



ENGINEERS
AUSTRALIA

NSW Curriculum Review Response

Newcastle & Sydney Divisions

26 November 2018



NSW Curriculum Review Response

Engineers Australia (EA) welcomes the opportunity to contribute to the NSW Curriculum Review. We consider the review as a once in a generation opportunity to review the NSW curriculum from the top down to ensure that our children (our future generations) are given the best opportunity to excel at school in the areas that will contribute to a stronger Australia. EA's particular interest is to ensure that Australia has an adequate supply of school-leavers who have the potential to develop and contribute to the engineering profession, as an increasing number of engineering professionals will be needed to shape and manage the future on behalf of Australian society.

We see this as an urgent need and would be pleased to provide further advice to the NSW Education Standards Authority. Please contact Helen Link, on +61 2 4911 7310 or hlink@engineersaustralia.org.au, if you have any further questions.

1. Recommendations

Recommendation 1 - *Ensure the curriculum supports the development of the necessary life skills and fundamentals, as well as the more advanced skills to enable students to pursue their passion in life, in an increasingly changing world, over their entire lives.*

Recommendation 2 – *Knowledge and skills in mathematics, science and technology (including engineering principles and design) need to be developed from primary school through to the senior stages of secondary school.*

Recommendation 3 – *Improve the content and delivery efficacy of higher levels of mathematics, science and technology in senior secondary school.*

Recommendation 4 – *Deliver STEM subjects within a context of their relevance to the community and environment.*

Recommendation 5 - *Develop an environment and curriculum design that encourages more students to study higher levels of mathematics, science and technology in senior secondary school.*

Recommendation 6 – *Deliver STEM knowledge and skills within the context of problem based and real-world application.*

Recommendation 7 – *Remove the current focus on teaching to pass examinations.*

Recommendation 8 – *Remove the need for teaching out of field by training sufficient teachers to cover specialist fields.*

Recommendation 9 – *Continually review and improve the curriculum with input from all stakeholders.*

2. Introduction

Engineers Australia is the peak body of the engineering profession and is home to the largest and most diverse body of engineers and engineering technologists in Australia. As Australia's principal engineering association, we serve and represent around 100,000 professionals at every level, across all fields of practice.

Our purpose is to advance the science and practice of engineering for the benefit of the community.

Engineering teams ultimately have the responsibility for the safety, security, reliability, performance and cost of technically-based infrastructure, products, systems and services on which individuals and society depend.

EA's interest in the NSW Curriculum Review stems from our interest in ensuring Australia has an adequate source of engineering professionals and that they have the qualifications and skills needed to professionally provide engineering services to the community. This is achieved through the maintenance of:

- national standards of tertiary qualifications in engineering by education program accreditation, and
- national standards for engineering practice through examination and registration of individual practitioners.

EA covers all branches of engineering including the emerging areas of artificial intelligence (software engineering), the Internet of Things, new materials and additive manufacture (3D printing). Increasingly, our engineering teams are working at the interfaces between people and technological systems in fields such as bioengineering, environmental engineering and humanitarian engineering.

In New South Wales, EA members undertake and support outreach activities in schools, such as the Science and Engineering Challenge (founded in Newcastle), CSIRO's STEM Professionals in Schools and Experience IT (for girls). Senior EA members in Newcastle are currently providing CPD to Engineering Studies teachers (a NESA accredited program) and senior Sydney EA members provide advice to NESA and to the reference group for the implementation of the Technologies learning area of the national curriculum.

3. Response to Review Questions

1. What should the purpose of schooling be in the Twenty First Century?

The purpose of schooling should be to develop young Australians as responsible citizens who contribute to society and excel over the whole of their lives. Of course, school students cannot learn all they need during their school years, and it is important for schooling to provide students with:

- a) The basic knowledge, skills and attitudes needed to succeed, including foundation levels of literacy and numeracy, and effective interpersonal and digital communication skills
- b) More advanced knowledge and skills to allow them to pursue their dreams (of further study or employment)
- c) Experience and skills in problem solving and research
- d) A passion of curiosity and interest in continual learning
- e) The social maturity and resilience to perform at school and in the community throughout their lives
- f) An appreciation of self-awareness, (how their behaviour may impact themselves and others). Mindfulness, (being and acting in the moment), self-confidence and mechanisms to deal with stress and anxiety throughout their lives.

Recommendation 1 - *Ensure the curriculum supports the development of the necessary life skills and fundamentals, as well as the more advanced skills to enable students to pursue their passion in life, in an increasingly changing world, over their entire lives.*

We believe that a major purpose of schooling must be to prepare MORE students to develop the analytical and problem-solving mindsets and skills that are needed to succeed in the more technologically intensive (STEM-based) and complex future areas of the Australian economy.

EA's particular interest is to ensure that Australia has an adequate supply of school-leavers who have the potential to develop as engineers. An increasing number of engineers and engineering technologists will be needed to shape and manage this future on behalf of Australian society. Over time, our current reliance on immigration of experienced engineers should be reduced. This implies that a higher than current proportion of school students will need to be encouraged to take higher levels of mathematics and physical

sciences in their senior year elective subjects. Part of that encouragement will come from a revised and refreshed school curriculum for the total student experience from K through to 12.

The revised NSW curriculum should ensure that ALL school students acquire a sound balance of fundamentals including:

- English language, which is fundamental to communication and collaboration;
- basics in science and mathematics (which underpin the technologies on which we all depend);
- digital literacy and an understanding of how technologies create the modern world (as in the F-10 national Technologies curriculum)
- the skills and drive needed to become a creative problem solver and to continually develop over their career

EA's understanding of the issues facing our education system is deepened through our continual involvement with other stakeholders in the education of our children (teachers, universities, TAFE colleges, P&C, industry). Our experience with these groups has enriched our responses to the curriculum review.

2. Knowledge, skills, attributes students should develop?

As outlined above, EA's prime interest here is on ensuring that more male AND female students leave school better prepared to enter tertiary education or employment in engineering.

We focus here primarily on the **knowledge, skills and attitudes** required at the end of compulsory schooling.

Knowledge and skills in mathematics, science and technology are essential in engineering. Student exposure to these subjects needs to begin in primary school and the skills need to be developed through the whole curriculum (K to 12).

Recommendation 2 – *Knowledge and skills in mathematics, science and technology (including engineering principles and design) need to be developed from primary school through to the senior stages of secondary school.*

By the end of secondary school education each individual will be different, and each must have been supported to develop their capabilities to the maximum possible extent. This diversity can be reflected across a range of technical and nontechnical subjects. We suggest that future students may be better served by subjects that include both dimensions, since engineering not only draws on and creates its outcomes from mathematics, science and technology but also encapsulates other creative areas such as design and the societal impact of the outcome.

The key areas of knowledge (building blocks) on which engineering is built include:

- mathematics (at the NSW 2-unit Mathematics level, and including introductory calculus, matrix algebra, probability and statistics)
- physical sciences (physics and chemistry)
- computing and information technology (including coding, visualisation and data manipulation)
- biological, environmental and earth sciences
- engineering and design principles (including systems, creativity, materials selection, manufacturability and reliability)

Mathematics at the level indicated above is essential for any student wishing to progress to a university degree or TAFE diploma in a STEM discipline. However, EA recommends that as many students as possible be encouraged to study at a higher level. Additionally, school students intending to study engineering (at university or TAFE) should take at least one and preferably two subjects in the other areas listed.

Recommendation 3 – *Improve the content and delivery efficacy of higher levels of mathematics, science and technology in senior secondary school.*

The key **skills** that are associated with the above knowledge areas include:

- critical analysis
- problem identification and solution (e.g. systems thinking, design thinking)
- communication (developing evidence-based and persuasive argument)
- retrieval and assessment of data and information
- teamwork and collaboration
- field-based inquiry (research)
- experiment design and interpretation, including possible computer simulations
- model-making and testing

The first five points on this list are often described as “generic skills” that all school leavers should be able to demonstrate within and beyond the contexts of their subject interests.

All school leavers should possess positive **attitudes and values** in areas of:

- learning for life
- ethics, the differences between right and wrong
- respect for others
- self-respect, self-reliance and resilience
- the Australian democracy (how it works, and personal responsibilities)

Recommendation 4 – *Deliver STEM subjects within a context of community and environment.*

3. How could the curriculum better support every student’s learning?

In seeking to add rigour to the curriculum (especially in mathematics, science and technology), but avoid overcrowding, we would recommend consideration of the following:

- increasing the science and technology (engineering) coverage over the whole educational experience from K to 12, and in the process develop topics that incorporate educational goals in several learning areas.
- increasing the amount of inquiry-based and problem-based learning, structured to be delivered across all learning areas.
- ensure the primary school curriculum extends children’s curiosity.
- allow students to progress at their own pace in learning areas such as mathematics and English where step-wise learning and mastery are critical;
- ensure that formal science and technology subjects in secondary school focus on fundamentals that can be illustrated from real-world (or laboratory) situations. Senior secondary science and technology subjects should be designed to underpin further studies at university and/or TAFE.
- Teachers should have flexibility to select from contemporary topics to cover a small number of topics in depth, rather than a very wide range of topics superficially. The new curriculum framework must be sufficiently flexible to allow for such topics to be changed several times over the planned curriculum life;
- increase the relevance of topics studied by making quantitative and logical connections to the real-world. Real case studies reinforce concepts and learning,

- provide curriculum flexibility that both encourages teachers to be innovative along with the ability to tailor teaching to student's strengths and passion.
- encourage the development of the generic and life skills and demonstrate their importance by effective assessment throughout the K to 12 experience
- change the culture of "passing exams" and the attainment of the highest possible ATAR rank. Each student should be encouraged to perform well in the subject units in which s/he is interested. This comment is based on feedback from teachers attending our teacher development programs and from universities where students seem to have an engrained exam-passing culture. Comment from a recent student as reported in the Sydney Morning Herald also supports this.

<https://www.smh.com.au/national/i-got-a-99-atar-but-i-had-a-lousy-education-20181123-p50hwo.html>

- reduce the focus on the public aspects of NAPLAN to increase the formative value of such assessment to the student, parents and school. The current focus by schools on improving their ranking in NAPLAN encourages students to focus just on the passing of exams mentioned above and discourages them from learning that can be gained from making mistakes – 'it is OK to be wrong'. Some of the biggest life lessons and most remarkable discoveries have come from mistakes. If NAPLAN is used in future, it should be for the development of education policy and not for the ranking of students and schools.

Recommendation 5 - *Develop an environment and curriculum design that encourages more students to study higher levels of mathematics, science and technology in senior secondary school.*

Recommendation 6 – *Deliver STEM knowledge and skills within the context of problem based and real-world application.* Learning must be fun and engaging and linking the teaching of STEM to the exciting real-world problems faced by the engineering community makes the learning relevant. Engineering is 'cool' and fun and the earlier students experience this the more likely they are to follow an engineering career.

STEM teaching does not need to be boring if tied to current contemporary issues we face as a community. E.g. Food and water security, social interaction, building better cities etc.

Recommendation 7 – *Remove the current focus on teaching to pass examinations.*

4. What else need to change?

EA recognises that the teacher's role is challenging at all levels. We are also aware that teachers may not have adequate education and training in the areas they are required to teach.

- Teaching out of field is unsatisfactory, is not conducive to good student outcomes and should be discouraged. It is acknowledged that Principals may assign teachers to teach in areas not in their area of specialty to meet daily demands, but this must be the exception rather than the rule.
- More teachers need to be trained in the specialist areas needed to provide balanced delivery of education to our students to limit the amount of out of field teaching.
- The levels of teacher professional development in subject content and in new pedagogies must be raised as a matter of priority. This is of particular importance in STEM related areas and EA and its members are keen to continue to support teachers and schools in professional development and course content and delivery.

- *The curriculum should be reviewed more regularly by ALL stakeholders (teaching, parents, industry, professional bodies for example), at the holistic and individual subject level, to ensure it continually improves and keeps up with developments in technology and pedagogy and changing societal needs.*

Recommendation 8 – *Remove the need for teaching out of field by training sufficient teachers to cover specialist fields.*

Recommendation 9 – *Continually review and improve the curriculum with input from all stakeholders.*



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