater understanding and application of engineering principles from F – 10, and support teachers to better deliver engineering

[10] Conceive, Design, Implement, Operate Standards 2.0. http://www.cdio.org/implementing-cdio/standards/12-cdio-standards

education. Furthermore, making quantitative and logical connections to the real-world can help to improve the relevance of topics, for example by including case studies to reinforce concepts and learning.

Improving STEM education across the board for all students in all years is a key policy priority for ATSE, ACED and Engineers Australia, and we would be pleased to further assist ACARA in this inquiry. For more information, please contact Harry Rolf, ATSE Senior Policy Analyst (harry.rolf@atse.org.au), Emeritus Professor Robin King, Consultant to ACED (robin.king@uts.edu.au), or Jane MacMaster, Chief Engineer, Engineers Australia (chiefengineer@engineersaustralia.org.au).

Please note that ACED also intends to provide an additional independent response to the review.