
AC 2011-2740: A REVIEW OF ENGINEERING TECHNICIAN EDUCATION IN AUSTRALIA:

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Professor David Dowling is passionate about helping engineering students learn and achieve their career goals. As Professor of Engineering Education at the University of Southern Queensland (USQ) his research and development activities are focused on enhancing curricula, and teaching and learning environments. Professor Dowling was Associate Dean (Learning and Teaching) from 1995 to until January 2009. He was a President of the Australasian Association for Engineering Education in 2005-2006, and was awarded an Australian Learning and Teaching Council (ALTC) Citation in 2008. David was the lead author of the recently published first year text: *Engineering Your Future: An Australasian Guide*. Professor Dowling is currently leading two major research projects: A study of engineering technician education in Australia, which was funded by a USQ Senior Fellowship; and The Define Your Discipline Project, an ALTC funded project that aims to develop a process that can be used by a discipline to develop detailed graduate outcomes for that discipline. During 2010 the project team has been working with industry and university stakeholders across Australia to develop a national set of graduate outcomes for environmental engineering programs.

A review of engineering technician education in Australia:

Programs, pathways and perspectives

Introduction

The Dublin Accord^{1,2,3} is an international agreement that defines the educational base for Engineering Technicians and is used for the recognition of equivalence of those qualifications. Under the agreement, the qualifications that have been accredited by one of the national organizations that is a signatory to the Accord are recognized by each signatory organization as being substantially equivalent to the accredited qualifications within its own jurisdiction. Currently there are four signatories to the Dublin Accord: Canada, Ireland, South Africa and the United Kingdom. Korea, New Zealand and the United States hold provisional signatory status and Australia is seeking to become a signatory.

In 2005 Engineers Australia, which accredits programs for professional engineers and engineering technologists, began developing an accreditation system for engineering technician programs. This accreditation standard is set at the level of the Exemplifying Academic Qualifications for Engineering Technicians established by the signatories to the Dublin Accord. Although only a small number of programs have been accredited to date, accreditation by Engineers Australia is expected to become the benchmark for technician education programs in Australia.

The Australian tertiary education system is divided into two sectors: the higher education (HE) sector and the vocational education and training (VET) sector. Traditionally higher education has been provided by universities, both public and private, while vocational education and training has been provided by technical and further education (TAFE) institutes and an increasing number of private providers, each of which is registered with the relevant state training authority as a Registered Training Organisation (RTO). For the last twenty years the major distinction between the two sectors has been the approach they take to learning and assessment. Traditionally universities have adopted a research led academic approach, and employed curriculum based pedagogies, while VET sector institutions have used competency based pedagogies and focussed on work skills and the recognition of workplace learning.

Some universities, such as RMIT and Swinburne universities, are called dual-sector institutions as their current structure is the result of the amalgamation of a university and a VET institution. Dual-sector institutions offer a range of VET competency based programs and university degree and research degree programs. They are also likely to have well developed, and efficient, articulation pathways between their programs.

The Australian Qualifications Framework (AQF) defines the titles, characteristics and scope of all nationally recognised awards delivered by high schools, VET institutions, and universities. The AQF, which is currently being reviewed, defines 10 levels of qualifications, from the Certificate I, at Level 1, through to the Doctor of Philosophy at Level 10. Two qualifications are defined at Level 6 and both are two-year qualifications that are used to educate engineering technicians, who are referred to as engineering associates in Australia. Advanced Diploma programs are competency based and offered by VET institutions while

the higher education Associate Degree programs were, until recently, only offered by universities. Graduates from these Level 6 qualifications ‘...will have broad knowledge and skills for paraprofessional, highly skilled work, and/or further learning’.⁴

The research questions

In 2006 a short online questionnaire was developed to explore the reasons for a large increase in enrolments in the Associate Degree in Engineering program at the University of Southern Queensland. The aim was to gather information about the students in the program, who normally work full-time in the engineering industry and study part-time by distance education, their career aspirations, and the reasons why they chose to study the program. An analysis⁵ of the 247 responses found that 63% of the students had a career goal to become a professional engineer and were using the Associate Degree as a stepping stone to the Bachelor of Engineering program. Surprisingly, less than 14% of the respondents intended to pursue a career as an engineering technician. If this unexpected result was representative of engineering technician students in Australia then it would challenge a long-held assumption that graduates from Advanced Diploma and Associate Degree programs would pursue careers as engineering technicians.

To test this hypothesis a university funded Senior Fellowship was used in 2010 to undertake research into a range of issues relating to engineering technician education in Australia. The research questions relevant to this paper are:

1. What engineering technician programs are currently offered in Australia?
2. What are the characteristics of the programs offered by each sector?
3. Why did the students choose their current program?
4. What are the career aspirations of the students?

The results of the research are reported in the following sections.

The programs

During 2010 a comprehensive desktop review was undertaken of the engineering technician programs offered by Australian institutions. This was necessary because this information, even in summary form, is currently not available in any one document or online location. For the VET programs the review began with a search of all of the relevant government websites to obtain information about nationally approved qualifications. This was followed by a search of the online sites of all of the higher education and VET institutions in Australia to determine, firstly, if they offered any national, state, or self-accredited programs for engineering technicians and, secondly, the details of any programs offered. This was followed by interviews with senior staff at the key institutions and universities in each state and territory to verify the information gathered during the desktop review.

The fourteen Advanced Diploma programs currently offered by VET institutions in Australia are listed in Table 1, which for each program also lists the program type, the number of institutions that offer the program, and the number of Australian states and territories where at least one institution offers the program. All of these programs are offered on-campus, and students may study full-time or part-time.

Eight of the fourteen programs are defined in Training Packages which were developed by federal government appointed Industry Skills Councils, each of which is responsible for the development, maintenance, and currency of the qualifications for their industry. ‘A *Training Package* is a set of nationally endorsed standards and qualifications for recognising and assessing people’s skills in a specific industry, industry sector or enterprise’.⁶ A training package describes the competencies, and the associated performance criteria, required for an individual to perform effectively in the workplace rather than the curriculum for the program.

Table 1: Australian Engineering Advanced Diploma programs by field and type

| Program Name and Type | | Number of Offers | |
|--|----------|------------------|--------------|
| Advanced Diploma of.... | Type | States | Institutions |
| Civil Engineering | | | |
| Engineering Design | State | 4 | 5 |
| Civil & Structural Engineering | State | 1 | 2 |
| Structural Engineering | State | 1 | 4 |
| Electrical, Electronic and Communications Engineering | | | |
| Electrical Engineering | National | 4 | 7 |
| Electronics & Communications Engineering | National | 4 | 6 |
| Computer Systems Engineering | National | 3 | 11 |
| Industrial Electronics and Control Engineering | National | 1 | 2 |
| Refrigeration & Air-conditioning Engineering | National | 2 | 2 |
| Renewable Energy Engineering | National | 1 | 1 |
| Electrotechnology (Industrial Electronics & Control Eng) | State | 1 | 1 |
| Mechanical and Mechatronic Engineering | | | |
| Engineering | National | 5 | 12* |
| Engineering Technology | State | 2 | 10 |
| Engineering (Aerospace) | State | 1 | 1 |
| Mining Engineering | | | |
| Engineering (Oil & Gas) | State | 1 | 1 |

*Includes one RTO

It is interesting to note that four of the engineering Advanced Diplomas that are defined in Training Packages are not currently taught by any of the Australian VET institutions: The Advanced Diploma of Civil Construction; The Advanced Diploma of Civil Construction Design; The Advanced Diploma of Telecommunication Engineering; and the Advanced Diploma of Telecommunication Network Engineering. This means that although an Industry Skills Council has defined a qualification that they believe is important for their industry none of the VET institutions have decided to offer the program. It would be interesting to research the reasons for the lack of take-up of these programs, which may include: a perceived lack of interest or demand for the program in a region; a lack of employment opportunities in a region; or a lack of staff or facilities to teach the program at an institution.

The remaining six Advanced Diploma programs currently offered in Australia are Accredited Courses (for consistency, courses are referred to as programs in this paper). Each of these

programs was developed by a VET institution and accredited by the relevant State Training Authority. Once accredited, the program may be registered and offered by VET institutions in other states.

Only one offer of one of the Advanced Diplomas currently offered in Australia is accredited by Engineers Australia: the state accredited Advanced Diploma of Engineering Technology offered by the Chisholm Institute, which is a VET institution in the state of Victoria.

The institutions that currently offer engineering Associate Degree programs are listed in Table 2 which, for each institution, shows the type of institution, the engineering fields (Majors) available for students to study, and the modes of study available. Those programs offered by a university, or a dual-sector institution, were developed and accredited by the relevant institution as universities are, by statute, self-accrediting institutions. The programs offered by VET institutions are accredited by the relevant state higher education authority.

Only three of the institutions have had some or all of the majors in their programs accredited by Engineers Australia. These are shown in bold type in the table.

Table 2: Australian Engineering Associate Degree programs by institution

| Institution | Type of institution | Majors offered | Study Modes |
|---|----------------------------|---|-------------------------|
| Australian National University and Canberra Institute of Technology | University VET | Mechanical; Electronic | On-campus |
| CQU | University | Civil; Electrical; Mechanical; Mining (Surface); Mining (Underground) | Off-campus |
| Polytechnic West | VET | Maintenance | On-campus |
| RMIT | Dual-sector | Advanced Manufacturing; Civil; Electrical / Electronic; Mechanical; Network | On-campus |
| Southbank Institute of Technology | VET | Civil | On-campus |
| Swinburne University of Technology | Dual-sector | Engineering* | On-campus |
| TAFE South Australia | VET | Electronic | On-campus |
| University of South Australia | University | Civil*; Electrical & Information*; Mechanical* | On-campus |
| | | Defence Systems | On-campus Online |
| University of Southern Queensland | University | Agricultural; Civil; Computer Systems; Electrical & Electronic; Environmental; Mechanical; Power | On-campus Off-campus |

*This program is designed as an alternative pathway into a Bachelor of Engineering program

The number of Associate Degree programs has grown in recent years and there is increasing diversity in the entry requirements and the graduate outcomes defined for these programs. Some Associate Degree programs have been designed to prepare graduates for work as

engineering technicians, some are designed to provide graduates with an alternative or efficient pathway into a Bachelor of Engineering program, and some are designed to enable graduates to achieve both of these outcomes. The recently developed Associate Degree of Engineering (Defence Systems) program, which is offered by the University of South Australia, has added to this diversity as it is designed to prepare experienced trades people for work as supervisors or managers in the defence industry.

There is an inherent tension in the design of programs that aim to equip graduates with the knowledge and skills they need to work as an engineering technician and also to enable them to receive full credit in a Bachelor of Engineering program. However, as King⁷ reported, there is widespread support for incorporating efficient articulation pathways in these programs. *'In contemplating any major revisions to the engineering education system, all those consulted in the review agree that the system must allow students and graduates to transfer between qualification pathways with maximum efficiency, in terms of allowed credit and study duration'*.⁷

The need for articulation pathways is also mentioned in the Joint Quality Initiative⁸, which is an informal network for quality assurance and accreditation of bachelor and master programs in Europe. It advises that Bologna higher education short-cycle awards (i.e. less than three years duration) may prepare students for employment while also providing preparation for, and access to, studies that lead to the completion of a three year (first cycle) award.

The growing diversity between the Advanced Diploma and Associate Degree programs offered in Australia highlights the potential for confusion amongst students and employers about the standing and purpose of the engineering technician qualifications. However, the Dublin Accord based Engineers Australia's accreditation system now provides a benchmark for engineering technician education in Australia.

The students

An online questionnaire was developed and deployed in 2010 to gather information from students in the engineering technician programs offered by universities and VET institutions across Australia. The main aim of the questionnaire was to test if the results of the earlier study⁵ were applicable across Australia. The key questions sought to identify the reasons students chose their current program of study, the amount and type work experience they had, and their career aspirations.

Three hundred and thirty engineering technician students from across Australia completed the questionnaire during the first half of 2010, with 327 valid responses being received. Students from three universities, five VET institutions and one dual sector institution participated in the study. The majority of the students were enrolled in an Advanced Diploma (45%) or an Associate Degree (40%) with the remaining students (15%) being enrolled in a VET Diploma, which is a subset of an Advanced Diploma. Some of the key characteristics of the students were:

- Gender: 89% were male and 11% were female.

- Age: 36% of the students were less than 20 years of age; 40% were between 20 and 29 years of age; 23% were between 30 and 49 years of age; and 1% were 50 or more years of age.
- Secondary schooling: 41% completed their secondary schooling in a school in a metropolitan city in Australia; 26% in a regional area; 11% in a rural area; and 22% in a school in an overseas country.
- Field of study: The major fields of study were: civil engineering (40%), mechanical engineering (26%) and electrical or electronic engineering (17%).
- Modes of study: 78% were on campus students and 68% were studying full-time.

The key findings from the study were:

- Only 16% of the students have a career goal to work as an engineering technician. Of the remaining students, 51% have a career goal to work as a professional engineer, 16% as a project manager and 4% as an engineering technologist
- When they graduate 74% of the students plan to enrol in another program, with 57% percent of those students planning to study a Bachelor of Engineering program, and 11% a Bachelor of Technology program.
- Most of the students believe it is *very important* (63%) or *important* (27%) that their program is accredited by Engineers Australia.

Some of the other important findings were:

- The four major influences on their decision to study engineering were: *I like building things; I like finding out how things work; Good employment opportunities; and Good pay when I graduate.*
- The four major influences on their decision to study their current program were: *To advance my career; It has the specialization I want; The institution has a good reputation; and The program has a good reputation.*
- Despite the fact they believed they were eligible for admission to a Bachelor of Engineering program, 45% chose to study an engineering technician program.
- The five major influences on their decision to study an engineering technician program rather than a Bachelor of Engineering program were: *I did not meet the entry requirements; I want to graduate as soon as possible to advance my career; I want to work in a hands on job; My program has a good mix of VET and university learning experiences; and A degree program would cost too much.*

Discussion

The study found that currently there are 43 separate program/major qualifications in engineering at AQF Level 6. However, only 39 of the qualifications are designed to equip graduates for a career as an engineering technician. The remaining four qualifications are designed as alternative entry pathways into a Bachelor of Engineering program. Only 16 of the 38 qualifications are accredited by Engineers Australia and these are offered by just four institutions; two in Victoria and two in Queensland. This low accreditation rate is despite the extensive dialogue about accreditation that has occurred over the last five years between Engineers Australia, Industry Skills Councils, individual VET institutions, and groups of VET institutions. Certainly the students believe accreditation is important, as 90% stated they believed it was *very important* or *important* that their program is accredited by Engineers Australia.

The students provided a variety of reasons why they chose their current program, but the major factors related to the focus and reputation of the qualification, or the reputation of the institution offering the program. The fact that, despite being eligible for admission to a Bachelor of Engineering program, many students chose an engineering technician program should be of interest to those educators who are responsible for developing programs and articulation pathways between programs. This is because more than 50% of the students plan to articulate to a higher level program to achieve their career goal of practising as a professional engineer.

The results from the student questionnaire confirmed the results of the earlier study⁵ were applicable across Australia: i.e. that less than 20% of the students in engineering technician programs have a career goal to work as an engineering technician. This finding has significant implications for both educators and employers. Firstly, it suggests that in the not too distant future there may be a shortage of engineering technicians. Perhaps it is time for the relevant employers to review their workforce strategies and personnel practices to ensure they are able to recruit and retain engineering technicians. Secondly, engineering educators need to plan efficient articulation pathways from engineering technician programs to Bachelor of Engineering programs so that students are able to achieve their career goals.

Conclusion

The results of the two studies reported in this paper provide an insight into engineering technician education in Australia. The first study found that there is great diversity in the programs offered by VET and HE institutions, and that this may lead to confusion amongst students and employers about the standing and purpose of engineering technician qualifications. It is expected that some of this confusion may dissipate when more of the programs are accredited by Engineers Australia.

The second study found that only 20% of the students planned to work as engineering technicians. This finding has implications for engineering educators, employers, Engineers Australia, and the engineering industry.

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