THE WARREN CENTRE

NSW Curriculum: Critical Issues

17 November 2018

Dear Friend of the Warren Centre

The NSW Government has initiated a review of the NSW school curriculum and has called for public submissions. These close on 30th November 2018. All issues, including implementation and teacher support and training, have been declared to be on the table.

The Warren Centre will be making a major submission and has developed a list of critical issues which we are distributing to fellow stakeholders in business, industry and academia to either complement their own submissions or maybe to prompt them to make one.

Since the last such review nearly 20 years ago, the world has undergone significant change due to the rapid advance of technology and information innovation and the introduction of the internet and social media.

The NSW school curriculum has not stood still over that time, and the requirement to integrate and implement the content of the new Australian curriculum in Technologies (incorporating Digital Technologies and Design & Technologies) has meant that the NSW Technology learning area (which incorporates Engineering) is now well structured and fit for purpose.

However, there are significant problems for both students and 21st Century STEM sector employers with the way that the current Technology curriculum is implemented and the readiness of teachers to teach it. Those problems are raised in this Issues Paper.

Sincerely

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General

The current Technology curriculum is generally fit-for-purpose, but implementation, assessment and teacher readiness must be reformed.

STEM Thinking

STEM is a pedagogical approach where fundamental scientific, mathematical and engineering principles, together with knowledge of the tools and practice of technology, are introduced alongside their application in the real world, whilst acknowledging and incorporating appropriately the contribution of every other discipline.

STEM breaks down the silo barriers in teaching and breathes life into learning.

STEM Thinking encompasses the following elements:

- Evidence-based reasoning;
- Understanding of design processes;
- Mental attitudes of critical, computational and systems thinking;
- Social behaviours like collaboration, joint creativity and ethics.

STEM Thinking is the very basis of STEM and should form part of every child's education.

These skills are crucial for our children to become informed citizens and to achieve their individual personal potential. Competence in STEM Thinking will unlock fulfilling careers and support a prosperous NSW economy in an ever more complex information and technology driven future.

STEM Thinking has long formed an essential part of the NSW Technology syllabuses and have been historically well described, culminating in the Stage Statements of the new Science and Technology K-6 Syllabus.

However, confining the learning of STEM Thinking to a single Key Learning Area (KLA) comprising just 10% of recommended classroom time for the first two years of secondary schooling (Stage 4) and much less in primary (Stage 1-3) fails to reflect its importance to our children's future; and obscures its relevance across the curriculum (see later Recommendations on "Technology & Engineering in the Curriculum").

The low proportion of women in engineering and technology occupations is of national concern and is directly related to the low participation of girls studying the higher-level precursor subjects in Stages 5&6. Project-based and experiential learning,

and engagement with the engineering design process have been shown to improve the engagement rate of girls in STEM subjects.

Recommendations

STEM Thinking - the evidence-based reasoning; design processes, and attitudes of mind (eg, critical, computational and systems thinking; collaboration, creativity, ethics, etc**)** should form part of every child's education and not be confined to a single KLA comprising 10% or less of classroom time in Stages 1-4.

This approach still requires basic knowledge of each of the STEM disciplines and might be introduced to the curriculum through integrated/cross-curricula units in primary school (K-6) and major projects in secondary school (Yrs 7-12); or embedded in the traditional discipline-based KLAs.

STEM units, or embedded STEM content in discipline-based KLAs, must be taught by teachers who have been trained and suitability qualified in STEM Thinking. Otherwise the units are activities devoid of understanding.

The experiential and project-based learning pedagogy that underpins the teaching of STEM units should be recognised as valuable in retaining the interest of girls in studying higher level STEM subjects in their later secondary school years.

Technology & Engineering in the Curriculum

Rodger Bybee, a distinguished US academic observes in his new book "STEM: Now More Than Ever" (Page 13) "With reference to Technology and Engineering (T&E), there are few other topics that influence our everyday existence more, and about which citizens know less."

Engineering design principles and practice drive the safe construction and timely delivery of infrastructure and systems, including the Internet. The engineering mindset supports a wide range of problem-solving methods and underpins much innovation. Technology brings into physical reality the outcomes of scientific discovery and the designs and plans of engineers and other creative occupations.

Currently "Technology" in the NSW curriculum covers both engineering and technology, with separation only becoming manifest with the Engineering Systems elective (a world first when introduced in 1966) in Years 11&12.

Earlier identification of Engineering as separate from Technology will lift the status of Technology and Applied Studies (TAS) teachers relative to other KLAs and recognise their professional expertise in teaching project-based learning and integrated STEM

units.

Although there is ample content covering engineering design principles and practice in the existing curriculum, only 10% of classroom time is allocated to Technology in Years 7&8, with much less in earlier years. This should be increased substantially given the importance of these essential 21st century life skills and the additional classroom time needed for project-based learning.

Consideration of appropriate careers and occupations will start to take practical form from the beginning of Stage 3 (Year 5). Appropriate role models and sample experiences are required, and elective subject choices from Year 9 onwards need to be identified clearly. In particular, the pre-requisite subjects required for entry into the first year of Engineering degrees at many Universities should be highlighted.

Recommendations

That a separate "Technology & Engineering" area of learning be introduced from Stage 3 onwards.

That the allocation of classroom time to Technology and Engineering education be increased substantially.

That a Technology & Engineering specialisation be established and recognised as a full-time teaching role from Stage 3 onwards. This specialty role could be split between adjacent Primary schools to make up the hours required for a full-time role in Stage 3.

That from the beginning of Stage 3, both students and parents are clear on the elective subject choices appropriate to any given STEM occupation.

That teachers be provided with support and guidance on how to strengthen and maintain linkages with local business and industry

That a publicly available video/VR library of industry and business role models and occupational experiences featuring young entrants to the roles be created.

Assessment of 21st Century Skills

The excellent "Learning for the future" content on the Department of Education's website comprehensively describes the complex combination of dispositions, skills, values and attitudes needed for school leavers to be successful future oriented lifelong learners.

These skills are what 21st Century employers want and need.

Whilst all are covered in current NSW Syllabuses, we understand that teachers are finding it difficult to assess and report on them in the absence of agreed objective criteria.

What is not assessed can easily be overlooked, and a lack of formal assessment means that parents, carers or guardians will not be aware of the increasing importance being placed on these skills as part of their children's education.

Recommendations

That guidance, exemplars and performance descriptors be provided to enable teachers to report to parents / guardians / carers a student's level of achievement in what are commonly referred to as 21st Century skills

That these skills be promoted as having high value and importance for success in a student's future.

Technology and Engineering Teacher Support & Training

Current undergraduate programs for educating pre-service teachers in the primary Science and Technology and secondary Technology curricula are falling well short of meeting the specific requirements of understanding Engineering and Technology.

Demand for teachers with the necessary technology and engineering training, particularly in digital technology, far exceeds the number of teachers who have been, and are being, educated in the necessary topics.

Secondary Curriculum

Undergraduate Technology secondary teachers no longer study Engineering, Materials Science, Physics, Chemistry, Industrial Design and Coding as was the case some decades ago. Instead, they are simply required to meet current curriculum needs in the Technology Mandatory years (7&8).

All pre-service Technology & Applied Studies (TAS) teachers train to teach every subject of the Technology KLA from Graphic Design to Engineering to Food and Textiles. On completion of this basic training they receive an ITX Technology Mandatory code.

This generalist training devalues engineering knowledge, in particular the crucial design process, as secondary at best or absent at worse.

The resulting situation in NSW schools where Engineering Studies, year 11 and 12,

as a pre-University degree engineering subject AND the year 9 and 10 elective subject in Engineering struggle to run for the want of adequately trained teachers. The popular NESA Endorsed Course in iSTEM (an integrative STEM program involving manufacture and digital production) also struggles to find teachers who can cover the breadth of understanding required.

Primary Curriculum

For the primary curriculum, the recommended classroom time for Science and Technology is only 6-10% of the total time available. The new digital technology content is even less. There is therefore very little incentive for Universities to spend the necessary time and money on the specialist resources required to teach the Technology and Engineering component of this KLA.

The result of this lack of training in the primary classroom, together with the general lack of confidence in teaching Technology in general and Digital Technology in particular, is that primary students are often placed in computer rooms working through screen-based activities for the requisite number of curriculum hours each week. This is not a learning activity – it is an activity devoid of understanding.

Recommendations

That the importance of a sound training in engineering principles and technology practices be recognised by the provision of both more time and modern resources in both primary and secondary undergraduate teacher training.

That the current teacher preparation programs for Technology and Engineering be reviewed and augmented if necessary to meet the needs of schools and future curriculum.

That undergraduate teacher training in Technology and Engineering education be a separate program drawing content from the Sciences, Mathematics, Engineering, Design and Production, utilising appropriate Technologies.

That Technology and Engineering teachers be provided with the continuous support and in-service training required for them to keep abreast of the rapid pace of change in this curriculum.

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About the Warren Centre for Advanced Engineering

The Warren Centre brings industry, government, and academia together to create thought leadership in engineering, technology, and innovation. We constantly challenge economic, legal, environmental, social, and political paradigms to open possibilities for innovation and technology to build a better future.

The Warren Centre advocates for the importance of science, technology and innovation. Our 30 years' experience of leading the conversation through projects, promotion, and independent advice drives Australian entrepreneurship and economic growth.

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