Overcoming education pipeline barriers to the supply of domestically educated engineers.

Abstract

This paper presents potential solutions to overcoming the barriers to the supply of engineers within Australia's education pipeline, along with examples of successful efforts from overseas.

Various strategies are explored to improve engineering education at different stages of the pipeline with an emphasis on the late primary/early secondary years. These are the years where students firm up in their own minds the most appropriate education pathways to achieve their goals in life, and where they work out what they would like to do.

Drawing lessons from successful overseas initiatives, the paper highlights the UK's STEM Ambassador program and recommends the establishment in Australia of a similar programme to recruit STEM Engineering Advocates.

Contents

Overview

The systemic barriers identified in the education pipeline to the supply of domestically educated engineers are not confined to Australia and are a feature of many education systems in the western world.

Potential solutions here in Australia, together with overseas efforts to overcome these barriers, are summarised below.

However, all these potential solutions might be considered band aids for the underlying issue that engineering's professional image is not as high as it should be considering the importance of engineers to the building of Australia's future infrastructure and defence capabilities.

Priority should therefore be given to raising the awareness of engineering as both the enabling discipline in STEM and of the role of engineers in Australian society.

A good place to start would be the establishment of a STEM Ambassador scheme modelled upon the successful STEM Learning/STEM Ambassador programme which has been running in the UK for over 20 years.

Universities (Engineering Degrees)

- Increase the level of project and team-based experiential learning based upon the core skills of problem solving and communication, together with engineering practice skills such as project and risk management, sustainability, cost effectiveness, and marketing. A good international example is The Engineering & Design Institute (TEDI) based in London.
- Engage in more engineering (as opposed to robotics) challenges in 1st year engineering courses.

Universities (Teacher Education)

- Develop micro-credential courses in either Universities or VET for the teaching of engineering and the two streams of the Australia Technologies curriculum (Design and Technologies and Digital Technologies). This is a good option to upgrade the skills of current out-of-field teachers.
- Offer subsided education-based elective undergraduate Engineering, Design, IT courses to encourage those graduates to consider a Master's degree in Education, or a career transition at some point in the future. This would provide undergraduates in popular courses like Industrial Design, where graduates are plentiful but local jobs are scarce, to consider teaching in Australia rather than going overseas.
- Consider subsidising a double Engineering & Education degree (or similar) either partially or in full if the candidate agrees to work in education for a certain time fraction over a certain amount of time. Full-time for 3 years or part-time for 5 years etc Earn as you Learn.
- Have Universities support the Technologies element in their teacher education programmes by providing facilities support from their Engineering Faculties and mentoring of specifically designed courses by their best engineering undergraduates (particularly females) – who should be suitably rewarded (eg with credits)
- Mandate a specific STEM/Technologies unit in all university teacher education courses where the role of Engineering in STEM education can be better understood and where the terms "engineered systems" and "engineered solutions" are more clearly defined and explained.

Universities (In-house and School Outreach)

- Encourage universities to collaborate with their state education and curriculum standards bodies to align Stage 6 (Years 11-12) Engineering Studies courses to their prerequisites for University Engineering degrees.
- Engage more with students in the middle school years (Yrs 5-8) as these are the years where students are making up their minds on their career and work educational pathways.
- Target both girls and boys equally in the middle school years, because ignorance of engineering may be due to its invisibility in the classroom in these early years – not necessarily gender.

Schools (Curriculum & Learning)

- Increase enrolments in Stage 6 (Years 11/12) engineering studies electives through continuous curriculum review to keep up with technology change, and seamless hand-off from similar courses in earlier years.
- Add an engineering component to the Year 12 Science Extension course introduced in NSW by NESA in late 2018. Students will learn about engineering principles and real-world practice by engaging in a real engineering project. They will document their experience in a

project portfolio and present their findings. to a real customer. It will be mentored by university tutors and its theoretical component examined online.

- Include experiential and project elements into the NSW Stage 6 (Years 11/12) Engineering Studies elective to provide better continuity to the Stage 5 (Years 9/10) iSTEM elective.
- Re-word appropriate parts of the generic learning outcomes in Years 5-8 curriculum to stress their engineering provenance. *You can't identify with what is not named….*
- Review the International Technology Engineering Educators Association (ITEEA)'s 'Engineering by Design' curriculum and resources for content and resources that might be adapted for use in Australian classrooms – particularly in the early years.
- Rebrand the NSW iSTEM Stage 5 (Years 9/10) elective to make it more acceptable for implementation in other States.
- Support the production and distribution of books and resources in primary classrooms featuring everyday examples of engineering or engineers in action. Eg Andrew King's Engibear books

Schools (Strategic)

- Ensure that STEM teaching roles (eg, STEM Coordinator) are recognised by teacher accreditation bodies.
- Make it a requirement for STEM Coordinators in schools to introduce the engineering design process and explain the role of engineering in making sense of STEM education.
- Encourage a higher percentage of Males to take up careers in Primary and early Secondary education.
- Improve recognition and remuneration for teachers with specialist Master of Education degrees.
- Include prior experience and skills (rather than rely solely on Degree units) in the teacher accreditation process.

Government & Industry

- Increase long term funding for successful engineering programmes developed outside the school system in support of Technologies teachers and the Technologies curriculum.
- Provide long term funding for engineering programmes developed outside the school system in support of Technologies teachers and the Technologies curriculum. These programmes should have a track record of high penetration in their chosen demographic, or, if in their infancy, a high probability of achieving good penetration.
- Support and fund the work of DATTA (Design and Technology Teachers Association) in all States in their efforts to support existing teachers and provide appropriate D&T professional development. These organisations are currently funded by subscriptions from their members, and only DATTA (Vic) has had sufficient funds to employ staff in support of their membership.
- Support initiatives to establish a Centre of Excellence for the development of a STEM workforce. Planning is currently underway for such a centre in Oxford Falls, Sydney. Currently called the National Space and Deep Tech centre, it will focus on excellence in STEM workforce training and leverage the current enthusiasm for space exploration as a significant motivating factor.

Industry & Business (Schools Outreach)

- The engineering industry should actively engage with the Australian and State primary and secondary curriculum reform processes to ensure that engineering principles, systems, and practices, are clearly defined, named, and explained in early year learning outcomes.
- Coordinate the administration and funding of existing national industry outreach programmes (eg, CSIRO STEM Professionals in Schools or the Australian Business and Community Network's Innovate programmes) at the governance level of representative organisations such as EA, ATSE, and AiG, rather than at the current individual school and individual business level.
- Provide bursaries/scholarships for aspiring engineering students in Years 11 and 12

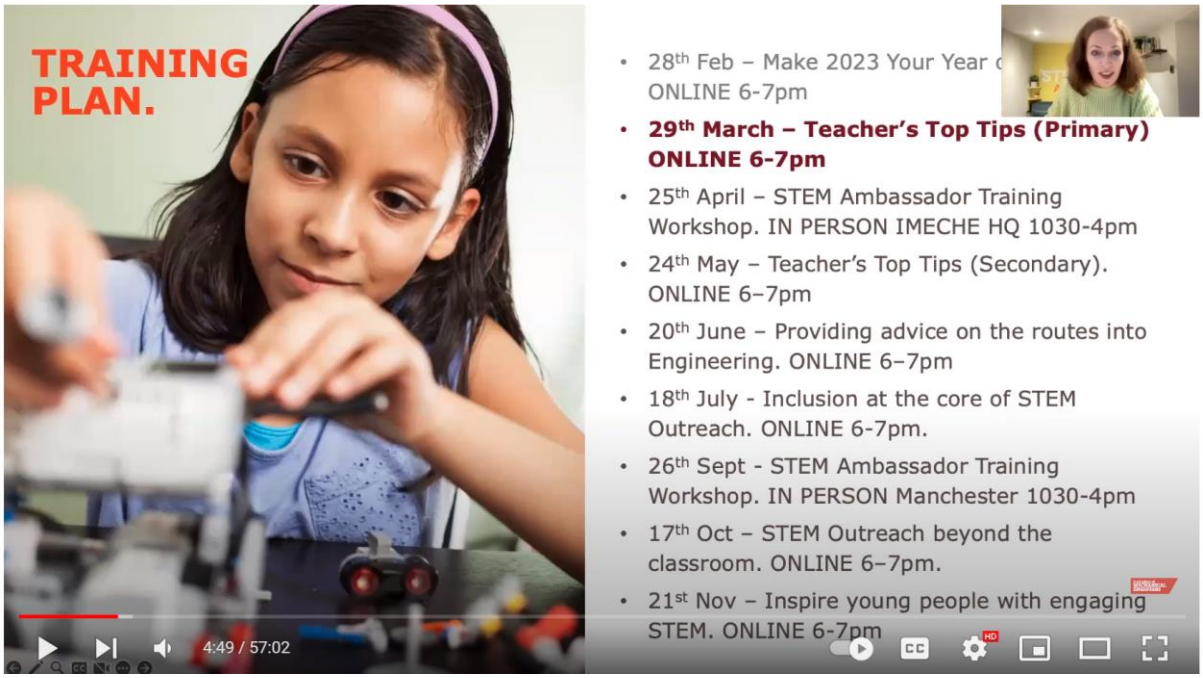
Overseas Initiatives

UK

The UK introduced its national STEM Ambassador programme in 2002. It brought together professionals working in STEM fields into schools and educational settings to share their knowledge, experiences, and passion for STEM subjects. These STEM Ambassadors engage with students, deliver interactive workshops, provide career guidance, and help dispel common misconceptions about STEM fields.

The STEM Ambassador program is coordinated by STEM Learning, a national network of organizations that promotes STEM education. STEM Learning provides training, resources, and support to STEM Ambassadors and helps match them with schools and other educational institutions seeking their expertise.

National bodies such as the Royal Institutes of Engineering (The equivalent of our own Engineers Australia) run webinars and training for their own STEM Ambassadors. The Institute of Mechanical Engineers have a comprehensive STEM Outreach programme and have trained around 10,000 STEM Ambassadors. This is their STEM Ambassador training plan for the remainder of 2023.



Canada

The province of Ontario in Canada recently updated its Grades 1-8 Science and technology curriculum to focus on fundamental science and technology concepts and STEM skills. Its new areas of leaning now include STEM skills and connections, **the engineering design process**, hands-on experiential learning, Indigenous knowledges and perspectives, contributions to science and technology, coding, food literacy and climate change.

USA

- The International Technology and Engineering Educators Association (ITEEA) changed its name in 2010 from the International Technology Educators Association (ITE) to specifically include, and give more prominence to, the teaching of engineering. Although international, most of its members are in the USA.
  The association has developed engineering courses for primary schools and runs engineering competitions for all levels of schooling. It produces teachers' magazines for all levels of teachers in technology and engineering.

- The Next Generation Science Standards (NGSS) in the USA includes Engineering Design as a part of the science curriculum. There is a very clear intent to raise the awareness of engineering and differentiate it from Science and Technology. This can lead to superficial treatment, but it has heightened engineering name awareness.

- The Education Unit at the USA's National Science Foundation offers extensive funding opportunities to "prepare a diverse STEM workforce and a well-informed citizenry".