A review of para-professional engineering education in Australia: Exploring the VET - HE divide

David Dowling
University of Southern Queensland, Toowoomba, Australia
dowling@usq.edu.au

***Abstract**: The differences between the Vocational Education and Training (VET) and higher education (HE) sectors have been well documented over recent years, often in the context of the impact those differences have on student movement between sectors. In engineering, the differences between the sectors are exemplified by the different approaches each sector takes to para-professional education. Both VET sector Advanced Diplomas and HE sector Associate Degrees are Level 6 qualifications under the Australian Qualifications Framework, and are designed to educate para-professional engineers.*

This paper describes some of the key features of the engineering programs offered in each sector and explores the differences between them. It then discusses the implications of those differences on student learning and student movement between the sectors. The final section describes some key changes occurring in the tertiary education sector and the impact they may have on para-professional engineering education.

Introduction

Para-professional engineering education straddles a divide in Australian tertiary education between 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, more recently, registered training organisations (RTO). However, this distinction between the two sectors has become blurred over the last five years as some VET institutions now offer HE programs and some universities have registered as an RTO and offer VET programs. Private institutions, companies and training organisations are also able to apply to become an RTO.

The VET sector consists of both government and private providers who together offer a vast number of courses, programs and qualifications to more than 1.6 million people a year (NCVER, 2008) Because this sector is designed to respond to both the formal and informal training needs of industry, it has much closer links with industry than universities normally do. In fact, because VET institutions educate and train people for work (IBSA, 2008, p. 10) this sector is normally referred to (implicitly or explicitly) when strategies for addressing skills shortages and skills development are being discussed in the public domain.

Over the years the many differences between the two sectors, including purpose, governance, pedagogy, and funding sources, have helped to create a divide that is proving hard to bridge, particularly by students who wish to move between the sectors. The divide persists despite the deployment of many government policies, strategies and funding initiatives to promote the development and implementation of attractive and efficient articulation pathways incorporating identified credit transfer arrangements. Bradley et al (2008, p. 179) suggested that the limited success of these initiatives was 'due to structural rigidities as well as to differences in curriculum, pedagogy and assessment'.

This paper explores the engineering programs that straddle the divide and the barriers that hinder student movement between the sectors.

Para-professional engineering education

The Dublin Accord is an International Agreement that defines the educational base for Engineering Technicians (para-professional engineers) and is used for the recognition of equivalence of those qualifications. The employment roles and the Exemplifying Academic Qualifications of the four current signatories are shown in Table 1, along with the data for New Zealand (a provisional signatory) and Australia, which is seeking to become a signatory. It should be noted that in Australia Engineering Technicians are normally called Engineering Associates or Engineering Officers.

The two Australian awards at this level are the Advanced Diploma, which is normally a VET award offered by institutions in the Vocational Education and Training sector, and the Associate Degree, which is a higher education qualification that has, until recently, only been offered by universities. Since 2005, VET institutions have been able to offer Associate Degrees, once the proposed programs have been accredited by the relevant state higher education authority. King (2008) highlights the differences between the two Australian awards that aim to prepare graduates for careers as para-professional engineers.

'The VET award system is unit-based around prescribed competencies, and designed to deliver an Advanced Diploma graduate with specific knowledge and workplace skills. The Associate Degree is, in contrast, a curriculum-based award intended primarily to be a pathway to a full bachelor degree. However, the award should also provide its graduates with clearly defined sets of outcomes that have value within the relevant industry sector' (King, 2008, p. 13)

Table 1: Engineering Roles and Exemplifying Academic Qualifications in signatory countries

Country	Organisation	Role	Exemplifying Academic Qualifications
Australia	Engineers Australia	Engineering Associate or Engineering Officer	Associate Degree Advanced Diploma
Canada	Canadian Council of Professional Engineers Canadian Council of Technicians and Technologists	Certified Engineering Technician Canada	Technician programs
Ireland	Institution of Engineers, Ireland	Engineering Technician	National or Technician Certificate in Engineering
New Zealand	Institution of Professional Engineers New Zealand	Certified Engineering Technician	National Diploma
South Africa	Engineering Council of South Africa	Professional Engineering Technician	National Diploma in Engineering
United Kingdom	Engineering Council United Kingdom	Engineering Technician	Examples: Edexcell National Certificate or National Diploma, Advanced General National etc.

Source: International Engineering Alliance (2010)

In 2005 Engineers Australia began developing an accreditation system for para-professional engineering programs. This accreditation standard is set at the level of the Exemplifying Academic Qualifications for Engineering Technicians established by the signatories of the Dublin Accord (International Engineering Alliance, 2010). To date only a small number of Associate Degrees and Advanced Diplomas have been accredited by Engineers Australia.

The research questions

This paper reports on one aspect of an ongoing research project that is investigating a range of issues relating to para-professional engineering education in Australia, including the characteristics and perspectives of students and their employers. The bulk of the work undertaken to date was funded by a USQ Senior Fellowship. The research questions relevant to this paper are:

1. What para-professional engineering programs are currently offered in Australia?
2. What are the characteristics of the programs offered by each sector?
3. What are the differences between the programs?
4. What are the barriers that impede articulation between the sectors?
5. What impact will recent and proposed changes in the federal government's tertiary education policies have on these programs?

Method

A range of methods were used to gather, analyse, synthesise and verify the information incorporated in this paper, including:

- A review of the literature, government reports and policies, and the websites of government organisations and the relevant education institutions;
- Interviews with senior engineering teaching staff at VET institutions in the ACT and all of the mainland states;
- Interviews with Engineers Australia staff; and
- Correspondence with relevant stakeholders.

The data included in this paper represents the research findings at the time of writing.

The para-professional engineering programs

The following sections describe the characteristics of the vocational education and training Advanced Diploma programs and the higher education Associate Degree programs that are currently offered in Australia in the field of engineering.

Associate degrees

The key characteristics of the engineering Associate Degree programs currently offered by Australian universities and VET institutions are listed in Table 2. The data has been extracted from online handbooks and documents, with the data for each institution being verified by an engineering staff member from that institution. In some cases the data has been summarised, for example, the four Associate Degree programs at RMIT have been listed as one program with multiple majors.

Table 2: Australian Associate Degrees of Engineering

Institution	Associate Degree of.....	Specialisations or Majors	Mode	Entry Requirements
Australian National University and Canberra Institute of Technology*	Engineering	Mechanical; and Electronic Engineering	ONC	Year 12 Cert + Maths
CQU	Engineering**	**Civil**; **Electrical**; **Mechanical**; Mining (Surface); and Mining (Underground) Engineering	OFF	Year 12 Cert + work in mining industry for mining majors
Polytechnic West*	Aviation	Maintenance Engineering	ONC	Year 12 Cert or Cert IV
RMIT#	Engineering Technology**	**Advanced Manufacturing; Civil; Electrical / Electronic; Mechanical; and Network Engineering**	ONC	Year 12 Cert + Maths & English
Southbank Institute of Technology*	Civil Engineering	Civil Engineering	ONC	Year 12 Cert or Cert III /Cert IV + Maths
Swinburne University of Technology#	Engineering	Engineering	ONC	Year 12 Cert + Maths & English
TAFESA*	Electronic Engineering	Electronic Engineering	ONC	Year 12 Cert or Cert III in Engineering
University of South Australia (UniSA)	Engineering	Civil; Electrical & Information; and Mechanical Engineering	ONC	Year 12 Cert or Cert IV
University of South Australia (UniSA)	Engineering	Defence Systems Engineering	ONC ONL	Trade + 5 years Industry Experience
University of Southern Queensland (USQ)	Engineering**	**Agricultural; Civil; Computer Systems; Electrical & Electronic; Environmental; Mechanical; and Power Engineering**	ONC OFF	Year 12 Cert + Maths & English

*VET institution # Dual-sector Institution **Program Accredited by Engineers Australia – accredited majors in bold type

Cert III - VET Certificate III – a trade level qualification
Cert IV - VET Certificate IV
Year 12 - The Senior Secondary Certificate of Education or equivalent
ONC - On-campus study mode
OFF - Distance education study mode
ONL - Online study mode

Some of these programs have been designed to prepare graduates for work as Engineering Associates, some are designed to provide graduates with an efficient pathway into a Bachelor of Engineering program, and some are designed to enable graduates to achieve both of these outcomes. On the other hand, the UniSA Associate Degree of Engineering (Defence Systems) program 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 the programs that aim to equip graduates with the knowledge and skills they need to work as an Engineering Associate and also receive full credit in a Bachelor of Engineering program. However, as King (2008) 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'* (King, 2008, p. 8)

The need for articulation pathways is also mentioned in the Joint Quality Initiative (2004), 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 completion of a three year (first cycle) award.

Figure 1 shows the many combinations of program admission requirements and planned outcomes that are exhibited in Australia's Associate Degree programs. It should be noted that the amounts of credit listed in the right hand boxes are estimates only, as the amount of credit received depends on the design of a particular program, and the policies of the target university.

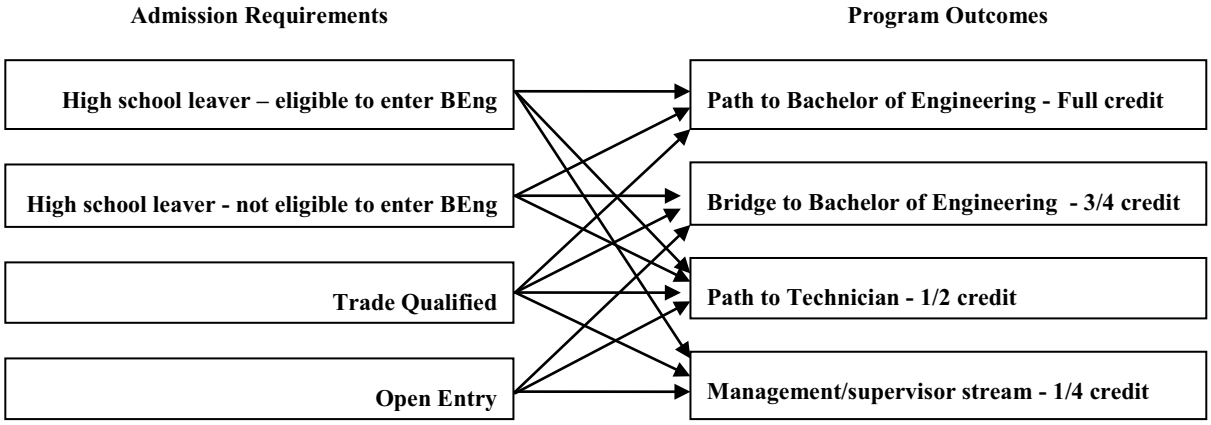

Figure 1: Schematic of possible combinations of admission standards and program outcomes

The growing diversity of Associate Degree programs demonstrated in Figure 1 highlights the potential for confusion amongst students and employers about the standing and purpose of the qualification.

Advanced diplomas

The Ministerial Council for Vocational and Technical Education has responsibility for, and is the key decision-making body for, the national training system. The Council is chaired by the federal Minister for Vocational and Further Education and consists of state and territory government ministers responsible for training (DEEWR, 2010). To implement their policies, the government has appointed and funded eleven *Industry Skills Councils* (ISC), each of which is responsible for the development, maintenance, and currency of the Training Packages in 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' (DEEWR, 2008, p. 4). A package describes the knowledge and skills required for an individual to perform effectively in the workplace rather than the training required for the job. The documentation includes full details of all of the qualifications defined in the package such as: the package rules relating to the core, stream, and

elective Units of Competency; and, for each of the defined Units of Competency, the competencies to be addressed, the performance criteria, and the assessment requirements.

As shown in Table 3, there are four Industry Skills Councils that have developed Advanced Diploma qualifications in traditional engineering fields. This contrasts with most other industry sectors which are covered by just one ISC.

Table 3: Engineering Advanced Diplomas developed by Industry Skills Councils

Industry Skills Council	Packages	Advanced Diploma of.....	Code #
Electrocomms and Energy Utilities Skills Council	UEE07 Electrotechnology Training Package Version 3	Electrical Engineering	**UEE60107**
		Electronics and Communications Engineering	**UEE60207**
		Computer Systems Engineering	**UEE60407**
		Industrial Electronics and Control Engineering	**UEE60607**
		Instrumentation and Control Engineering	UEE61510
		Refrigeration and Air-conditioning Engineering	**UEE60707**
		Renewable Energy Engineering	**UEE60907**
Innovations and Business Industry Skills Council	ICT02 Telecommunications Training Package	Telecommunication Engineering	ICT60202
	ICT10 Integrated Telecommunications	Telecommunication Network Engineering	ICT60210
Manufacturing Industry Skills Council	MEM05 Metal and Engineering Training Package	Engineering	**MEM60105**
SkillsDMC National Industry Skills Council	R1109 Resource and Infrastructure Industry Training Package	Civil Construction Design	R1160509
		Civil Construction	R116060

The codes of qualifications currently taught in Australia are shown in bold type. Key source: (NTIS, 2010)

In addition to the qualifications defined in Training Packages a VET institution, or RTO, may develop, and seek accreditation for, a program in a field that is not covered by the existing Training Packages. The program design must use the same competency based approaches to teaching and assessment that are used in Training Packages. Once the proposed program has been accredited by the relevant State Training Authority it is called an *Accredited Course*, and it may then be offered by the initiating institution and by other institutions in Australia who purchase a license for the product.

The characteristics of both the Accredited and the Training Package Advanced Diploma programs currently offered in key fields of engineering are listed in Table 4. For consistency, Accredited Courses are referred to as programs in this paper. The following points should be noted when reviewing the information in the table:

- The information about the entry requirements and structure of the program is based on that defined in the Training Package or Accredited Course documentation. The structure of an individual program may vary as individual institutions may not offer all of the Units of Competency defined for the qualification.
- The number of institutions listed for each state is based on the institutions registered to offer the program. Some of these institutions may not offer a program in a particular year.

The Charles Darwin University Advanced Diploma in Engineering program is not included in the table as it is an accredited higher education award. This program has been offered since the early 1990's and is available on-campus and by distance education. It has three majors: Civil Engineering; Electrical and Electronics Engineering; and Mechanical Engineering.

The data in the table shows that there is great diversity in the structure of the engineering Advanced Diplomas. Perhaps this is to be expected as the ISCs work independently to develop their Training Packages, and the qualifications defined in the packages.

The data also shows that VET institutions in most states offer and teach the Advanced Diplomas in the UEE06 and MEM05 Training Packages. This is not the case, however, for the Advanced Diplomas in the other Training Packages listed in Table 3, particularly those in the civil engineering discipline.

While there has been a significant take-up of some of these qualifications by metropolitan VET institutions, the take up by regional institutions is minimal. The lack of access in regional areas is exacerbated by the fact that, unlike the Associate Degree programs, none of these qualifications are offered by distance education. Thus, the VET sector appears to be failing to address the engineering skills shortages in regional areas where there are major mining and infrastructure projects.

Table 4: Advanced Diplomas currently offered in fields of engineering

Advanced Diploma of...	Program Code	Required/ Available Units	Number of Institutions offering the full qualification								Entry Requirements
			QLD	NSW	ACT	VIC	TAS	SA	WA	NT	RTO	
Civil specialisation												
Engineering Design	40604SA	36/99	**2**		**1**	**1**		**1**				Year 12 or Year 11 + Experience
Civil & Structural Engineering	52011	39/44							**2**			Maths & Comms skills[4]
Structural Engineering	91155NSW	31/31		**4**								Year 12
Electrical specialisation												
Electrical Engineering	**UEE60107**[1]	13/16 +41 U[2]	**1**	**4**		**1**		**1**				4-5 years of high school, access to workplace
Electronics & Communications Engineering	**UEE60207**	12/15 +80 U[2]	**1**	**1**		**3**		**1**				4-5 years of high school
Computer Systems Engineering	**UEE60407**	12/15+80 U	**1**			**9**		**1**				Year 12
Industrial Electronics and Control Engineering	**UEE60607**	12/15 or 13/16 + 45 U[2]		**2**								4-5 years of high school, access to workplace
Refrigeration & Air-conditioning Engineering	**UEE60707**	14/17 + 23 U[2]	**1**					**1**				Completion of Cert III
Renewable Energy Engineering	**UEE60907**	13/16 + 45 U[2]		**1**								4-5 years of high school, access to workplace
Electrotechnology (Industrial Electronics &Control Eng)	51974	3/3 + 200h							**1**			Maths & Comms skills[4]
Mechanical specialisation												
Engineering	**MEM60105**	30/120	**1**	**4**		**1**		**3**	**2**		**1**	Year 12
Engineering Technology[3]	21622VIC	1400h 74 U[3]		**1**		**9**						Year 12
Engineering (Aerospace)	15696VIC	37/37 + 400h				**1**						Year 12
Mining specialisation												
Engineering (Oil & Gas)	52170	30/30							**1**			Maths & Comms skills[4]

[1] Advanced Diplomas defined in a *Training Package* are shown in bold type. [2] The Unit Strand Total (UST) which is the sum of the strand values of the units completed. [3] Students must complete 1400 hours of study from the 74 available Units, each of which has a defined hour value. [4] Well developed maths and communication skills.

Over the last five years there has been extensive dialogue about accreditation between Engineers Australia, Industry Skills Councils, individual VET institutions, and groups of VET institutions. Despite this, none of the Training Package based Advanced Diplomas have been accredited by Engineers Australia. The only Advanced Diploma currently accredited by Engineers Australia is the Advanced Diploma of Engineering Technology program offered by Chisholm Institute. The program has two accredited majors: Mechanical Design, and Robotics and Mechatronics.

The other assessed Advanced Diploma programs have failed to meet one or more of the following criteria: they did not have the required rigour; they did not have the word(s) Engineering and/or Technology in their title; or, because of the high degree of flexibility, they did not provide graduates with the expected depth and breadth of knowledge and skills for them to practice at the designated level in their area of specialisation, for example, civil engineering (pers.com 2nd August 2010).

The package rules for the Advanced Diploma of Engineering (MEM60105) will be used to illustrate the latter point. Students must complete all six of the core Units, which mainly cover generic skills, and 24 of the elective Units. The elective Units, which cover all of the key fields of mechanical

engineering, are in two groups. Students must complete eight of the 35 Units in Group 1 and at least 16 of the 85 Units in Group 2, including four Units of free electives, i.e. any of the Units offered by their institution. Many of the Units in the two groups are at AQF level 3 or below, which may influence credit arrangements with universities. It should be noted, however, that this degree of flexibility is unlikely to be available in an individual program. This is because each institution will package the core Units and a sub-set of the electives to define an Advanced Diploma that meets local industry requirements and its teaching resources.

Anecdotal evidence suggests that the variability of Advanced Diplomas is one of the reasons why some qualifications are not well regarded in the industry or by some senior TAFE teachers. It is also the main reason why universities are reluctant to develop standard credit arrangements for graduates of these programs as staff believe each student's academic transcript must be individually assessed. Where credit arrangements have been negotiated between institutions, it is normally on the basis that students will complete a defined set of Units in their program, with minimum electives.

The impact of changes in government policy

This section provides an overview of some of the many changes occurring in the tertiary education sector at the present time as both state and federal governments seek to implement new policies.

The Australian Qualifications Framework Council (AQFC) has governance of the Australian Qualifications Framework (AQF) and maintains, monitors, and promotes the national implementation of the AQF (AQF, 2009). The scope of the tertiary education framework is defined by the AQF and it includes the titles, characteristics, and scope of all nationally recognised awards delivered by high schools, VET institutions, and universities (AQFC, 2010).

The AQFC is currently overseeing a project that aims to enhance the AQF: The Strengthening the AQF project. An initial consultation paper was released by the AQFC in September 2009 and another consultation paper was published in July 2010. It confirms previous recommendations that VET institutions should be able to offer the following HE awards: Associate Degrees, Bachelor Degrees; Vocational Graduate Certificates, and Vocational Graduate Diplomas.

As previously stated, three VET institutions already offer engineering Associate Degrees. It is likely that Chisholm will be the first VET institute to offer an engineering degree as it is currently finalising the accreditation documentation for a Bachelor of Engineering Technology (pers. com, 28th July 2010). It is expected that in the coming years more VET institutions will seek approval to offer Degrees and Associate Degrees. For example, in July 2010 TAFE NSW was accredited by the state government, under national guidelines, to offer these programs from 2011(Craig N & Dow S, 2010). If these programs, rather than the existing Advanced Diplomas, are used for articulation purposes then this may help to alleviate some of the current articulation problems.

The Tertiary Education Quality and Standards Agency (TEQSA) is currently being established and, from 2011, it will be responsible for overseeing the quality of tertiary education in both the VET and HE sectors. Thus, it will replace the Australian University Quality Agency which currently has this role in the HE sector. One of its first tasks will be to oversee the introduction of *academic standards* in the HE sector in 2011. The introduction of learning and teaching academic standards in the HE sector will see many universities embracing outcomes based education for the first time.

Finally, the broadening of Skills Australia's role in 2009 to cover the whole of the tertiary education sector (Australian Government, 2009) may also help to bridge the sectoral divide. Skills Australia is an independent statutory body that provides advice to the Minister for Education, Employment and Workplace Relations on Australia's current, emerging, and future skills needs and workforce development needs (Skills Australia, 2009).

Conclusion

There is great diversity in the para-professional engineering programs currently offered in Australia, both between and within the university and VET sectors. This diversity makes it difficult for students to select the most suitable program for them to achieve their goal and for employers to source

graduates that suit their needs. This complexity may be lessened when more programs are accredited by Engineers Australia and this international standard becomes the benchmark for these awards.

The differences in the engineering programs described in this paper highlight the difficulties of creating efficient pathways between the sectors. While some efficient pathways have been created by dual sector institutions these arrangements often do not apply for students from other institutions. The impact of the proposed AQF changes and the introduction of TEQSA are less certain, although TEQSA's oversight of both sectors may lead to a convergence in curriculum design and delivery and improved pathways between the sectors.

References

AQF. (2009). The Australian Qualifications Framework. Retrieved 6th April, 2010, from http://www.aqf.edu.au/AbouttheAQF/TheAQF/tabid/108/Default.aspx

AQFC. (2010). *Strengthening the AQF: A Framework for Australia's Qualifications - Consultation Paper* (Consultation Paper): Australian Qualifications Framework Council.

Australian Government. (2009). *Transforming Australia's Higher Education System*. Retrieved from http://www.deewr.gov.au/HigherEducation/Pages/TransformingAustraliasHESystem.aspx.

Bradley, D., Noonan, P., Nugent, H., & Scales, B. (2008). *Review of Australian Higher Education: Final Report*. Retrieved from http://www.deewr.gov.au/HigherEducation/Review/Pages/ReviewofAustralianHigherEducationReport.aspx.

Craig N, & Dow S. (2010, 22 August 2010). TAFEs to offer degrees. *The Sun-Herald,* p. 2.

DEEWR. (2008). *Training Packages @ Work - Back 2 Basics*. Retrieved from http://www.tpatwork.com/Back2Basics/default_home.htm.

DEEWR. (2010). Who is a part of the national training system? Retrieved 9th April, 2010, from http://www.dest.gov.au/sectors/training_skills/policy_issues_reviews/key_issues/national_training_system/who_is_part_of_nts.htm

IBSA. (2008). *Learner Guide - TAARNV401B Work effectively in Vocational Education and Training (VET)*. Melbourne: Innovation and Business Industry Skills Council Ltd.

International Engineering Alliance. (2010). International Engineering Agreements. Retrieved 20th July, 2010, from http://www.ieagreements.org/

Joint Quality Initiative. (2004). *Shared 'Dublin' descriptors for Short Cycle, First Cycle, Second Cycle and Third Cycle Awards.* Joint Quality Initiative.

King, R. (2008). *Engineers for the Future: addressing the supply and quality of Australian engineering graduates for the 21st century*. Sydney.

NCVER. (2008). 2007 Statistics. Retrieved 5th April, 2010, from http://www.ncver.edu.au/statistic/index.html

NTIS. (2010). Training Packages. Retrieved 29th July, 2010, from http://www.ntis.gov.au/?trainingpackage/all

Skills Australia. (2009). About us. Retrieved 6th April, 2010, from http://www.skillsaustralia.gov.au/about-us.shtml

Acknowledgements

The work reported in this paper was funded by a USQ Senior Fellowship. The author also acknowledges the assistance of Ms Megan Brodie in gathering and analysing the data.

Copyright statement