

# Where is Australia's

by Desi Corbett



The majority of countries are supporting well established science, technology, engineering and mathematics (STEM) national programs, while the federal government is yet to mull over a cohesive strategy. Industry groups, professional bodies and the chief scientist have all called for a national STEM strategy that will encourage children's interest in engineering and ultimately ensure a vibrant and economic future for this country. But our school students continue to fall behind in skills competency, the states run a wide but disparate range of school student programs, support is lacking for STEM skilled teachers and we continue to deliver inadequate messaging that fails to attract more females into engineering.

# national STEM strategy?

In July 2013, a national strategy on STEM subjects in Australia appeared finally set to go ahead with the chief scientist Professor Ian Chubb launching a position paper on the subject at the National Press Club.

The Office of the Chief Scientist called for a national strategy, warning that action needed to be taken to secure Australia's social, cultural and economic prosperity. Chubb emphasised that Australia must "take as much control of our destiny as we can". He compared Australia with Europe, Canada, Scandinavia, the UK and the US saying those countries were actively supporting STEM programs to interest children in professions that utilise those skills.

Many countries not only run STEM programs but actively encourage children to discover engineering from an early age with programs by companies like LEGO and innovative toys such as Goldi Blox. Chubb forecast that if action is not taken – and taken with a sense of urgency – "we will be left behind".

A step in the right direction has been this year's introduction by the Australian Curriculum, Assessment and Reporting Authority (ACARA) of new subjects, design and technologies, and digital technologies.

"In design and technologies students from Foundation to Year 8 learn about and apply engineering principles and systems to create designed solutions. Optional further study in Years 9 and 10 is also available," Dr Phil Lambert, general manager, curriculum at ACARA explained.

An argument for implementing a national STEM strategy is posited by The Warren Centre (TWC) for Advanced Engineering at The University of Sydney which says Australia (in common with other developed countries) is facing a

"critical shortage of technology and engineering skills", according to John Phillips, manager education projects.

He said this in particular pertains to a shortfall in the number of experienced qualified engineers needed to specify, tender, and participate in the boom in engineering infrastructure projects required over the next decade and beyond.

Phillips says shortfalls in the past have been met by immigration, but this will become increasingly difficult as opportunities continue to expand in those engineers' home countries, making the issue of STEM "the highest priority" at a national level.

Any quantum increase in the number of engineering graduates is likely to require significant initiatives targeted at the middle school years (12-15 years old) according to TWC and these subjects will need to be more interesting, relevant to real life and "cool" plus have the support and full co-operation of business and industry.

In 2012, only 15% of year 12 students were studying STEM subjects that would equip them to take up engineering at university and only 35% of those were choosing to do a Bachelor degree in engineering. Alarming, 30% of those who commenced a degree in engineering did not complete it.

## Decline holding Australia back

The Australian Industry Group (Ai Group) paper on STEM skills last year stated Australia's decline in these skills was holding back the national economy. Chief Executive Innes Willox said an estimated 75% of the fastest growing occupations require STEM skills but that the report's findings painted "a disturbing picture".

“These are the worst PISA results since 2000. They are a serious wake-up call for the Australian education system.

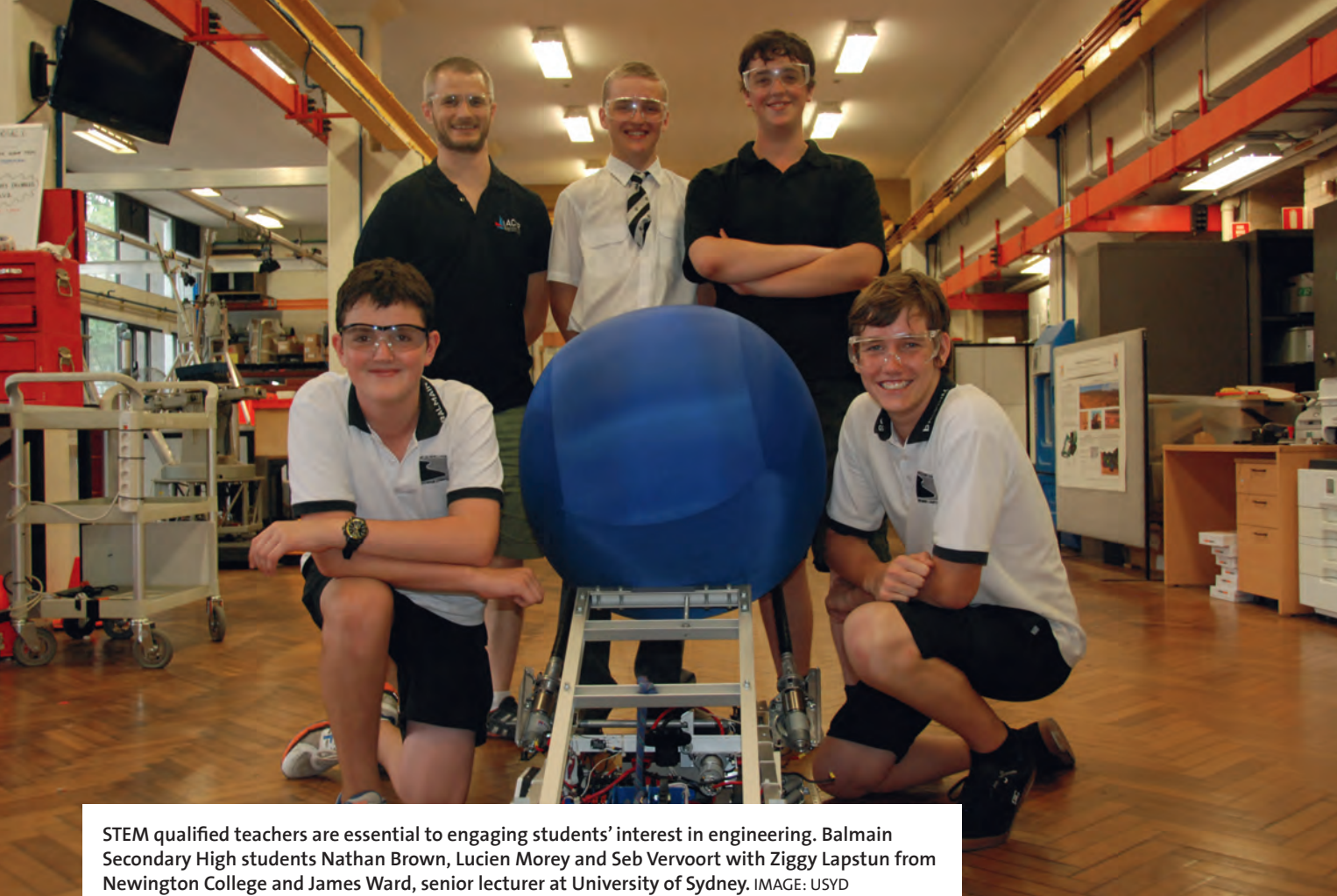
He said employers were having significant difficulty in recruiting people for occupations with STEM skills This is despite ABS census data from 2006 to 2011 for workforce participation that shows the number of jobs held by people with STEM qualifications grew by 14%.

Chubb has stressed that our neighbours, India, Taiwan, Japan and China, have "very high performing education systems" with national policies concerning science and technology. He compared Australia's situation with the US which established a National Science and Technology Council chaired by the President, with members at the top level of government. Australia has no such equivalent but Chubb suggested the Prime Minister's Science Engineering and Innovation Council (PMSEIC) could undertake the task.

Chubb said having such a high level council aimed at science, engineering and innovation would lead to "a harmonised array of activities and programs collectively and coherently aimed at one outcome".

"The performance of our students would be high. And the disciplines that underpin STEM would be strong and taught with inspiration by teachers who are supported to keep abreast of their field". By 2025, Chubb said Australia should have reached a





STEM qualified teachers are essential to engaging students' interest in engineering. Balmain Secondary High students Nathan Brown, Lucien Morey and Seb Vervoort with Ziggy Lapstun from Newington College and James Ward, senior lecturer at University of Sydney. IMAGE: USYD

point where our society has a better understanding and value of science used in everyday life and where STEM will be widely accepted as a central and visible source of solutions to societal changes. And Chubb argued that it's not that we lack programs in Australia. "What we do lack is a national approach to STEM," he said. "Investment of public funding for STEM requires a systematic approach to ensure maximum return. We require a whole of government approach to STEM."

## Political hot potato

However, in the wake of Chubb's urgent call to action there is still no word on a national STEM strategy from the federal government nine months later.

And it may come down to politics. In September 2013, Australia had a change of federal government with a new PM who abolished the post of federal science minister for the first time since 1931, distributing the responsibility between the portfolios of the minister for industry Ian Macfarlane and the minister for education Christopher Pyne.

However, Chubb told *Engineers*

*Australia* magazine that the plan for a national strategy for STEM is "still on the table".

"I am preparing it for the government's consideration. The strategy will propose a whole-of-government approach to Australia's investment in science," he said. The chief scientist estimated a timeframe for this as "soon as reasonably possible as any delay means we will continue to only chip away at the margins". The decision is clearly up to the federal government as there has been no opposition from industry or stakeholders on a national strategy.

In a recent presentation to Universities Australia, Chubb pointed out that there were only three out of 33 OECD countries without a STEM strategy, one of which is Australia; the other two, Portugal and Luxembourg.

The US, UK and countries in Europe have already reached a consensus that a strategy is needed however a national STEM strategy for Australia is clearly not a given as Chubb added, "We could decide to follow their lead, or we could risk falling behind. That is the choice facing us and I hope we choose wisely".

In December 2013, the Program

for International Student Assessment (PISA) results for 2012 placed Australia 17th out of 65 OECD countries in maths and equal 8th in science and reading.

Pyne declared, "These are the worst PISA results since PISA began in 2000. They are a serious wake-up call for the Australian education system but, more importantly, they tell us one fundamental thing - money is not the answer in education".

When *Engineers Australia* magazine queried the minister about the introduction of a national STEM strategy he would only say was that "the Australian government is committed to restoring the focus of science, technology, engineering and mathematics (STEM) subjects in primary and secondary schools".

Pyne said the government would ensure these subjects get more focus when teachers are being trained; and will work with state and territory governments to ensure more STEM subjects are given a greater focus. Yet, Pyne's science portfolio colleague, minister for industry Ian Macfarlane, firmly indicated in March that industry should be driving the skills and training to provide business with

skilled workers into the future.

"The key goal is to put industry back in the driver's seat to make sure our skills and training system is providing business with the skilled workers they need, now and into the future," Macfarlane said.

He referred to Australia's "convoluted skills and training system", declaring it "fractional, dysfunctional and overcomplicated", while distancing the Abbott government and blaming the previous Labor government for the situation.

However, Re-engineering Australia (REA) chairman Dr Michael Myers said the response to the shortage of engineers by successive federal governments has been based on "rhetoric focused on the development of a skilled nation".

Myers said industry has "failed to understand its responsibility" nor take the opportunity to use its leadership position to attract students to professions critical for success.

"Industry has failed to understand the need to attract, guide and encourage the next generation; to give our young people a desire to pursue STEM subjects whilst at high school in order to prepare for careers in STEM areas of work," Re-engineering Australia has stated.

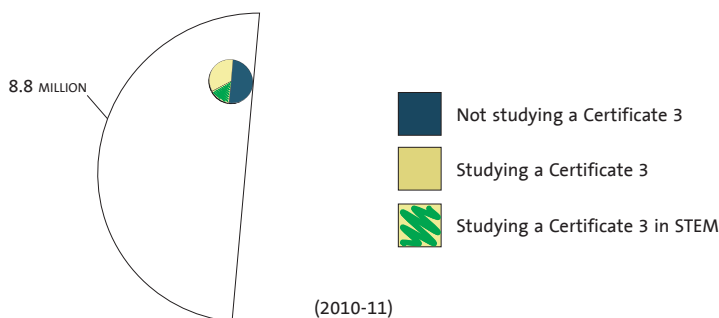
Economic rationalism has also driven big business to focus on short term solutions leading to fragmented approaches and the failure to engage with the appropriate stakeholders: educators, facilitators and students.

## Fragmentation or foundation

What has been done since, by way of industry developed career intervention programs aimed at attracting students to appropriate professions, according to Myers' white paper, has been, "in the vast majority of cases, ad hoc and ill structured" in terms of the design, implementation or measurement of outcomes".

With Australia placing 33rd out of 33 OECD nations for the rate of business collaboration with higher education (and public research agencies) based on data gathered by the chief scientist

## STEM and Certificate III studies



Australia Bureau of Statistics, February 2014 – of Australia's 17.7 million people aged 15 years and over in 2010-11, only 2.7 million had a Certificate III or above in STEM subjects out of 8.8 million with a Certificate III in higher education.

in June 2013, industry would appear to have a much bigger role to play in the 21st century.

John Phillips, TWC's manager education projects, said the issue in Australia has been "recognised, analysed, worried about, and reported upon for the past decade" with the problem having progressed from chronic to acute.

"It is time for action which can only come for a grand coalition of all interested parties, specifically governments, industry, professional bodies and educators," Phillips said.

Associate Dean Education at the University of Sydney's Faculty of Engineering and Information Technologies, Professor David Lowe, explained there are numerous initiatives focused on promoting interest in STEM related subjects to years 7-12 students (and earlier in some cases).

On the surface the national approach may appear fragmented, Lowe said, but the variety of approaches is a strength and provides a range of opportunities that addresses the diversity of backgrounds and needs of students.

Dr David Pointing, Engineers Australia (EA) national program manager – tertiary development, agrees that the approach to getting students interested in engineering with all the programs across Australia "potentially"

looks fragmented but he says that in reality there are different sized programs which he would like to see linked to each other more.

"There are so many different programs with different focus but there's a lack of culture encouraging students from one to another," Pointing said. An EA roundtable involving the chief scientist two years ago looked at the need for a common platform for all programs which is a concept, Pointing said, EA supports.

But Re-engineering Australia's Michael Myers said few programs have been based on fundamental social science research which could add significant validity to the processes being called upon to achieve the required intervention outcomes.

His research was reporting on the impact of the F1inSchools Technology Challenge in motivating school students towards a career in engineering since its establishment in 2003.

## Teachers at the root of the STEM

Two years ago, TWC called for a national STEM strategy in its submission to the Senate Inquiry into the Shortage of Engineering and Related Employment Skills saying that investment in STEM qualified teachers was a key plank due to an "alarming



lack” of STEM qualifications in teacher trainees. Suitably qualified and enthusiastic teachers are influential in the outcomes of children’s interest in STEM subjects. Education minister Christopher Pyne said the latest PISA results showed that for Australia, “teacher quality is the most important determinant of outcomes for students”. The chief scientist’s STEM paper from last year also stated that not enough time on average is spent teaching science in primary school along with there being declining interest in STEM subjects in secondary school. And as far back as 2008, the National Centre for Vocational Education Research’s (NCVER) said having good science teachers in high school is an important motivator for pursuing post-school STEM study for almost three quarters of young people.

Despite a labour market increasingly driven by and reliant on technology, NCVER contended that underlying shortages of suitably qualified teachers of science and maths was a particular area of focus.

However, the centre also found that careers advisors were perceived by students as more influential in steering them away from, rather than into, STEM careers and recommended better training and education of careers advisors about STEM career opportunities.

In 2011, Curtin University recommended there be a continuing effort to run projects focused on engineering

and technology for primary and secondary school students and that it needed to be strengthened by professional development of teachers.

The university advocated having a unit on engineering education be added into teacher education programs.

Professor Archie Johnston, dean of Engineering and Information Technologies at The University of Sydney, said the institution is including teacher support in a multipronged approach to encouraging students to take up engineering as a career.

“The efforts of three faculties within the university have been combined to form a STEM Teacher Enrichment Academy, aimed at inspiring and building the confidence of teachers across Australia responsible for the delivery of mathematics, science and technology education,” he said.

The program, modelled on successful international programs such as the Mickelson ExxonMobil Teachers Academy in the US, will see the first cohort enrolled in November 2014. As many as 50 teachers are expected to attend the cross faculty run program each year, with opportunities to explore cutting edge discoveries, emerging technologies and STEM innovations pioneered by the university. Johnston said the flow on effect to students is expected to be substantial.

“With the average high school teacher in charge of approximately five classes of 30 students, the program has the potential to impact over 80,000 high school students in its first five years,” Johnston said.

Engineers Australia’s EngQuest, a national primary school outreach program designed to equip teachers with the tools and resources to teach science, technology and engineering is widely successful according to Engineers Australia CEO Stephen Durkin.

“The program is the largest of its type in Australia, with over 100,000 student participants in 2013,” he said. Within the first week of the 2014 EngQuest launch, 38,000 registrations were received.

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## Many approaches, one goal

Engineers Australia (EA), Re-engineering Australia (REA), CSIRO, and FIRST Australia to name but a few, are running programs (often based on those developed overseas) and calling for more support of STEM skills in schools to ensure we have enough engineers for economic prosperity and to complete projects needed in the future.

TWC executive director Nick Cerneaz, is interested in teaching children to ‘apply’ the knowledge they gain through learning STEM subjects with engineering and technology integral to the focus on science and mathematics.

“Teaching just science and maths and not adding the application of it through the technology and engineering elements is like teaching kids a vocabulary and how to spell, but then not teaching them how to write prose. Perhaps ... the term should be: sTEM,” Cerneaz remarked.

Re-engineering Australia said conventional education has struggled to deliver subjects in a way that links the learning process to the relevant application of that learning. Instead it says “action learning” - learning by doing - presents students with a

challenge that inspires them to seek out the necessary education to solve that challenge.

Professor David Lowe, associate dean education University of Sydney Faculty of Engineering and Information Technologies said some academics and industry leaders believe in making engineering appear ‘cool’ or ‘exciting’ by focusing on the underlying concept as a way of attracting school students onto the pathway to become an engineers. But this approach is of some concern to Lowe.

“While these are valuable, such approaches are bound to engage those students who already understand, or are already on board with, STEM related areas,” Lowe said.

“To be truly effective, the engagement needs to go back a step and begin by connecting students with the problems that are likely to be of concern to them – and then engage them in understanding how STEM can play a role in addressing these problems.”

Curtin University researchers released their findings of an action research study into the development of learning environments to increase the understanding and interest in engineering and technology among Australian primary school students.

Their findings showed that prior to the study, the students generally had

“It’s not that we lack programs in Australia. What we do lack is a national approach to STEM.

a poor understanding of the type of work engineers do but more than 60% had a clearer idea about technology.

REA’s Michael Myers said the results of the F1in Schools program confirmed it was “able to have a significant impact on the career motivations of the children who participated, with 64% of boys and 35% of girls indicating that Fin1Schools had influenced a change in their career motivations toward engineering”.

In March, REA launched a new program, SUBS in Schools, a multi-disciplinary challenge for teams of year 10-12 students to use industry technologies to design, analyse, collaborate, make and test a working model of the SEA 1000 Future Submarine.

The Royal Australian Navy sub will have more than 3,000,000 parts along with state of the art communications, defence and electronics systems. The goal, according to REA, is to “excite students” about STEM based careers.

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However, ATSE has taken a more pragmatic approach by relating subjects in its STELR (Science Technology Education Leveraging Relevance) program to “highly relevant issues” such as climate change and renewable energy.

## Gender motivators and messages

While there is a wide range of programs across Australia, one theme running through all of them is the desire to get school students interested in engineering.

Although much effort is focused in delivering these programs, traditionally their content has been delivered in a way that speaks to boys’ motivations more so than girls’.

Last year, AiGroup chief executive Innes Willox called for a “major re-think by Australian education at all levels and in all sectors” to address the situation.

He said research was indicating

“The current image of the profession of engineering has historically been developed based on appeasing a set of motivational drivers which work for boys rather than girls.

that girls were opting out of maths and science. In NSW, the percentage of girls not studying any maths in the High School Certificate (HSC) increased from 9.5% in 2001 to 21.8% in 2011. And only 13.8% of girls studied one maths and one science subject for their HSC in 2011.

As a result, Ai Group stated, “the

gender disparity in maths and science participation is now greater than it was in the 1980s”.

Michael Myers is a big supporter of promoting engineering to male and female students differently. He said boys respond to a different set of motivators than girls. For example, in contrast to stereotypical expectations, the focus on promoting interaction between students and the engineering role models had “a particularly important impact on the boys and a lesser impact on the girls”.

“For the girls, development of a clear understanding of the processes involved in the profession, particularly in the way that they can relate to, and can make critical career decisions about, appears to have a greater impact on their propensity to include engineering as a viable career option,” Myers said. Given a clearer understanding of the motivational drivers of boys and girls, Myers said there exists “significant scope” for



F1inSchools 2014 - (L-R): Fusion team member from Wesley College Andrew Braysher and Radical Racing team member Jaxon Biden from Melba Copland Secondary Schools. IMAGE: REA



industry to recreate the way it sells itself to students.

“The current image of the profession of engineering has historically been developed based on appealing a set of motivational drivers which work for boys rather than girls,” Myers said.

“The longer term challenge for the profession, if it is to develop intrinsic interest in girls toward engineering, will be to develop an image of the professional that both boys and girls can relate to, an image that fits with their different motivators.”

Water resources engineer, Felicity Briody, featured in *Engineers Australia* magazine in October 2013, is co-founder of the educational program, the Power of Engineering, aimed at changing the perception of engineering among female students aged 13-15.

Her focus has been to “quash the perception that a career in engineering is only maths and hard hats” and her call to action aimed at industry, educational and professional bodies is: change the way you talk about engineering.

Briody said engineers tend to communicate about projects in the way they’re trained, how long or high a structure is instead of why it is being constructed and how it connects communities. This is playing a part in how engineering is being perceived by the community, according to Briody. Communicating the ‘why’ of projects and the difference an individual can make to the world around them has captured the impact of the projects in students’ minds, she said.

Another young female engineer, Nikki Mead, cited studies that show women and minorities are drawn to professions where they can contribute directly to the welfare of others, and wonders why it is that engineering is not one of these. Mead argues that the Australian stereotypical engineering image of mining or building big concrete structures by a guy in a hard hat not only says technology is for men but carries the message that female engineers are not real women or worse, not real engineers.

“This perception of engineering has not kept up with the actual

evolution of the vocation where the focus is shifting to economic, social and environmental sustainability, urbanisation and globalisation,” Mead wrote in *EA* magazine last year.

While the consensus is that Australia needs a cohesive national STEM strategy to avoid the loss of would-be engineers needed for our future economy, industry, innovation and global success, most stakeholders agree that teachers must also be supported and the messages to all schools students will have to better tailored to specific needs and motivations. ➡

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