ASSOCIATION OF CONSULTING ENGINEERS AUSTRALIA

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IN RESPONSE TO SENATE INQUIRY INTO THE ACADEMIC STANDARDS OF SCHOOL EDUCATION

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ACEA SUBMISSION

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INTRODUCTION **2**
ABOUT THE ACEA 2
ACEA'S STRATEGY FOR EDUCATION AND SCHOOLING 2
PREMAMBLE 3
PRIMARY EDUCATION **3**
CURRICULUM REQUIREMENTS 3
QUALITY OF TEACHING 4
RESOURCE CONSTRAINTS 4
SECONDARY EDUCATION **6**
CURRICULUM REQUIREMENTS 7
QUALITY OF TEACHING 7
RESOURCE CONSTRAINTS 8
CAREER ADVICE 9
TERTIARY EDUCATION **9**
CURRICULUM REQUIRMENTS 9
WORKFORCE LEARNING 11
FINAL COMMENTS **11**

INTRODUCTION

ABOUT THE ACEA

The Association of Consulting Engineers Australia (ACEA) is an industry body representing the business interests of firms providing engineering, technology and management consultancy services.

There are over 250 firms, from large multidisciplinary corporations to small niche practices, across a range of engineering fields represented by ACEA with a total of some 29,000 employees.

ACEA presents a unified voice for the industry and supports the profession by upholding a professional code of ethics and enhancing the commercial environment in which firms operate through strong representation and influential lobbying activities. ACEA also supports members in all aspects of their business including risk management, contractual issues, professional indemnity insurance, occupational health and safety, procurement practices, workplace/industrial relations, client relations, marketing, education and business development.

ACEA'S STRATEGY FOR EDUCATION AND SCHOOLING

ACEA's education and schooling strategy seeks to affect change across primary, secondary and tertiary education levels to foster the development of more Australian engineers.

ACEA's strategy for an improved Australian primary and secondary education system centres on achieving a sufficient breadth of curriculum coverage for students, particularly in science and mathematics disciplines. Graduating engineers are seen as all round, cross-competency skilled attractive employees, this means not only are graduating engineers entering into consulting engineering roles, but also into the banking and finance industry, the government, Information Technology etc. Approximately the same number of graduates is emerging from the University sector each year, but trends in recent years show graduates are being dispersed across a wider range of sectors.

The quality of the educational experience will have a profound impact on the skills shortage crisis currently facing the consulting engineering industry. Without action, the industry skills shortage will become more acute as students decide not to enter into engineering.

From a tertiary perspective, allowing for industry engagement and flexible learning opportunities is key to producing engineering graduates who exit the tertiary system work ready and employable.

PREMAMBLE

ACEA has prepared this submission to address the following terms of reference:

- Whether school education prepares students adequately for further education, training and employment.
- The extent to which each stage of schooling (early primary; middle schooling; senior secondary) equips students with the required knowledge and skills to progress successfully through to the next stage.
- The extent to which schools provide students with the core knowledge and skills they need to participate in further education and training, and as members of the community
- Standards of academic achievement expected of students qualifying for the senior secondary school certificate in each state and territory.

ACEA has chosen not to comment or outline a position in detail surrounding how academic standards compare between states and territories and with those of other countries. However we would support the data being compiled by the relevant education groups which suggests that primary and secondary school students compare well against international standards.

Our submission addresses the above-mentioned terms of reference across primary, secondary and tertiary education levels.

We thank the committee for the opportunity to provide our views on this occasion and would be pleased to offer any further information that may be required throughout the inquiry.

PRIMARY EDUCATION

CURRICULUM REQUIREMENTS

The difference in curriculums adopted across Australian States and Territories makes understanding the primary school syllabus complex and confusing. This is particularly true for industry groups such as ACEA when attempting to seek answers and reasoning as to whether primary school students are receiving the level of science and mathematics education acceptable for transition into secondary school.

We believe that the lack of curriculum requirements and the deficiency of guidance in this area as send a message that science and mathematics studies are not an important part of primary education.

As it is difficult to ascertain what is being taught to primary school students for the purpose of analysis, ACEA would recommend a curriculum which outlines how much time should be spent as a minimum for educating students in each area of primary school education. We recommend that science, mathematics and English teaching comprise 50% of daily classes and the other 50% be divided up of arts, sport, languages and other creative teaching units. ACEA would further suggest that the 50% portion of the day where English, mathematics and science are taught be distributed evenly between the three (3) disciplines. The premise for dividing teaching content in such a way is that mathematics, science and English are critical in the development of socially capable citizens and without these skills, or an interest in these areas it is unlikely primary students will have a fascination in science or an understanding of mathematics in secondary school years.

Furthermore, ACEA would recommend that this proportion be even higher in the early childhood learning experience. For example, years K-2 might spend as much as 75% of classroom time covering (equally) the basics of math, science and English. Such a strategy to address the foundation skills in a more comprehensive manner would certainly result in improved literacy and numeracy capabilities overall.

QUALITY OF TEACHING

Primary school teachers (by definition of the nature of their work) should be well-rounded, multi skilled and inspired, with an adequate desire to teach students equal amounts of varied subjects. Primary-school teachers who do not have sufficient mathematics and science skills themselves will inadvertently teach a lower level science and mathematics syllabus. It is also likely that the teaching methods may not inspire interest or enthusiasm in students.

The quality of primary school teaching needs to be monitored and controlled by ensuring the requirements to become a primary school teacher are contemporary and inclusive of multiple disciplines.

However, factors such as lack of resources, classroom management problems, teacher workloads, and lack of training and in-service programs have contributed to a huge disparity between intended curriculum and its implementation. Students often feel class content is irrelevant and uninteresting with insufficient hands-on activities.[1] This in turn contributes to reduced learning outcomes and students' diminishing interest in mathematics and science.

RESOURCE CONSTRAINTS

There is no doubt that most primary educators believe that the lack of resources is restricting the attainment of core primary education outcomes. Almost 2,500 Australian primary principals in government schools were surveyed in 2000. Most believed that their schools were under-resourced to meet the rising expectations placed on them.[2]

ACEA considers that there may be a number of resource factors contributing to problems with science and mathematics education in primary schools nationally. These can be summarised by the following topics:

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[1] Sadler, T. (2002). *Bright Minds,* Mattick Report.

[2] Angus, M. & Olney, H. (2001). *Our Future: Report of a Survey of Australian Government Primary School Principals*. Sunbury, Victoria: Australian Primary Principals Association.

- Class sizes
- Experimental learning
- Occupational Health and Safety Impacts on experimental learning
- Quality of teaching resources

Class sizes

ACEA has been in contact with the NSW Department of Education and Training and have been advised that for non-government schools there is no class size requirement for primary (or secondary) class sizes in NSW.

From a government school perspective, recommendations are offered to schools suggesting that for grades 3 – 6 there should be enough of a teaching resource provided that class sizes need not exceed 30 students per class. It is universally recognized that more individualized assistance results in better learning outcomes and thus in our estimation this number is too high. Lack of definitive guidelines means that student to teacher ratios may still exceed 30:1 in some instances. The annual audit of class sizes conducted by the NSW Class Size Reduction Unit offers some form of monitoring but cannot enforce a firm requirement outlining the number of students that *must* not be exceeded per primary school class.

This year's annual audit of NSW class sizes (March 2007) found that government schools in New South Wales had an average of 20 students per kindergarten class, an average of 22 students in a year one (1) class and an average of 24 students per year two (2) class. These numbers seem reasonable at a maximum standard but as they are a calculated average, it is difficult to gauge true maximum class sizes across the state.

Class sizes in Victorian primary schools in 2003 averaged 22.9 students, but as this figure is also represented as an average, some primary schools still have relatively high classroom numbers, up to 33 students in some cases.[3] Using averages rather than maximum class sizes masks the fact that there are some larger classes across the state that are being levelled out by smaller classes, particularly in regional areas.

ACEA believe students starting their education should have the chance to learn in smaller classes, where teachers can give more individual attention and deliver teaching results that increase literacy and numeracy standards. Introducing a maximum cap of students per class will give students access to an appropriate level of individual attention.

Experimental learning

Learning about science is a matter of experiencing its effects, doing rather than reading and listening. Encouraging science, engineering and technology (SET) skills at a young age in primary school provides the impetus for interest in the enabling sciences.

For most secondary school students science involves learning facts for an exam, remembering formulae, plugging the right number in to get the correct answer, and the need to perform some short experiments that hopefully produce the result required by the teacher. Many, if not most, students who spend four or six years going through this system become both somewhat naive and disenchanted about the role and process of science. The traditional teacher-led classroom with its emphasis on passive learning and experiments with

[3] Tomazin, F. April 29 2003. The Age, (Online article retrieval: articles/2003/04/28/1051381899169.html)

predictable outcomes does little to foster and develop the innate curiosity and interest with which many of them commence their formal study of Science.[4]

Experimental learning fosters engagement and interaction. ACEA believes the reduction in experimental learning is driven by a number of factors, including, for example, occupational health and safety concerns due to large class sizes. With class sizes affecting the potential for incidents to occur during experimental learning, ACEA believes that it is likely for primary school teachers to continue to move away from hands-on experimental teaching, removing the excitement of science from the learning experience.

Occupational Health and Safety (OH&S) impacts on experimental learning

The increase in occupational Health and Safety awareness and concerns for students conducting and participating in experiments, particularly with increased class sizes means that teachers are less likely to conduct experiments for all students to participate in, taking away from the learning experience. Students now read rather than do, making science a less enjoyable subject to learn in primary school.

Experimental learning should form a key part of science education in primary schools. Smarter safety measures being taken and a maximum cap for class sizes have the potential to bring experiments back into the primary school classroom.

ACEA would like to see an initiative encouraging parental involvement in science, just as reading groups run by parents exist to help primary school students advance their English and reading skills. Encouraging parent's to get involved in science and run science groups has the ability to influence community perceptions towards the importance of science and increase student participation in experimental learning. It may also have the added benefit of re-engaging parents with science and increasing parental understanding of science based career paths.

Quality of teaching resources

The overall quality of teaching resources for primary school students has a substantial impact on the learning experience. Out of date mathematic text books and insufficient equipment to conduct science experiments has a resounding impact on the way primary school students assimilate and associate with these two subjects. If a student is not stimulated throughout primary school within mathematics and science classes, they are unlikely to have a desire to pursue these upon entering secondary school. Science is compulsory for early secondary school students (up to year 10) but they are likely to go into these subjects with an already negative view (fostered in primary school) hindering participation and their opinion of mathematics and science.

SECONDARY EDUCATION

ACEA's secondary education strategy looks to promote a system that provides students with the ability and interest in mathematics, technology and science to produce more tertiary engineering students. Contemporary engineering professions are misunderstood by secondary school students, and subjects like mathematics and science are not always linked to engineering as a career. ACEA see the cause for misconception and lack of students entering into engineering degrees as falling into the following categories:

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[4] Hollow, R.P. *The Student as Scientist: Secondary Student Research Projects in Astronomy*. Publications of the Astronomical Society of Australia, (ASPA)17 (2), 162

- Curriculum requirements
- Quality of teaching
- Resource constraints
- Careers advice

CURRICULUM REQUIREMENTS

ACEA supports Minister Bishop's June 2006 announcement to introduce a standardised *Australian Certificate of Education* in all states and territories across Australia. We applaud a unified Certificate and any independent study that will review maths and science in Australian secondary schools.

A nationally consistent certificate would enable necessary changes to be made to the curriculum in a cohesive manner as Australian industry and culture evolves. Monitoring the level of academic standards required for students to receive their senior school certificate would also become more coherent and one consistent curriculum would mean that expectations for entrance into further study and then employment would be better met.

Compulsory mathematics and science

Modern Australian society has evolved into a culture fueled by the desire and expectation of choice. From a secondary education perspective, this has led to reduced standards for core subjects being chosen for study by secondary students. By core subjects, ACEA refers to science and mathematics; in our opinion these subjects are core to the development of well rounded members of society.

English, the only compulsory subject for year eleven and twelve students, teaches the art of reading and writing and advanced language skills. What the English curriculum lacks is problem solving and basic mathematical skills. ACEA believes that the purpose of the Australian education system is to deliver and create well rounded individuals, ready for employment, further study or research. Without the problem-solving skills that science subjects teach and the basic numeracy skills that mathematics subjects instil, students are not emerging at the completion of their school studies well rounded and ready for further study/employment. This is felt through the university sector, tertiary educators claiming that the secondary school system is not providing engineering students with the competencies to jump straight into engineering their first year of study. Some educators even claim the situation is so bleak that first year university for many aspiring engineers is a re-hash of high school maths and science principles.

Most schools will stream their subjects to make at least some form of mathematics and science a part of student's year 11 and 12 education. However some secondary schools are allowing students not to elect any maths and science subjects at all. This is because it is at the schools discretion how they set out the subjects on offer. This means that students can make their selections in such a way that it is easy to overlook and not select any type of mathematics or science subjects.

QUALITY OF TEACHING

ACEA recognise that there are many quality teachers who are passionate and knowledgeable within their designated fields or disciplines. The prevalent issue is that there are not enough of them and the fact that the

average age of teachers worldwide is mid to late forties[5] indicates that currently there are not enough teachers graduating from University and remaining in this field.

Even with the teacher shortage, it should be the priority of the education department to ensure that teachers are teaching within their disciplines. It is not feasible for example to expect a physical education teacher to deliver a comprehensive and engaging mathematics class.

A study conducted by the Australian Council of Deans of Science in 2005 revealed the following statistics:

- Nearly 43% of senior school physics teachers lacked physics majors, and 1 in 4 had not studied the subject beyond the first year at university.
- Among senior school chemistry teachers, 1 in 4 lacked a chemistry major.
- Geology teachers had the lowest levels of discipline specific qualifications. More than half of these teachers had not studied any geology at a tertiary level.[6]

These results reveal that the quality of science teaching within secondary schools lacks the fundamental core concepts and knowledge to be effective. The Australian Secondary Principles Association asked participants of their 2006 survey "On the date specified above (May 22nd 06) and for each of the subject areas listed below, how many classes in that area are being taught by teachers who are untrained or lack subject expertise?" The results revealed that about one third of schools report having between one and five classes covered by teachers untrained in that subject area.[7] Teachers should not be asked to teach classes outside their tertiary disciplines. Students will ultimately suffer the burden and not receive the degree of education they would with a tertiary qualified teacher providing and teaching a syllabus they have a demonstrated level of expertise in.

RESOURCE CONSTRAINTS

Resource constraints within science, technology and mathematics departments in secondary schools have the ability to drastically affect whether or not students choose these subjects in years eleven (11) and twelve (12). This may ultimately decide which avenues will be open to them when considering higher education or employment.

Resources must meet the contemporary needs of dynamic mathematics and science disciplines. Teaching without engaging materials and tools does not encourage a learning environment that is satisfactory by today's standards.

With no maximum cap for class sizes, students are paying the price for this constraint on resources. Class sizes of twenty-five (25), not as an average but a maximum would ensure students receive the right level of attention in years 7-10. For years eleven (11) and twelve (12) a maximum cap of 20 students per class would greatly increase the potential for a comprehensive learning experience and an appropriate level of individual student-teacher time.

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[5] Kelchtermans, G. (2005). Professional commitment beyond contract: Teachers' self-understanding, vulnerability and reflection. Paper presented at the *Challenges for the Profession: Perspectives and Directions for Teachers, Teaching and Teacher Education* - 12th International Conference of the International Study Association on Teachers and Teaching, Sydney.

[6] Who's Teaching Science, Report prepared by the Australian Council of Deans of Science, 2005, Centre for the Study of Higher Education, the University of Melbourne.

[7] Australian Secondary Principals Association Inc. 2006 Survey *Teacher Supply*. Source: www.appa.asn.au

Appropriate tools for experiments and learning materials that are modern and appeal to contemporary learning needs must become a priority for secondary schools. Non-engaging materials only hinder the already identified problem of teachers teaching outside their disciplines.

CAREER ADVICE

The current support from a careers advice perspective is well below what Australian secondary school students require. Advice is not being delivered from educators with a wide background on all occupational avenues. The largest constraint on careers advice being delivered comprehensively is the lack of careers advisors at secondary schools whereby a typical high school has one (1) careers advisor for one thousand plus (1000+) students. Typically careers advisors spend much of their time with high-risk students and organising work experience for year ten (10) students, and little time is left for counseling more academically capable students on potential career choices.

Furthermore, Careers Advisors cannot be expected to fully comprehend and appreciate every career path available. Few careers advisors have an understanding of engineering as a career. To this end ACEA has developed a DVD which explains and sells engineering as a career choice for young Australians. It is envisaged that the DVD will be delivered to school students around the country by the end of 2007.

ACEA believes, however, that the long-term solution requires the engagement of classroom teachers in delivering careers advice to students. Classroom teachers have significantly more impact on students due to their increased interaction time and individual understanding of students. They also will have a far better understanding of students' strengths and weaknesses and can thus provide better guidance than Careers Advisors who have extremely limited interaction.

ACEA sees this model working by allowing industry groups to communicate with classroom teachers to provide insight into industry's ever changing and evolving workforce. When considering the engineering industry for example, historically there were five (5) different types of standard engineer occupations; now over one hundred (100) different types of engineering and related roles can be classified. Currently classroom teachers would not be expected to know this, but using very simple methods like industry group meetings or giving teachers access to industry newsletters would allow careers advice to be delivered through the classroom in a more beneficial and student-specific manner.

Furthermore, formal industry outreach programs could become part of a teacher's KPI's. Just as the Summer School initiative by the Federal Minister for Education seeks to reward teachers who proactively enhance their general teaching skills, knowledge and understanding, so too could teachers be further rewarded for interest and understanding of career paths for those students who excel in their subject area.

TERTIARY EDUCATION

ACEA supports a more competitive tertiary education system with an increased focus on student and industry engagement. The engineering industry needs graduates who emerge from tertiary education well rounded and business knowledgeable as well as technically competent.

CURRICULUM REQUIRMENTS

As mentioned earlier in the submission, anecdotal evidence has suggested that first year university for many engineering students is a re-education of basic science and mathematics principles. Addressing this challenge relies heavily on changes being made to the secondary school curriculum and a better cohesion between the syllabuses in each state.

ACEA members support the Melbourne University model (commencing 2008) which will allow the university's students to undertake one quarter of their studies in other disciplines. This model has the potential to provide students with a more focussed and relevant degree, as ¾ of the course is focussed on their discipline and the other quarter provides room to expand further knowledge. Double degrees for example leave no room for other disciplines as they are too intense. From an expectations point of view ACEA supports the current entry level point units that the Melbourne University model asks for, e.g. a score of 25 in maths, science & English to do a science (engineering) degree.

For students that do not study science and maths or do not reach the required scores to enter into a tertiary engineering degree ACEA supports the Australian Technology Network of Universities' (ATN) *Engineering tomorrows engineers* initiative. Part of the project enables the use of an engineering aptitude test which is aimed at increasing the cohort of potential engineers to include those that can not necessarily demonstrate the appropriate background preparation, but can demonstrate an aptitude for the course and a profession as tomorrow's engineer.

Work experience

ACEA believes that a stronger emphasis on encouraging more opportunities for work experience like cadetships, internships and apprenticeships for tertiary students should become a priority for tertiary education strategy. These kinds of placements of course can not occur without a level of support being provided to the business community.

It is imperative for businesses hosting and training students to be provided with government support from an advisory perspective, which might best be delivered through the appropriate industry association. Information should be made available to businesses around minimum pay requirements, length of term, how the selection process should work and other day to day issues. ACEA would support this incentive being provided in the form of an interactive website or a telephone help-line, preferably a combination of the two.

Consistency between vocational education and training and tertiary education

Introducing content standardisation which maintains a correlation where possible between TAFE and university subjects will benefit the higher educations system as well as its students. In application this consistency will ensure that advanced standing can be offered to students who have completed a TAFE degree for university subjects and visa versa. This is not to say that a TAFE diploma should become the same as a tertiary degree, only that if there are similar or same subjects offered at a university and a TAFE within the same discipline, these two subjects should be similar enough to be interchangeable between the two learning sectors.

The government should encourage higher education sectors to adopt a flexible and collaborative approach that will allow content standardisation (where possible) to occur. This process will allow students who have either not completed their studies or want to move between the sectors the opportunity to resume or further their education and (re)enter the workforce.

International competitiveness

The Australian tertiary education sector must remain internationally competitive to attract the best international and domestic students. International fee paying students encourage improved standards for course design, content and delivery.

Australian Universities need an appropriate balance between domestic places and full fee paying overseas places and we would like to see more Australian students going into university to study engineering. ACEA believes Australia needs to attract overseas students which will in turn force universities across the nation to deliver internationally competitive and high standard courses benefiting our domestic students as well.

By having the most internationally comprehensive courses, tertiary institutions can provide the best and most globally competitive graduates alongside attracting the best and brightest from overseas to study (and potentially work) in Australia.

WORKFORCE LEARNING

Having the ability to learn through interaction with the workforce creates a better correlation between tertiary students leaving the educational institution and entering the workforce. Understanding skills that may not necessarily be taught at university like coping with pressure and management capabilities or leadership competencies has a huge impact on whether or not a graduate is work ready once their studies are complete.

Workforce learning as part of an engineering degree should become a compulsory unit of study. By engaging the business community, Australian universities have the ability to build relationships with firms within their state, and students in turn will have better opportunities and contacts for internships.

Work readiness

The engineering industry requires graduate engineers that are technically competent as well as work ready to start narrowing the skills shortage gap as soon as they leave university. Work readiness extends to graduates having already been exposed to business environments and understanding the range of current industry issues which they will have ideally gained though internships or cadetships during tertiary education.

Contemporary business needs extend to graduates being flexible and having an adaptable approach to a variety of situations. Being aware of global standards and markets and having a desire to accumulate core leadership competencies are key areas that can be developed through encouraging workforce learning during tertiary studies.

Flexibility for lifelong learning

Another part of the flexible approach referred to in 'Consistency between vocational education and training and tertiary education' would include part time and after hours study to be made more readily available through the tertiary education system. Flexibility for lifelong learning includes making learning available at different times of the day, to a range of different groups. A mature age student for example who has a desire to complete an engineering degree should have access to evening classes, whether they be at TAFE or University, to make the course or desired degree attainable.

Although part-time university study has been readily available across some universities, part-time courses do not extend to every tertiary body, nor do they extend to all degree and diploma types. Measures put in place to allow the flexibility of lifelong learning would encourage and enable a number of previously not catered for groups to obtain relevant and contemporary qualifications to aid in our industry's skills shortage crisis.

In particular, the University sector should be encouraged to be more flexible so as to allow employees with vocational training to up skill to an engineering degree without having to give up full time employment.

FINAL COMMENTS

The standards of school education in Australia are critical to Australia's future and, in particular, our ability to compete in a global market. ACEA appreciates the opportunity to submit comments to the Inquiry into education standards. We furthermore appreciate the continued dialogue we have been afforded with government on these and related issues.