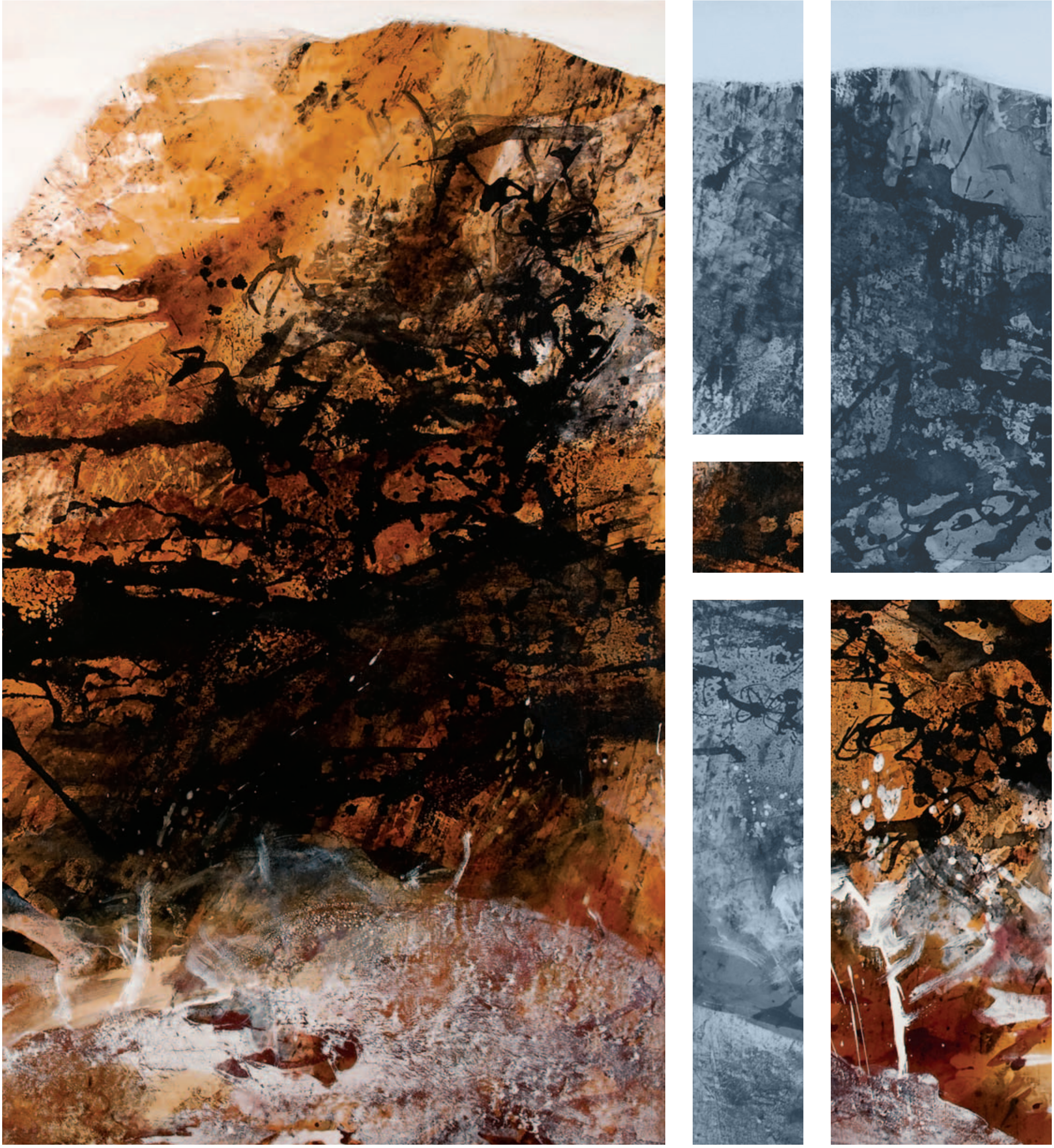


VET and the diffusion and implementation of innovation in the mining, solar energy and computer games sectors

Robert Dalitz
Phillip Toner
Tim Turpin

NCVER MONOGRAPH SERIES 06/2011

NCVER

Australian Government
Department of Education, Employment and Workplace Relations

NCVER Monograph Series

In 2007 the NCVER Board agreed to establish an editorial board to peer-review work commissioned or undertaken by NCVER for publication in a monograph series. Each contribution to the NCVER Monograph Series is subject to peer review by two editorial board members. Research accepted for publication in the NCVER Monograph Series will assist university-based researchers make use of their NCVER published work in the Research Publications Return of the Higher Education Research Data Collection and in Excellence in Research for Australia evaluations.

Cover design using artwork from
'Ngadjuri Country' by Robert Weaver

Mixed media on canvas, two panels

I believe that contemporary drawings and paintings should be visually exciting.

Visually exciting artworks rely heavily on the artist's creativity, spontaneity and use of the unconscious and their interpretation should actively involve the imagination of the viewer.

This approach is based on Surrealist methods and forms the basis of my work – it has been applied to the landscape Ngadjuri Country (the Ngadjuri language group is part of the contemporary Adnyamathanha sphere within the Yunta Region of the Flinders Ranges, South Australia).

This work is from NCVER's collection
which features artwork by VET students.

NCVER

NCVER MONOGRAPH SERIES 06/2011

VET and the diffusion and implementation of innovation in the mining, solar energy and computer games sectors

Robert Dalitz
Phillip Toner
Tim Turpin
CENTRE FOR INDUSTRY AND INNOVATION STUDIES,
UNIVERSITY OF WESTERN SYDNEY

Australian Government
Department of Education, Employment and Workplace Relations

Publisher’s note

To find other material of interest, search VOCED (the UNESCO/NCVER international database <http://www.voced.edu.au>) using the following keywords: case study; education industry relationship; employee; employment; industry; innovation; performance; productivity; research; skill development; skills and knowledge; vocational education and training.

The NVETRE program is based upon priorities approved by ministers with responsibility for vocational education and training (VET). This research aims to improve policy and practice in the VET sector. For further information about the program go to the NCVER website <http://www.ncver.edu.au>. The author/project team was funded to undertake this research via a grant under the NVETRE program. These grants are awarded to organisations through a competitive process, in which NCVER does not participate.

ISSN 1837-0659

ISBN 978 1 921955 14 3 web edition
ISBN 978 1 921955 15 0 print edition

TD/TNC 104.07

Published by NCVER
ABN 87 007 967 311

Level 11, 33 King William Street, Adelaide SA 5000
PO Box 8288 Station Arcade, Adelaide SA 5000, Australia

ph +61 8 8230 8400 fax +61 8 8212 3436
email: ncver@ncver.edu.au
<http://www.ncver.edu.au>
<http://www.ncver.edu.au/publications/2392.html>

About the research

NCVER

VET and the diffusion and implementation of innovation in the mining, solar energy and computer games sector

Robert Dalitz, Phillip Toner, Tim Turpin

Innovation is thought to improve productivity at the firm level and economic prosperity at the national level. This would seem to have implications for the skills and skills development of employees. However, little is known about the relationship between skills development and innovation.

This report is the culmination of case studies exploring the interrelationship between innovation and education and training in three industry sectors—mining, solar energy, and computer gaming.

Key messages

- Each sector experiences differing drivers of innovation and different processes of diffusion, with consequential differences in how the sector relates to the vocational education and training (VET) sector.
- Creative and skilled people are at the heart of the innovation process, so the greatest contribution that formal VET can make is in establishing foundational knowledge and understanding, which build the capacity to learn.
- Informal skills development plays a crucial role in providing the actual skills for innovation (such as using new equipment or processes), although theory learnt in formal education is also important.
- The present model of training packages, and the model of competency-based training which underpins it, have advantages in providing a common skills language but may hinder effective innovation because of the focus on current competencies rather than future innovation.
- VET providers are seen as slow to pick up on innovation.

The messages are a fundamental challenge to the VET sector. They suggest that the focus on the competencies currently required by industry is misplaced—if we think innovation is critical. Rather, more emphasis should be placed on foundational knowledge, theory and building the capacity to learn.

Tom Karmel
Managing Director, NCVER

Contents

Tables and figures 6

Abstract 7

Introduction 8

- How does VET keep up to date with innovations in technology and methods? 9

Links between education and training and innovation systems 11

Patterns of innovation in the three sectors 13

Mining 17

- Introduction 17
- Innovation in mining 18
- The VET workforce in mining 19
- Safety, regulations and the organisation of training 20
- Training in mining 21
- Why mining companies do not use training to improve performance 22
- The training package and connecting actors 23
- Diffusion, implementation and learning 23

Solar energy 25

- Innovation and competition in solar energy 25
- Training in solar energy 26
- The training package and connecting actors 28
- Diffusion, implementation and learning 28

Computer games 30

- The games workforce 30
- Innovation in the games sector 31
- Internal firm learning 33
- Training in computer games 33
- Keeping up with industry innovation 33

Conclusion 34

- How the VET system affects the abilities of individuals and firms in generating, dealing with, and diffusing innovations 35
- How workers learn for innovation 36
- How VET keeps up with innovation 37

References 39

Other publications in the NCVER Monograph Series 41

Appendix 1: Method 42

Appendix 2: Questionnaires 45

Tables and figures

Tables

1	Respondents	9
2	Drivers of innovation, ranking out of 16 sectors	13
3	Types of expenditure for innovation purposes, ranking out of 16 sectors	14
4	Sources of labour for innovation by industry, ranking out of 16 sectors	16
5	Respondents	43

Figures

1	Skills used for innovative activities, % by industry, 2006–07	15
2	Enrolments in courses containing solar-related topics from government-funded training organisations	27

Abstract

Innovation drives the competitiveness of firms and alters workers' knowledge and skills requirements, and so affects the skills development system. The relationship between skills development systems and patterns of innovation in industry is an underdeveloped field of knowledge. This project explores the relationship between innovation and skills development (especially vocational education and training) in three sectors: mining, solar energy and computer games. The research was done using the exploratory case study method, supplementing interviews with statistical and documentary data. The interviews were with firm managers, teachers and trainers, industry bodies, suppliers and others involved in skills development in each of the three sectors.

The study found that each of the three sectors studied displayed different relationships between the education and training system and innovation. The mining sector is characterised by heavy capital investment, Tayloristic training and work organisation, high use of the training package to structure competences for training and labour markets, and a heavy reliance on external labour markets. The solar energy sector is characterised by a booming market, driven by government incentives, regulatory insistence on licensed electricians and accredited workers, a reliance on the established electrotechnology skills system and organisational innovation focused on efficiency. Innovation in the computer games sector is based on creative and highly competent workers, with close interpersonal links between teachers and industry to keep up to date with the rapid rate of technological and market change; individuals adopt self-learning practices to maintain currency in the field.

The formal and informal education and training systems have distinctive roles. The formal education and training system teaches knowledge and skills important for a vocation. Informal education and training (on-the-job specialised training not resulting in a qualification, or experience) lead to the specific skills used in innovation and are often based on the fundamentals learnt in formal education and training. Although skilful and creative individuals are at the heart of innovation, it is firms that structure the array of skills for innovation. Firm strategy, competitive position and innovations lead to firm-specific informal and formal training regimes. However, firms are constrained by the availability of education and training-derived skills.

This study did not find evidence of a set of generic innovation skills, but workers with stronger fundamental knowledge and skills in their vocation were more effective in innovation. Regulations and legislation shape the relationship between innovation and skills development in the mining and solar energy sectors, but not in computer games. In keeping up to date with innovation, teachers used their personal networks, suppliers, publications, conferences and web-based media. There were few industry or government bodies involved in assisting teachers to keep up with innovations. The VET system tends to be slow in responding to new skills needs. This has both positive and negative implications for innovation and economic development.

This project's overall conclusion is that the education and training system (especially VET), from the point of view of innovation, should focus on providing people with the fundamental knowledge and skills for their vocation and the ability to learn and adapt. This serves two purposes: firstly, it supports innovation and so the nation's economic development. Secondly, it provides students with greater employability over time, and thus better wages and career paths.

Introduction

Workforce skills underpin innovation, and innovation also drives skills development. Firms need certain skills to innovate and compete, and innovation itself changes the skill requirements of firms and the number of people needed in each occupation. Ideas to improve firm competiveness have many sources: internal creativity and problem-solving, including R&D; external suppliers of equipment or software; imitation of other firms or talking with customers (Tidd, Bessant & Pavitt 2001). The knowledge and skills[1] of people are central to all these processes (Lazonick 2005). This study uses the Oslo Manual (OECD & Eurostat 2005) definition of innovation: 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations'.[2] The methods used by firms to innovate, and indeed, whether to invest in innovation at all, are a function of a firm's competitive strategy. Firms can compete in a multitude of different ways: through price, quality, service, marketing, and new products and services. The different methods used to source ideas and the many different ways to innovate require a different mix of occupations, skills and knowledge. Even within a given industry, there can be large differences in the ways individual firms choose to compete and innovate and, therefore, differences in occupational structure and training requirements. Innovation by firms alters the scale and content of the skills required, thus affecting the education and training system. Understanding the specifics of the relationships between education and training systems and innovation in particular sectors can assist policy for both skills development and innovation.

Despite the overwhelming agreement on the importance of workforce skills for innovation, there 'is little systematic knowledge about the ways in which the organization of education and training influences the development, diffusion and use of innovations' (Edquist 2005). Correspondingly, we know little about how innovation influences the education and training system. This study aims to improve our understanding by answering the following questions:

- What is the role of VET qualifications and ongoing vocational training in the diffusion and implementation of innovations?
- How does the VET system affect the abilities of individuals and firms in generating, dealing with and diffusing innovations?
- How do workers learn the skills needed for working with new technology and methods?

1 A brief discussion of knowledge and skills and the concomitant learning is presented in the next section.

2 The Oslo Manual divides innovation is into product, process and organisational. Product innovation is expenditure on developing new or improved products or services. Process innovation is expenditure on developing new, or improved production processes. Organisational innovation entails changes designed to improve the performance of the organisation and how people do their work.

How does VET keep up to date with innovations in technology and methods?

Our case study approach is designed to explore the interrelationships between innovation and education and training. The selection of case studies was based on the maturity of each sector and how well each sector is integrated into the education and training system. Mining is a mature sector with long-established linkages; solar energy is a new sector based on the mature electricity sector, with new linkages in an established system; and games is a new sector with developing linkages. The case study approach is well suited to exploratory research aiming to elucidate relationships in such complex systems (Yin 2003).

Data collection was primarily through interviews but also includes statistics and available documents. We conducted 66 semi-structured interviews with teachers, firms, and a range of other stakeholders, as shown in table 1. Our research methods are more fully explained in appendix 1.

Table 1 Respondents

	Mining	Solar energy	Computer games	Other	Total
Firm	12	10	11		33
Teacher*	7	8	9	1	23
Other**	3	6	2		11
Total	**22**	**21*** **	**22**	**1**	**66**

Note: * The term 'teacher' includes all people with a teaching or training role. **Other includes industry skills councils, industry bodies and government bodies. *** Three respondents were both a firm and a teacher.

Our research found that, although each of the three sectors studied had quite different characteristics in their relationships between the education and training system and innovation, the formal and informal education and training systems carried out distinctive roles. The formal education and training system generally aims to produce people qualified according to the Australian Qualifications Framework (AQF). The formal system teaches fundamental knowledge and skills important to the ability to learn, to adapt to change, and to creativity in each vocation. Informal education and training (whether done on the job, through specialised training or through experience) leads to the specific skills often used in innovation, but is usually based on the fundamentals learnt in formal education and training. Firms innovate, not individuals, because it is firms who are the actors who produce the products that are sold in markets and so are the locus for product, process and organisational innovation. Firms structure the array of skills they have to perform innovation and operations as part of their competitive strategies. But firms ultimately rely on individuals to apply their skills, ideas, creativity and knowledge to achieve innovation. Each firm's strategy, competitive position and consequent innovations determine skills needs. In doing so, firms develop proprietary technologies and ways of working, leading to firm-specific informal and formal training regimes. In this we did not find generic innovation skills,[3] but workers with stronger fundamental knowledge and skills in their vocation, which were more effective in innovation. In keeping up to date with innovation, teachers used their personal networks, suppliers, publications, conferences and web-based media, with variations by sector. There were few industry or government bodies involved in assisting teachers to keep up with innovations.

[3] The idea of generic 'innovation skills', common, general and transferable innovation skills that are applicable to all, or most, occupations has been promoted by government, employers, unions and VET policy-makers. There is even a unit of competency (BSBINN501A: Establish systems that support innovation) and a facilitator guide to incorporate innovation skills into all training packages (Innovation and Business Skills Australia 2009).

The implications of these findings are: firstly, that policy should not treat each sector as the same in determining how VET should relate to it; and, secondly, VET should focus on teaching fundamental knowledge and skills, not just current on-the-job competencies. Because each sector uses somewhat different training regimes, has different needs, and varies in the pace of technical change, a single model of how VET relates to industry will be inappropriate. Mechanisms allowing flexibility in how the VET system finds and reacts to industry needs are important. The second implication, that formal VET should focus on teaching fundamentals and assist students to learn how to learn supports the recent review by the Joint Steering Committee of the National Quality Council and the Council of Australian Governments (COAG) Skills and Workforce Development Subgroup, 'to revise the current definition of "competency" to embody the ability to transfer and apply skills and knowledge to new situations and environments' (National Quality Council 2009). Changing the focus of VET from current on-the-job competences to fundamental knowledge and skills may have an impact on some courses and alter industry relationships. The role of informal skills development is important to innovation. Policy-makers should pay attention to the way informal skills development interacts with formal learning. The informal system interacts with the formal system, often providing targeted training not otherwise available by the public system.

The following sections present a distilled analysis of the literature on the linkages between innovation and the education and training system. Following this is a section presenting a comparative analysis of the dynamics of innovation and skills in the three sectors studied, using Australian Bureau of Statistics (ABS) innovation survey data. The discussion on the three case studies follows, with mining being the most complex in detail, followed by solar energy, and then computer games. We then discuss the research and our findings in the conclusion. The method, including questionnaires, is included in the appendices.

Links between education and training and innovation systems

The linkages between VET systems, workforce skills and innovation have been the subject of growing research and policy interest. This topic has also been extensively reviewed and assessed (Warner 1994; Tether et al. 1995; Toner 2011).

Since the nineteenth century high levels of educational attainment have corresponded with strong economic development (Bruland 2002). There are robust linkages between economic development, innovation and skills development systems (Landes 1969; Freeman & Louca 2001; Perez 2002). At its most basic we can say that a better educated nation is more likely to grow faster and thus enjoy a higher standard of living. We do know that there is a relationship between the performance of a nation's education and training system and its industry and trade structure (Prais 1995; Crouch, Finegold & Sako 1999; Hall & Soskice 2001). The interaction between research conducted in universities and its use by firms in innovating has been closely studied (Bekkers & Freitas 2008; Jacobsson 2002), but little work has been done on the role of university education in innovation. Thus, although we know this is a vitally important relationship to economic development and the health of nations, we have very few details about how education and training interact with innovation.

The literature shows that patterns of innovation change over time, along with the industrial structure of economies and skills needs. Many industries follow a life cycle, in which skills change in a predictable manner (Klepper 1997; McGahan, Argyres & Baum 2004; Utterback & Abernathy 1975). Many technical innovations when first introduced onto a market require highly educated workers to produce and operate them, but over time, as the technologies become better understood and more standardised, the level of skill required for their operation declines. As sectors and their associated labour markets grow, distinct occupations emerge and the training system, either internal or external to firms, develops. Thus 'innovation and training in modern economies are inextricably linked' (Warner 1994, p.348). This co-evolution of innovation and skills development introduces time lags, because innovation and skills development systems take time to adjust to one another. Over time innovation changes the content and scale of the skills development system, while skills development drives the ability to innovate and determines which innovations are successful.

Skills needs are poorly articulated in new sectors in particular and there are limited linkages to the formal skills systems (Whittingham 2003; Toner 2005). From the point of view of the VET system, there are inherent difficulties in responding to the needs of developing sectors. Before it can commit resources, the VET sector needs to know, for example, which competing technologies will 'win' or gain market dominance, and there is uncertainty about the demand for training in new technologies and the rate of change in this demand. How should it respond to existing technologies which are being displaced by new ones? Hence, the education system typically has difficulties meeting the specific needs of parts of industry, especially the most innovative areas.

Firms are the central actors in innovation, and so we can expect that how firms innovate will influence skills development and labour markets. In fact, 'the essence of the innovative firm is the organizational integration of a skill base that can engage in collective and cumulative learning (Lazonick 2005, p.34). Firms employ and develop people to gain a certain set of skills, and then structure how these people are organised and managed to support the firm's innovation strategy

(Warner 1994; Lazonick 2005). Firms also imitate one another, meaning that firms in a sector tend to have similar innovation patterns (Lieberman & Asaba 2006; DiMaggio & Powell 1983).

It has been found that certain types of skill development systems support certain modes of innovation to create ecosystems that reinforce certain patterns in innovation and therefore advance (Finegold & Soskice 1988; Hall & Soskice 2001; Crouch, Finegold & Saki 1999; Keep & Mayhew 1999; Prais 1995; Casper, Lehrer & Soskice 1999). The importance of skills development to individual firms is shown by the fact that it has been found that training is associated with higher productivity and technological innovation (Baldwin 1999; Dearden, Reed & van Reeden 2006). Such a relationship is to be expected, as the introduction by a firm of a new or improved product, service or production process usually requires training to be efficiently implemented and adapted. The development of new products, services and production processes also often requires firms to undertake workforce training to enable their workers to keep up to date with the new technologies that underpin their own innovation efforts. However, firms are reliant on the education and training system to which they have access and so are, to varying degrees, limited in what competences they are able to accumulate and organise (Warner 1994; Freeman 1988; Friel 2005).

Underlying the relationship between innovation and education and training is the knowledge, skills and learning of workers who create and perform innovation. By knowledge we mean understanding the information relevant to the subject, and how these pieces of information are organised. By skills we mean the ability to carry out certain tasks and groups of tasks. It is possible to have the knowledge underpinning a task without knowing how to perform the work. Conversely, one may know how to perform tasks without understanding the knowledge underpinning the work. From the innovation perspective both knowledge and skills are required to undertake work and to purposefully change how that work is done. Workers' knowledge and skills are a result of their learning, both in doing a job and their prior education and experience. The existing knowledge and skills that workers bring to their work shapes how they are innovative and how they respond to innovation by others.

Embedded in the definition of innovation is learning. Innovation is attempting to do something new in a commercial context and thus people learn from that innovation. This learning is based on both their prior knowledge and their understanding gained from performing the innovation (Cohen & Levinthal 1994). Pisano (1994) presented a similar issue when he discussed 'learning by doing' and 'learning before doing'. Learning by doing is well known and involves people learning through performing tasks. Learning before doing is where learning is done prior to tasks being undertaken. The purpose of education and training is to provide learning before doing. This means that we should expect an ongoing process of learning for workers and the organisations and networks of which they are a part. This innovation-derived perspective on knowledge and skills is different from the implicit logic of much discussion of education and training, especially competency-based training. In some views of competency-based training, what is learnt should be immediately applicable to the current job. We would expect from the innovation literature that VET would not be different in this regard from any other level of education and training.

This literature provides us with an understanding that there are linkages between innovation and skills development and an understanding of the logic behind how these linkages work. But it does not delve into the details of linkages in different sectors, nor does it provide clarification of specific issues that policy should take into account, or how policy can be shaped to benefit innovation and economic development.

Patterns of innovation in the three sectors

This section compares and contrasts the relative patterns in innovation behaviour and skills issues in each sector using Australian Bureau of Statistics (ABS) innovation survey data. These data are important because they illuminate the fundamental dynamics of the three sectors, showing similarities and differences. As the ABS only specifically identifies the mining sector, we use the electricity, gas, water and waste services sector as a proxy for solar energy, and the information, media and telecommunications sector for the computer games sector. For each data item the ABS reports on 16 industries. The ABS data rank mining fourteenth; electricity, gas, water and waste services thirteenth; and information, media and telecommunications fourth, in terms of the percentage of firms innovating in each of the 16 industries (table 3).

The drivers of innovation, shown in table 2, reveal patterns as to why firms innovate and the imperatives that, in part, drive skills development in each sector. Mining is driven by the need to increase capacity (first) and safety (first) and to improve environmental protection (second). Given the importance of the government in mandating standards in safety and environmental protection, it is not surprising that government regulation (third) is important. Competition is a very low driver of innovation (fifteenth). The latter follows from mining typically producing an undifferentiated commodity, which provides low market drivers for innovation. Mining is also undergoing a major boom, with demand expanding beyond existing supply, so mining companies focus on production volume rather than efficiency.

In the electricity, gas, water and waste services sector competition is a low driver (sixteenth), reflecting in part that the output of the sector is mostly undifferentiated commodities. It is also a highly regulated sector. The most important drivers of innovation are the environment (first); increasing capacity, probably due to increased population in many locations and overall economic growth (second); government regulations (second); adherence to standards (second); and safety (third). These utilities often face some direct regulatory control over pricing, forcing a focus on efficiency (fifth). Solar energy firms in the present study are primarily involved in the installation and maintenance of the infrastructure necessary to produce electricity from the sun, and so are not entirely typical of the electricity, gas, water and waste services industry.

Table 2 Drivers of innovation, ranking out of 16 sectors

	Mining	EGWWS	IMT
Any competition, demand and market-related drivers	15	16	3
Increase efficiency of supplying/delivering goods and/or services	11	5	7
Improve quality of goods or services	16	15	7
Improve IT capabilities or better utilise IT capacity	14	8	1
Increase capacity of production or service provision	1	2	5
Any production or delivery reasons	14	8	4
Reduce environmental impacts	2	1	10
Improve safety or working conditions	1	3	14
In response to government regulations	3	2	15
Adherence to standards	8	2	15

Note: EGWWS = electricity, gas, water and waste services; IMT = information, media and telecommunications.
Source: ABS (2010) and own calculations.

Not surprisingly, the information, media and telecommunications sector is strongly driven by improving IT capabilities (first) and competition (third). Its innovation activity is little driven by environmental (tenth), safety (fourteenth), regulatory (fifteenth) or standards (fifteenth) issues. Information, media and telecommunications firms typically sell a digital product or services in a keenly competitive market, and have few physical, environmental or safety issues. Computer games fit this profile well. Mining and electricity, gas, water and waste services have quite similar drivers, following from both selling undifferentiated commodities and having engineering-intensive production processes. In contrast to the ABS data for electricity, gas, water and waste services, we found competition to be a major driver of innovation and skills development in the solar energy sector.

Table 3 shows the rankings of the proportion of firms spending money on certain innovation-related activities. Out of 16 industries, mining has the highest proportion of firms spending money on equipment for the purpose of introducing an innovation. It has the third highest proportion of firms spending money on process innovation and training related to the introduction of an innovation. The high ranking for research and development is partly explained by the fact that mineral exploration activity is captured under this heading. As expected, it is ranked lowly as a product innovator and, as a seller of undifferentiated commodities, it is the lowest marketing innovator (sixteenth). Electricity, gas, water and waste services has a high intensity of expenditure on equipment (second), intellectual property rights[4] (second), research and development (third), design (fourth) and training (fifth) for innovation. Its focus is on process innovation. Our case results show that the solar energy sector focuses on equipment for process innovation, as it integrates one form of energy generation into the overall electricity system. Information, media and telecommunications is high spending on equipment, marketing, research and development, design, and intellectual property rights and, not unexpectedly, focuses on product innovation. Our case results show the Australian computer games firms have a very similar set of expenditures, except that they rarely get involved in marketing to consumers. Intellectual property rights are very important in information, media and telecommunications, as ownership of the software code, brands and other intellectual property (IP) is often the basis of a company's ability to compete.

Table 3 Types of expenditure for innovation purposes, ranking out of 16 sectors

	Mining	EGWWS	IMT
Equipment	1	2	4
Training	3	5	14
Marketing	16	8	2
Research and development	1	3	5
Design, planning & testing	2	4	1
Intellectual property rights	10	2	1
Product	12	11	1
Process	3	2	9

Source: ABS (2010) and own calculations.

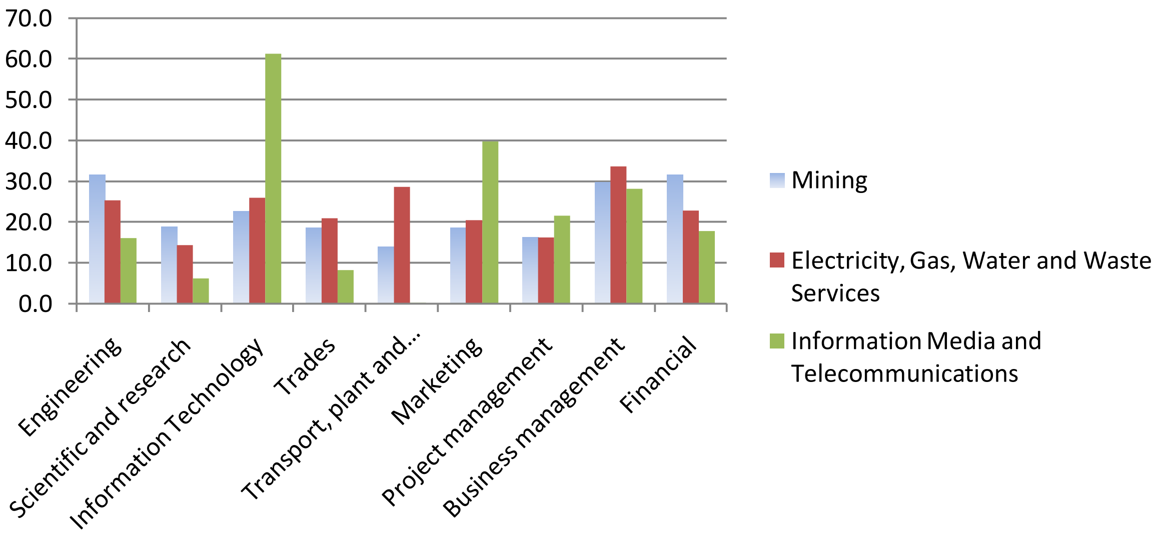
Overall, tables 2 and 3 show that the three sectors have somewhat different innovation profiles, with training an important innovation-related activity in mining and electricity, gas, water and waste services. The mining and electricity, gas, water and waste services sectors are capital-intensive process innovators, with a strong regulatory/safety focus, but little marketing focus. This emphasises the production volume driver of mining, a very important driver in the case study of the relationship between skills development and innovation. The solar energy sector has more

4 IPRs are intellectual property rights, such as patents and trademarks.

direct competition between firms than the overall electricity, gas, water and waste services sector. However, issues of regulations, environment, safety and equipment are a vital concern. Computer games are typical of the information, media and telecommunications sector as a product/competition-focused innovator, innovating using equipment (especially IT), intellectual property rights and marketing, except that there is little contact with the final market and thus less attention on marketing innovation.

The ABS survey also collected data on the skills used for innovative activities (figure 1). Mining and electricity, gas, water and waste services have similar skills for innovation profiles, although mining more intensively uses engineering and financial skills. The electricity, gas, water and waste services sector uses transport plant and machinery skills more intensively due to the large-scale infrastructure required, of which solar energy generation is one part. Noticeably, these sectors use trades skills relatively little in innovation, although these are industries that are strongly represented in trades. The use of IT and marketing is very strong in information, media and telecommunications, reflecting the basis for competition in the sector. Overall, we see that mining and electricity, gas, water and waste services have a similar skills profile for innovation, reflecting the large-scale, capital-intensive, engineering-based production basis of both sectors. Information, media and telecommunications is, for obvious reasons, focused on IT skills for innovation.

Figure 1 Skills used for innovative activities, % by industry, 2006–07



Source: ABS (2010) and own calculations.

Where firms get their skills for innovation is shown in table 4. Mining has the strongest reliance on external people, either new employees or contractors. This fact is important in the case study analysis that follows. The electricity, gas, water and waste services sector has a strong reliance on new employees, but is moderate for contractors or existing employees. The information, media and telecommunications is the sector most reliant on existing employees for innovation. This follows from each firm producing a specialised product, often with a distinctive set of software tools, thus requiring people experienced in the idiosyncrasies of the firm's operations to facilitate innovation. The data indicate a continuum from mining, which is strongly reliant on external skills for innovation, through electricity, gas, water and waste services, to information, media and telecommunications having a very strong reliance on internal skills. These dynamics will be further explored in the following sections where sectoral cases are analysed.

Table 4 Sources of labour for innovation by industry, ranking out of 16 sectors

	Mining	EGWWS	IMT
Existing employees	15	10	1
Any new employees	2	4	14
Contracted organisations	1	10	8

Source: ABS (2010) and own calculations.

From the comparative data presented in this section we can see the three sectors have different innovation and skills dynamics. Although mining and electricity, gas, water and waste services are similar in many ways, there are important structural differences in the mode of competition and how the firms source their skills for innovation. Both of these sectors produce undifferentiated commodities through large-scale engineering processes. Their innovation is focused overwhelmingly on process innovation designed to increase capacity. As shown in table 2 the mining sector's attention is squarely on increasing production through new mines and extensions to existing ones, with little focus on improved efficiency. The electricity, gas, water and waste services sector innovates to a somewhat greater degree to increase efficiency compared with mining. Innovation in both the mining and electricity, gas, water and waste services sectors is guided by government, regulatory, safety and environmental issues, shaping training and skills needs. Information, media and telecommunications is a product innovator focused on IT, with little attention on regulations and with strong internal skills for innovation. Significant labour market differences exist regarding innovation, showing the relative importance of transferable skills. Mining's high reliance on external sources of expertise is reflected in the case study results. The electricity, gas, water and waste services sector is moderately reliant on both external and internal expertise sources. The information, media and telecommunications sector represents something of a paradox, as it is the most reliant of all 16 industries on internal expertise for innovation, but information, media and telecommunications firms are much less likely than other firms to spend money on training to introduce an innovation. This paradox is taken up later.

Mining

Introduction

Mining is a large, diversified and complex sector, involving exploration, mine construction ore extraction and basic processing. It is Australia's largest export sector. Our research focused on the operation of mines, not exploration or construction of mines. This was due to mining-specific VET training being predominantly on mine operations and to provide clarity for the case. Respondents included industry bodies, SkillsDMC (the relevant industry skills council), trainers, equipment suppliers, mining companies (human resources and training managers) and contract miners. Australian mining companies are among the largest firms in the world, and operate very large mines, often in remote areas, as well as large-scale processing facilities, railways and ports. These large mining companies have a portfolio of mines across the globe. There are also many smaller firms that operate smaller mines as standalone projects. There is also a wide array of technology suppliers, consultants and contract miners. The mining sector is undergoing a boom, whereby demand exceeds available supply.[5] As a consequence the strategic focus of firms is primarily on increasing output through new mines and infrastructure rather than improving efficiency, as previously shown in our analysis of the ABS innovation survey data.

Statistics on skills and labour markets in the mining sector provide a useful backdrop to the dynamics between skills and innovation. The mining industry invests 2.3% of gross wages and salaries on training, more money per employee than any other industry (NCVER 2008). The proportion of mining firms providing training has increased over time, to 96% providing training in 2006–07, with 82.7% through the VET system, 45.8% with unaccredited training and 88.1% with informal training. The mining industry had 28.2% of employees with certificate III or IV, compared with 17% for all industries. There is relatively high job mobility in the mining industry, with an average of 27.7% of workers having been in their job for less than a year compared with 21.3% for all industries. Labour turnover of up to 85% for some mine sites has also been reported (National Resources Sector Employment Taskforce 2010). Although the high investment in training is reported by NCVER (2008) to reflect a strong desire to upskill workers, our research suggests that high turnover and legislative requirements are also significant drivers. The mining industry faces a current skills shortage and is projected to have a shortfall of over 60 000 suitable employees into the near future (National Resources Sector Employment Taskforce 2010). According to the latest census data, the mining workforce is comprised of approximately 25% managers and professionals, 25% technicians and trades workers and 40% operators and labourers. The majority of VET-trained people are in the technician and trades, and machinery operators and driver occupations. University-qualified people are generally managers and professionals. Certificates III and IV dominate the VET-qualified workers. As shown previously, the skills involved in innovation in mining are largely those of engineering, business management and finance. This follows from the

[5] Demand has grown more rapidly than mine production volumes, leading to large price rises for ore. This means that previously marginal mines are now profitable, and the mining companies are trying to build and start operation of these mines. Additionally, the large-scale infrastructure required for mining operations and export of ore has to be augmented or built. All of will take years before production increases to match recent demand rises.

large-scale and heavy engineering nature of mining production operations, and the need for control over the management and finances for these operations, as shown later. Although engineering drives much of the innovation in mine operation, the greatest area of training activity related to this innovation is for operators, as discussed below. Operators have competences for dump truck driving, operation of specific mining and extraction equipment and so on. Thus, the statistics show that mining provides a great deal of training by comparison with other sectors, has increasing skills shortages and a strong relationship with the VET system.

Innovation in mining

Process innovation dominates innovation in mining operations because the product is typically a commodity with little scope for product differentiation. Mining operations are often on a large scale, and frequently part of a much larger corporate mining portfolio. The design of mines is centralised and done by professional engineers. Mine operations are run by a small core of professionals at each mine site. This division in innovation responsibility between corporate areas and mine sites was described by a mining company manager:

> we've got technical people who are looking at greenhouse, who are looking [at] gas plants, methane gas plants, and big picture stuff. The operational stuff tends to be left to the mine sites.

The amount and type of innovation in a mine varies greatly by site. Some smaller mines are one-off projects, with limited innovation, as mine design specifies equipment and methods for the mine's duration. Some mines are large-scale investments of billions of dollars and can involve the establishment of major infrastructure and have an economic life of many decades. These large mines have a greater incentive to improve operations over time, potentially allowing internal learning and transfer of best practice. These results derived from respondents accord well with the ABS statistical data shown previously. As a senior training manager of one of the largest mining companies said:

> innovation tends to create an impression that we need a quantum leap or a shift in paradigm. And I don't believe that's a requirement to what we try to do in the mining industry.

Training managers and trainers for equipment suppliers explained that innovation in mining operations comes in mainly through new process equipment, employing a structured training pathway from new equipment through to operator training. Selection of new equipment typically involves mining company engineers and lead operators. As part of the purchase, the equipment producer develops training materials and provides training to key operators and trainers in the mining company. These key operators and trainers then train other operators, and the equipment becomes embedded into ongoing operations. Through this process new equipment is introduced, which allows for improved productivity or a new way to perform certain operations.

The common use of the training package in this process links the formal VET system through new equipment, and training for that equipment, to innovation. As discussed below, the mining sector training package provides a template for the development of training materials and training provision, and assists mining firms in coordinating their skills development to innovation and labour markets, without being heavily involved with the public VET providers (especially TAFE). Consequently, innovation in operations comes about primarily through changes in equipment, and, secondarily, in operational methods. A few of the larger mining companies use training for continuous improvement of operations, but this is rare. Most mines simply use training to meet regulatory obligations, to assist in safe operations, and to ensure workers meet minimum standards of personal competence.

The VET workforce in mining

The VET workforce is split into two areas in mining operations: traditional trades and operators. Respondents were somewhat critical of what they saw as an excessive emphasis of the VET system and government incentives on traditional trades rather than on operator training and other job-specific training. As the training manager of one of the largest mining companies said, although trades training takes up a large proportion of his time:

> you just cannot refer to training in our business and the relevance of the maintenance trade and apprentices, it's just such a small drop in the bucket of what we do, it's just about irrelevant. That's the only training that is visible to State and Federal Governments.

This clash between the training needs of mining firms and the structure of formal VET policy re-occurred throughout the research. For mining companies operator training is a more important training focus than trades, because the standard trades system produces suitably skilled workers.

The traditional trades, especially electricians and fitters and turners, provide maintenance for the mining operations. Training managers reported that the traditional trades just need a top-up in mining-specific technologies to be suitable for work in mines, usually through specialised private suppliers. A mining company training manager explained:

> obtaining a trade certificate is your minimum standard to enter a trade. The problem is you [have] then got to use that knowledge … adapt it to the workplace and the equipment that you're working on. The best example there is that if you learnt how to be heavy equipment fitter on a Caterpillar haul truck at the Caterpillar dealer, no possible way that you can use those skills, out on one of our mine sites where the fleet is all electric drive.

Training and human resources managers in the mining firms said the management of trades apprentices and ongoing training of licensed tradespeople costs a lot of money and takes a great deal of time, in terms of meeting government and TAFE requirements. However, although trades training is a major cost, it is not the main training focus, because the mining companies can rely on external labour markets to get qualified trades workers. They then use primarily external specialised training providers to supply training in mine-specific technologies and practices.

Operators are the main focus of skills development because they require job and equipment-specific skills that reflect the firm's structure, practices and innovations. The firms cannot rely on external providers to produce overarching fundamental knowledge and skills for operators the same way they can for trades workers. When asked, SkillsDMC, trainers and training managers stated that, in terms of the underlying dynamics driving training, there was little difference between the various modes of mining, underground and above ground, or in the type of mines, coal and metalliferous, or even in specific jobs. Thus the research didn't try to focus on one particular type of mine or job. The aims of operator training are to ensure that workers have the competences to safely operate specific types of machinery to perform certain jobs.

Entering the mining workforce is difficult due to the stringent personal requirements and attitudes across the sector. Operators work long hours in repetitive jobs in remote locations, and the firms have strict rules about issues such as alcohol and drugs, attendance at work and obeying rules in the mine. The firms have found that many people cannot work to these requirements and so the mining companies are conservative about taking people on who are new to the mining industry. Typically, the larger mining companies will only take on Indigenous people or those already known to mine workers. There is also a focus on rural people who are familiar with working with heavy equipment and who are comfortable with remote locations. This situation is problematic with a rapidly expanding workforce, where large numbers of new, 'green', entrants are required (Minerals Council of Australia 2006). The mining companies' solution to this is to 'buy in' skills. (This is discussed in more detail later.) Entry for individuals to the mining sector is usually through mining contractors and smaller, more marginal mines. The larger and better resourced mining companies

then offer higher wages and better conditions to get experienced operators with specific competences and tickets. Other routes into the mining sector are moving from another sector with similar competences, such as from quarrying, or the 'importation' of workers from overseas.

All respondents said that the mining companies' primary concern in operator training was that they achieve specific competences and associated tickets. There is much less emphasis, in general, given to the attainment of whole qualifications under the AQF. Training and certification is aimed at the tasks required to do certain roles, which correspond with the competences in the training package. Often associated with attaining a specific competence is a ticket or certification that legally allows that person to operate a certain type of equipment, or perform a specific job. As a training manager said:

> you got to have a national ticket for operating a crane, or for operating a forklift or an elevated work platform. So we will go to a private training provider to train people, but that private supplier must be an RTO and must be able to issue the national work safe license.

Once a worker has a ticket and experience in a job, they are generally accepted throughout the mining sector as competent. Supervisory roles legislatively require certain qualifications, forcing training for managerial levels in mining operations. A comment by a training manager typical of all large mining companies is that:

> we're not particularly interested in giving our staff the nationally recognised certificates, unless there's something in it for us. Now one of the benefits of giving nationally recognised certification is retention. We can lock guys up for couple of years to give them a Cert. III.

As a training manager, who is also involved with SkillsDMC, said, 'a lot of the training we have to do to comply with company standards, we have to comply with State and Federal law, we have to comply with our duty of care and therefore the training is predominantly targeted around giving us a license to operate'.

Safety, regulations and the organisation of training

Once a mine is set up, safety becomes the paramount driver of training. This is because it is legislatively required that mines operate in a safe manner, and training is seen as an important factor by the regulator. Although each state and type of mine has slightly different specific requirements regarding safety, the mine site manager generally has direct responsibility for safety at that mine site, and the mine's licence to operate is reliant on safe operation. Safety training is essential to a licence to operate for a mine and to safeguard managers from prosecution, as well as to minimise stoppages due to safety incidents.

Private training providers claimed that there is a great variability between mining companies in their attitude to training and safety. For some, especially small mining companies, the focus is on compliance with legislation and regulations. In this case training is simply a matter of 'ticking the box', according to trainers. For some mining companies safety is integrated throughout their operations as a focal point for improving the efficiency of operations. In all cases everyone working on a mine site must have safety training for that mine site and for any equipment they operate. Combined with the high turnover of personnel in the mining sector, this leads to very high levels of training aimed at safety induction for people coming onto sites and operating equipment new to them. Although we could not find figures for this aspect of training, respondents indicated that it can dominate training provision.

Training in mining

Most training of operators is done through the mining companies themselves and specialised private training providers. This is driven by an array of factors, especially that the knowledge and capital equipment required for training largely resides within the mining firms themselves. Furthermore, the mining companies want training to be on site (often in remote locations), and flexible in timing, so as to not disrupt production. This means that other potential training providers, especially TAFE institutes, cannot provide the 'right' equipment or people with up-to-date knowledge specific to that equipment at the suitable time and place. A senior mining training manager said of TAFE:

> there's no way they can compete with the mining industry in salaries and remuneration for their staff. Therefore, they simply cannot provide the service, regardless of the programs they've got … The second thing is our operations run 24/7 and 52 weeks a year, we do not shut down. We need to train people on back shifts, night shifts, over weekends.

Safety drives most training, because of regulatory compliance and the high-risk environment, as discussed above. Responsibility for safety is carried by the mine manager at each mine and so each mine customises training to the specific requirements of each mine. Although the Mining Industry Skills Centre in Queensland has developed the GI training program[6] to provide for a 'transportable' safety induction between mine sites, it has yet to become an industry standard. Differences between mine sites and types of mines, as well as local control over training, mean that most mines conduct their own idiosyncratic safety induction and operational training.

Even the biggest companies have fragmented training regimes. For example, a training manager in a large mining company said he had about 40 people directly reporting to him, but:

> there're another 95 full-time training roles sitting out in the business that do not report in through my structure. And to a certain extent, most of those positions don't even have a dotted line through to my structure, and so there's a little bit of dysfunctionality … Then [there are] the on-job trainers, of which there is another 300 to 400 out there, so there could be up to 500 employees in our business [who are] involved in training at any one time.

Even in this firm, which had one of the strongest central training structures of our mining respondents, about 90% of all training personnel are local and independent of central control. Another large mining company only had one human resources manager in corporate managing training, but each mine site had a full training staff. The corporate manager then coordinates interaction between mine sites to spread best practice and standardise training. This means that training is linked to innovation by adapting training to the specific operational needs of each mine.

Trainers consistently referred to the need to teach 'theory' before operators become competent. A trainer of dump truck drivers explained that 'theory' covered how trucks worked, how to drive them in mines, and the logic of mining operations, because, although 'anyone can drive a car and trucks aren't much different, easier in some ways', the drivers should know how to operate the trucks to maximise productivity, reduce maintenance and improve safety. As operators move on to more complex roles and pieces of equipment, they obtain more competences and a better understanding of how the mine works, in both the abstract and practical senses. Understanding the theory behind the operation of specific types of equipment and how mines work allows workers to adapt more quickly and effectively to new equipment and practices. This adaptability is important because of the frequent introduction of new technology, and the fluid movement of workers in the sector means that people face new situations regularly.

---

[6] GI means Generic Induction.

Mining contractors

Most mines are either run by or have large numbers of contractors. According to respondents, most workers in the mining industry are contractors, although this varied by mine site. These contractors get the standard safety induction and site training for each mine. However, training to improve operational performance is typically up to the contactor. Contract mining company respondents said that there were two standard approaches to employing contract miners. Many smaller and less financially viable mines prefer the cheapest tender, which limits the ability to train. Many of the larger more profitable mining companies focus on incentives for performance in operating the mine. Consequently, the contract mining companies essentially have two routes, a cheap no-frills model, or a model of efficiency and improvement. The cheap route involves employing less expensive labour, usually less experienced people, with only the minimal training as required by legislation, regulations and contracts. This cheap mining contracting route limits innovation and associated skill development. Often workers enter the industry through these cheap contractors and as they gain experience move on to other contractors or work directly for mining companies.

The other route for contract miners involves employing and trying to retain good workers, and continually developing their productivity. These contract mining companies try to transfer best practice, purchase more productive equipment and improve. They usually have a small central corporate group that supports innovation and operations and employs contract labour as needed. These firms tend to follow leaders in the industry globally, and innovation is squarely aimed at improving productivity.

Contractor workers are often poached by the mining companies, which a training manager at a large mining company said was a deliberate approach because of its low cost and risk. This means that contractors face another problem: if they develop their people 'too' well, they may lose them to mining companies that can pay more.

Why mining companies do not use training to improve performance

The rationale for why most companies are not strongly focused on using training to improve mining practice is multifaceted: for cultural, labour market, and commercial reasons. Culturally, mining companies are focused on technology and equipment and adopt a 'buy it in' approach. Training and human resources managers talked of how the focus on technology and equipment leads to a diminution of attention on people. A training manager at a large mining company said: 'they're all engineers and they only understand technology, not people'.

Virtually all respondents talked of the tendency of the mining companies to buy in things they do not possess, especially skilled people. The phrase 'buy in' or 'buy it in' was repeatedly used to describe the attitude of the mining sector to the development of new resources, such as technology or people. This means that mining companies will look externally for expertise when needed. This is reflected in the ABS innovation statistics previously shown, where mining was ranked second for using new employees and first for using contracted organisations as sources of labour for innovation, while being fifteenth of the 16 industries in using existing employees. Some respondents in the mining companies are frustrated by this approach because it means that the company rarely invests in developing resources, whether they are technological or human resources. Culturally, the 'buy it in' approach means that training for innovation is seen as unnecessary, as long as the company can acquire suitable people through higher wages and/or better work conditions.

Alongside this is the current mining skills shortage and associated fluidity of labour markets. Training people makes them more valuable to other firms, who then buy in these skills, boosting

wages and disrupting the ongoing improvement associated with incremental workforce skills development. As stated above, employee turnover is about 27% overall, and ranges up to 85%. Thus training beyond a certain standard can easily be thought of as self-defeating, as operators move to more lucrative jobs. Larger mining companies 'poach' workers from mining contractors, smaller mines, other industries and import skilled labour. Most respondents talked of how workers in mining are attracted to other employers through higher wages and/or better working conditions. The National Resources Sector Employment Taskforce (2010) noted that 'companies have resolved their labour needs by outbidding each other in the market place'. The large number of tradespeople required by mining is largely filled by attracting tradespeople from other industries. Some respondents said that, if necessary, they would import operators from overseas, such as dump truck drivers, rather than training them up from scratch. As discussed, it is difficult for people to enter the mining industry, due to the stringent requirements and the reluctance of mines to take on 'green' staff.

Finally, in the current boom conditions the mining industry is focused on expanding capacity as quickly as possible or increasing production to 'get the good stuff out of the ground'. This means that the core of making profits, currently, is about finding and exploiting ore bodies rather than improving ongoing operations. The ABS innovation statistics, shown above, show that the mining sector is first of all sectors in the driver of innovation being to *increase capacity of production or service provision*, but eleventh in terms of efficiency as an innovation driver.

The training package and connecting actors

The mining industry training package was used by respondents as a template for training and assessing the competences of workers. The training package is developed by SkillsDMC, the industry skills council for the civil construction, mining and quarrying sectors. SkillsDMC has representatives of all important stakeholder groups involved in the development of the training package. Actors include industry bodies, trainers, equipment suppliers, mining companies and contract miners. All respondents involved with SkillsDMC stated that the training package accurately reflects the competences required to undertake mine operator jobs. The competences required for specific jobs are mapped against the training package, and so both training and employability are structured by the training package. The training package provides clarity in qualification pathways and allows the creation of pooled labour markets. The high mobility of labour in the mining sector is facilitated by employers having a single structure of competences to map jobs against.

There are many other organisations involved in the relationship between the education and training system and the mining sector, such as the Mining Industry Skills Centre and the Mining Council, that provide research and advice about mining skills. These groups connect the various players and inform policy and the firms. However, the mining firms tend to operate as competitors in the skills arena, except in a few areas such as undergraduate and postgraduate university degrees, where sector-wide cooperative initiatives have been set up (National Resources Sector Employment Taskforce 2010). Training managers at the largest mining companies said that they provided support to TAFE institutes and other educational infrastructure in rural and remote areas, because the companies felt an obligation to give something back to the region and it helped in staff retention.

Diffusion, implementation and learning

Innovations are mainly realised through improvements to the performance of new equipment and software bought by mining companies and contractors. Diffusion of these innovations follows a clear path from equipment suppliers, who produce manuals and provide training to lead operators and

trainers in mining companies, who in turn train operators. This process is increasingly linked to the VET system through training packages. Training is tightly linked to safety and regulatory compliance.

A finding specific to the mining sector is that the widely acknowledged skills shortage it faces is partially due to the way people enter the sector. Firms want experienced people and the main routes for new entrants into mining are through either being Indigenous or knowing current mine workers. The larger and wealthier firms most capable of training new entrants are the least likely to take 'green' workers. It is possible that a government–industry partnership aimed at expanding the existing situation of some specialist firms providing training to people wanting to enter the sector could alleviate the skills shortage into the future.

Solar energy

This research focuses on the installation of solar photovoltaic (PV) panels and electricity production from PV cells. Government incentives have moved the sector from a focus on standalone remote area power sources (RAPS) towards 'grid connect', where the PV cells produce power that is put back into the main electricity grid. Grid connect is now the major market area and is the focus of this research. It is also a heavily regulated sector. The manufacture of PV cells in Australia is a minor aspect of the industry and was not researched. Respondents included solar energy company managers, teachers at registered training organisations and universities, EE-OZ (the relevant industry skills council), and industry bodies. Over the last few years the industry has grown rapidly, mainly driven by government incentives stimulating demand. Currently, solar energy is not cost-competitive with traditional electricity sources, but it is predicted that by about 2020 solar energy will become cost-competitive with traditional electricity sources without government assistance (European Photovoltaic Industry Association & A.T. Kearney 2009).

Incentive and regulatory schemes lie at the core of the relationship between the education and training system and innovation in the solar energy sector. The major drivers for training are, first, government incentives, which require installations to be done by installers certified by the Clean Energy Council (CEC). Second, the legal requirement is that connection to the grid is to be done by a trade-qualified electrician. Government incentives for installation and feed-in tariffs led to a boom in the sector, increasing the demand for people accredited by the Clean Energy Council and licensed electricians. Thus licensing and accreditation drives the relationship between innovation and education and training in solar energy. Only suitably licensed electricians can connect a house to the mains electricity grid. Grid-connect solar energy companies must employ a licensed electrician either directly or as a contractor. This links solar energy companies to the electrician apprenticeship system. The regulators who provide licences use apprenticeships as their basis for licensing. To access government incentives the design and installation of PV systems must be signed off by a person accredited by the Clean Energy Council. The council does not require this to be a licensed electrician. Thus, some of the firms we spoke to were managed by a non-electrician with accreditation, who signed off on the designs and installations. All grid-connect solar energy firms must manage their skills profile to include accredited workers and licensed electricians.

Innovation and competition in solar energy

Innovation in solar energy firms includes regularly incorporating incremental improvements in technology and organisational innovation to reduce costs. The core PV technology (silicon on glass) has been stable for decades. There are many alternative technologies being researched, but according to all respondents, none is yet commercially viable. Other technologies in the solar energy system such as inverters have undergone considerable change. This ongoing technological change has improved the efficiency of electricity production from PV cells. Firms incorporate these improved technologies mainly through internal expertise, but also use supplier training and training materials. This technological innovation is relatively easy to adapt to as long as the firms have a strong understanding of the fundamentals of electrotechnology. Firms try to differentiate themselves into either high-quality or low-cost through their use of more or less expensive PV equipment. (Many consumers rely on the installation company to also supply the PV unit and

associated equipment.) The low-cost business model attempts to minimise the apparent up-front cost to the consumer. The high-quality business model aims at less cost-sensitive consumers and tries to maximise the system performance over its designed life. Low-cost producers use lower-quality equipment and cheaper labour, which, given that warranties range up to 20 years, means that the firms face long-run costs of warranty claims. In addition, the customers of low-cost installers are very cost-sensitive, and reductions in government incentives and the removal of the previous rebate scheme mean their sales are likely to be very volatile. However, the low-cost producers have forced widespread cost-based competition.

The main current driver of competitiveness for solar energy firms is organisational innovation driving down costs. Much of the cost for PV installations is labour costs, especially for electricians. This has led to firms both outsourcing and directly employing electricians. Small-scale firms cannot keep an electrician working full-time, and so they typically outsource. As firms grow larger, they can employ electricians full-time on the installation and connection of systems, which costs less than using contractors. However, some firms have used outsourcing as a way to grow large. By being a sales and design firm and outsourcing installation and connection, firms can rapidly grow to a large size, often national in scale. Each installation requires a small team of one electrician and one or two unskilled staff working autonomously. A company manager said that: 'about half an hour's work really requires the electrician's skills, but they have to be on site anyway, so you use them to do the lifting and installing'.

This has led to many electricians entering the sector as contractors, some working to a firm with accredited staff or gaining their own Clean Energy Council accreditation. Household installations usually use modular technology, user-friendly design software and low-skilled labour for installations, aside from on-site electricians, according to solar company respondents. Large installations are usually one-off and require a higher level of skills and knowledge to cater for the peculiarities of the installation and issues brought about by scale. Such installations are currently a small market segment. Many firms have focused on improving their efficiency through workforce management and the planning and development of techniques to undertake installations more rapidly. The general manager of one solar energy firm said that: 'some competitors have managed to get two or even three installations per day, where it used to be one'.

This massive increase in efficiency lowers costs dramatically and requires careful design and management, including a great deal of on-the-job training.

Training in solar energy

There are two main routes to formal VET training in solar energy. A certificate III or higher in renewable energy is intended to enable non-electricians to undertake design of PV installations and gain Clean Energy Council accreditation. Trade-qualified electricians can undertake post-trade qualifications in design and/or installation of PV systems, needed for accreditation. Non-electricians cannot do connections to the grid, but engineers and others often do the more complex design work. Non-electricians undertaking design, or getting accreditation to sign off on installations, require grounding in the theory of electricity as well as solar energy specifics, usually through the VET courses on renewable energy. Consequently, the core skills in this sector are VET-derived, but increasingly engineers are involved in design and management. Figure 2 shows the dramatic rise in people undertaking courses that contain renewable energy components at the certificate III level, that is associated with the specialised renewable energy qualification and electrician apprenticeships.

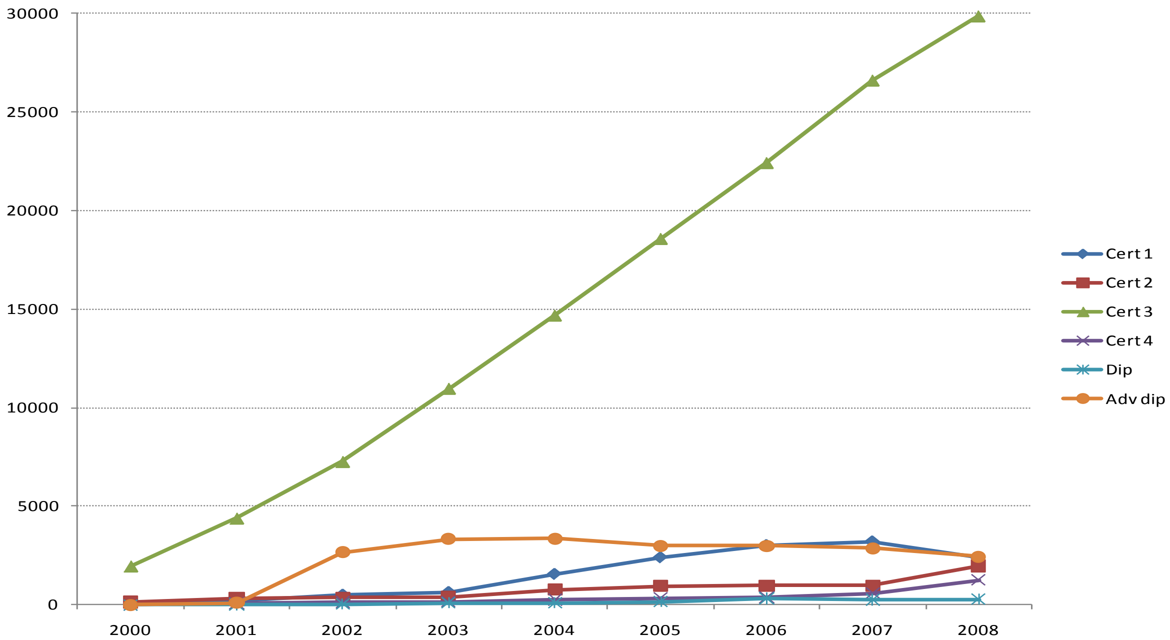
These courses are typically taught through a TAFE institute or industry body registered training organisation. These institutions have the required infrastructure and teachers because of their delivery of off-the-job training to electrical apprentices. The teaching bodies employ teachers

currently working for solar energy companies to bring knowledge of current industry practice and products to the courses. As a head teacher for a solar energy course at a TAFE said:

> we rely on our teachers who are skilled professionals from industry. We try always to keep ourselves abreast of current practices by making sure that we maintain our ties with industry.

The teachers we interviewed who also work in industry said that they gained useful knowledge and contacts from teaching the courses. This is because many students currently undertake PV installations and so provide useful information on current industry practices and technologies. The students do the courses to gain Clean Energy Council accreditation and usually find that the training helps them to do the work more efficiently. The short courses are targeted at Clean Energy Council requirements and are done by licensed electricians. Currently, some electrician apprenticeship teachers are doing the established renewable energy courses so that they can teach this to apprentices.[7]

Figure 2 Enrolments in courses containing solar-related topics from government-funded training organisations



Note: The figure shows for each qualification level the number of courses enrolled in each year that incorporated 'solar', 'renewable' or 'PV' in the course description.

Source: NCVER, unpublished data.

To teach a renewable energy course the teaching body is required to have infrastructure for solar installations. Almost all of the teachers we interviewed use training materials originally developed by the Brisbane North Institute of TAFE. These provide good basic coverage of solar content. To teach these courses the registered training organisations have had to acquire the full equipment for solar cell installations. These organisations thus have up-to-date equipment and contacts with industry as a by-product.

---

7 This will probably make the link between teaching and industry less close, as most electrician apprentice teachers are full-time professionals, and renewable energy is a minor part in the entire apprenticeship. However, this was only just occurring during the research, and so the effects of the inclusion of renewable energy into the core of the electricians' apprenticeship are not yet clear.

Most managers of solar firms said that they provided training, mostly on-the-job training provided by experienced workers, with occasional formal internal training. Supplier manuals for new technology are also used, but as one firm respondent said: 'they aren't much use, you learn more playing with it to work it out'.

This ongoing learning is based on people's fundamental knowledge of electrotechnology. The workers assisting installations only do lifting and shifting under supervision and so 'any reasonably fit and strong person can do it', according to a manager of a solar company.

Innovation in the solar energy sector is reliant on the widespread availability of people with good fundamental electrotechnology knowledge and skills. Because the electrotechnology regulators license electricians to practise they have great sway over the development of training packages and qualifications. The regulators we interviewed gave high priority to electricians acquiring a broad understanding of electrotechnology theory so that they can learn how to work with a broad range of technologies, industries and innovations. The other players we talked to, EE-OZ, the unions, and employers all support this approach for focusing on general, rather than job-specific, knowledge and skills.

Electricians only require a few additional competences to those gained in their apprenticeships to become proficient in solar energy. Solar-specific areas include low voltage, inverters and installation design. This means that the solar sector faces a large labour market of skilled workers relatively easily trained to high standards, rather than having to develop a pool of skilled labour from scratch.

The training package and connecting actors

The links between training package development, teaching and industry are through general electrotechnology mechanisms and some renewable energy-specific organisations. The general electrotechnology area has strong and well-established linkages between industry, industry skills councils, training, providers and other bodies such as regulators. There are also some solar-specific organisations: the Clean Energy Council and the Appropriate Technology Retailers Association of Australia (ATRAA). Central to this relationship is the electrical apprenticeship system, because only licensed electricians are allowed to perform many electrotechnology tasks such as grid connection. Therefore, solar energy training and firm activities are guided by the general electrotechnology regulatory and administrative system.

Renewable energy generation has moved from being a small activity of minor importance to the major electricity utilities, to an important issue and vital future concern. Renewable energy subjects have for the first time been included as core units in the latest release of the electricians training package, which will begin to be widely taught in 2011. This moves the entire renewable energy area into the established heart of the VET electrical apprenticeship system. As grid-connect solar energy grows, it becomes more important to the established electrotechnology actors and thus more tightly linked to the established training system.

Diffusion, implementation and learning

Regulations and the government drive the solar energy sector to a reliance on the electrical apprenticeship system and renewable energy-specific VET training. This supports the diffusion of innovation by providing workers with the fundamental knowledge and skills to learn and innovate. This type of innovation is supported by pooled labour markets and the ability of electricians to learn solar energy competences relatively easily. Once the basic skills are learnt, workers tend to be able to deal with the slow and steady pace of innovation diffusion in the sector. The VET system keeps up to date with innovations by employing teachers working in the solar sector and forming linkages with solar companies, through equipment purchases and other contacts.

It was also found that, at the level of the firm engaged in the design and installation of PV units, organisational innovation is just as important as technological innovation. Improvements by firms to activities such as scheduling and planning lead to significant increases in the efficiency of installations. Such improvements underpin cost reductions, profitability and price competitiveness. Almost all technological innovation is developed by suppliers and embodied in incremental improvements to PV equipment, a factor that reinforces the fact that the focus of firms is on organisational innovation by firms. Most, if not all firms have access to this latest technology, so that it is difficult for firms to gain a sustained competitive advantage through access to technological innovations alone.

Computer games

The computer games sector involves the development of interactive entertainment software. Global sales of computer games exceed those of the film industry. Respondents were from both traditional and 'serious' computer games firms, Innovation and Business Skills Australia (IBSA, the relevant industry skills council), private and public registered training organisations, universities and industry associations and bodies. The games industry in Australia is comparatively small, with, at the end of 2007, 49 commercial operations employing 1431 people (ABS 2008).The core of the sector in Australia is firms developing games for the foreign publishers who own the brands, characters and events that constitute the intellectual property (IP) for a game. Alongside this are 'serious games', whose purpose is not entertainment per se. These sorts of games are used for simulation and as organisational aids, for example, organisations achieving their goals more effectively through simulation and training, using games. These 'serious games' are used in a wide range of industries and applications, including defence, mining, marketing, films, training, real estate and urban design.

The games workforce

The games sector's primary fields of expertise are artists (34.3%), programmers (29.1%), management (14.8%), designers (9.5%), quality assurance (7.3%) and other technical staff (5%) (ABS 2008). Formal courses are primarily divided between art and programming, with design being an emerging specialisation. Programmers write the code that allows the games to be produced and run on computers. Artists create the graphics that provide the game with its look and feel. Designers develop the internal structure of the game and the rules that it follows. Of the core states in the games sector, Victoria and New South Wales (including the Australian Capital Territory) support both VET and university courses, while Queensland has only university level. Entry-level education is moving from the VET level toward the university level. The expanded education and training system has created a set of pooled labour markets with people having skills in various professions and, within those, in various tools and types of games. This is important in allowing firms to grow and shrink as projects move from initiation, through major production to the end. Currently, the major slump in the sector, induced by the Global Financial Crisis and the rising Australian dollar, is causing an increase in the availability of experienced people and a decrease in the ability of firms to hire. Offsetting this to some degree is an ongoing increase in the use of games skills in areas outside the production of traditional entertainment games, especially 'serious' games, as noted above. Teachers are well aware of this and many train the students to have more generic skills, allowing them to move across various facets of the games sector. This means that the games companies have a large pooled labour market to recruit from, although the project-based nature of games development means there is less continuity of employment for individuals. This project-based nature of employment and the rapid rate of technical change in software tools put pressure on individuals to continually upgrade their skills.

Every respondent said that to succeed in the games industry a person had to have passion.[8] Passion drives learning and experimentation, interaction on social networking forums and reading outside work. The passionate and talented individuals are those who drive the innovation that makes games companies competitive. An education in games technologies hones existing talent, but some people have made it in the games sector without a formal education. Once in the sector it is people's own learning and ability to do research that drives their success. Individual learning in games requires researching new tools, techniques and ways of working, using the internet, social networks, attendance at conferences, access to publications, and, most importantly, the learning gained from an individual's own experimentation. This is partly behind a rising preference by firms for university-educated people. Several respondents said, compared with VET training in games, university training provides research skills and greater theoretical knowledge.

Innovation in the games sector

The computer games sector is continually evolving, with regular transformations driven by changing demand and technology. Respondents described the following pattern of innovation in the sector. In the 1980s firms had small multiskilled teams producing relatively simple games, consistent with the comparatively limited computing power available to games users and producers. In the 1990s games became larger and more sophisticated, the division of labour increased and the growing market allowed specialist games styles for particular customer groups. In the 2000s large complex games dominated sales, with sophisticated platforms and globally segmented demand by type of game. Currently, there are a variety of games types, some very large sophisticated games, smaller versions of the large games, and a wide array of very small games for mobile phones and the internet. The Global Financial Crisis sharply reduced funding for the large games, leading to a downturn of at least 30% across the sector, according to respondents. Several respondents said that they expected their firms to fail in the months after our interview.

In simple terms the games industry can be segmented into three types of firms. First of all there is a small number of large games producers with specialised teams and a hierarchical management system. These act as the prime contractor for overseas and local firms, who outsource, either in whole or in part, the development of large games. Second, there is an array of medium-sized companies with moderate specialisation. Thirdly, small companies have multiskilled workers and a flat management structure. As noted above, activity in the sector and employment levels in firms fluctuate substantially, reflecting the mostly project-based nature of funding.

Each large console game, such as a Playstation or X-Box, typically has a budget of $30–100 million, and a team of 60–200 people working on it. The Australian companies don't own the intellectual property[9] for the game they are producing but are contracted by a publisher, usually US, European or Japanese, or are subcontracted by the prime contractor. The large teams lead to a fine specialism in skills, and often a command and control management system, with large numbers of 'pixel monkeys' simply producing graphics designed by a small core of managers and designers. Much innovation is driven by internal teams of experts developing company-specific game engines[10] and software tools, allowing the company to go beyond the capability of the publically available technologies and tools. The smaller console game companies typically have $2–10 million projects, with teams of 10–50 people. The division of labour is less pronounced and there is less art work. There is a flatter hierarchy, with key experts typically driving innovation, but not dedicated teams.

---

8 Passion was not an issue for any respondent in mining. Some respondents in solar energy had a passion for working with renewable energy, but it was not considered important to being an effective worker in the sector.

9 Examples include sports such as Formula 1 racing, specific fantasy worlds, and characters such as James Bond.

10 'Game engines' are software designed to provide simplified and rapid development of video games, and allow the same game to be run on various platforms, reducing cost, complexity and time to market.

Phone and internet games are a newly emerged market segment with low budgets and teams of up to five people. Workers have to multitask and management structures are flat. This segment has quite different competitive dynamics, as purchases are driven by the fun of the game and word-of-mouth recommendations rather than ownership of valuable IP or expensive marketing. This diversity of market segments means that a wide range of tools and technologies and associated skill sets and types of workers are required. However, common to all firms is the need to have individuals with the knowledge and skills to develop ways of going beyond the capabilities of the publicly available tools to provide a competitive edge.

Innovation in the games sector is substantially driven by external suppliers of software and hardware. Games firms have to rapidly adopt this new technology, although an important competitive edge is gained by having the skills within the firm to adapt this software to novel uses. Such continuous innovation is required to win projects. There are major changes every two to four years in platforms and software, with constant upgrading occurring. The core software programs and game engines are stable, but many other programs and tools emerge, find favour then disappear over time. Moreover, when games companies get a project, they determine what the final technology on its launch will be and freeze the project at that technology. Lead designers, programmers and artists learn the technology and tools for the project and then pass it on to new workers on the project as it grows to full production; as the project nears its end the project team shrinks. Accordingly, firms will range from leading edge to laggards, in terms of technology and skills requirements, depending on where they are in the cycle of games development. For example, a head games teacher told of how one of their students had been recruited to a firm nearing the end of a major project, and that student showed the firm how to use a physics engine that automatically worked out the mechanics of events such as a rock hitting a wall. The firm was using old technology that predated this tool and was keen to incorporate this new tool into its future work.

Games firms are idiosyncratic, in terms of the technologies they use and so the skills they require. This means that a games student cannot learn all of the available tools and techniques. The VET teacher respondents selected the tools and techniques they taught, pitching to a certain subset of the firms in the sector and ensuring students had broad employability by providing the fundamental knowledge and skills to develop the ability to learn. Once established as a commercial quality programmer, artist or designer, people are expected to be able to adapt to whatever tools the company uses. But employees familiar with the firm's software and products require less training and are more capable, leading to the internal focus on skills for innovation, as indicated by the ABS data.

Games companies have to develop ways of going beyond what publicly available technology will achieve to be competitive in selling their services. This means that much innovation is developed and retained inside firms until after a game is launched. Developing their own tools and tricks requires high-level skills and creativity, so that companies are always looking for exceptionally talented individuals. As noted by the manager of a games company, going beyond what the available software tools can realise requires 'hard core programmers' who can quickly deliver very specific features for the games being produced and to a high standard. Several respondents said that programming for games is different from most other programming. One lead programmer said that most business applications use only a fraction of the computer's power, but games aim to use all of what each platform can do; therefore, the work has to be 'tighter' than in virtually any other computer application. The games companies thus need exceptional programmers, with great skill and creativity. On the art side, certain people can produce 'better' graphics than others and the artwork provides a great deal of the feel of the game and thus its competitiveness. These dynamics produce a focus on highly talented creative individuals, which allows games companies to be competitive. Because of the constant improvement in technology and games production techniques, the games companies need people who can learn for themselves.

Internal firm learning

Learning within the firm typically occurs through mentoring, informal group exchanges, a lead person developing or learning something new, then passing it on, and more formal training and knowledge exchange. Games companies rely on employees having the fundamental programming or art skills from which they can learn, so that the company can innovate and compete. The formal education and training system provides this fundamental knowledge and skills, and the actual skills used in innovation are developed after graduation. A comment typical of all firm respondents when asked whether fresh graduates were useful for innovation was that 'they are not very useful for at least two or three years; it takes that long to learn how to produce at a commercial level'. A CEO of a large games company explained what he wanted from the education system:

> the only thing that educators could give us is graduates [who] have a very broad base knowledge, with no particular skills at all. That sounds counter, but I'd much rather someone has broad knowledge and understands how things work at a very base level, than actually particularly knowing a package. We can adapt anyone that has the broad knowledge, to any package. The world changes too fast. Today it's Maya, tomorrow it's Max. Today it's Adobe's stuff, tomorrow it might be Microsoft stuff. These things change, and I think that's one of the failings that I find, is that people are being particularly trained.

Training in computer games

Training in the games sector has evolved from an undersupply over a decade ago to a current oversupply. In the 1990s many experienced people came from overseas, and some companies still source experts in areas where Australia is weak. The games sector is very 'sexy' to many people, and there are more students doing games courses than there are jobs in the sector. Although there are many games-specific courses at VET and university levels now, according to respondents a large proportion are simply rebadged programming or arts courses with a couple of games units added. Some registered training organisations and universities provide dedicated games courses in close cooperation with industry, which means that their graduates have skills in using the relevant current tools and technologies, and thus find it easier to get jobs. The rebadged courses were perceived by most respondents to produce graduates unlikely to be employed by games companies because, as a games company manager said, 'they get taught the wrong tools, the wrong techniques, and don't understand how the games industry works'. The dedicated courses aim to be close to industry and so provide the specific skills required by games companies and also an understanding of how games production works. Along with the specific tools required to assist graduate employment in the sector, this provides the fundamental knowledge and skills required to learn once in the sector.

Keeping up with industry innovation

Constant change in technology, tools and techniques means that training organisations have to actively engage with industry so that training provides students with the skills and knowledge they need for work. There is active interaction between the games companies and the education and training system. Most teachers have worked in industry, and often still do part-time games work. The teachers rapidly pick up the latest innovations through strong interpersonal networks in the sector. In addition, most courses undertake both formal and informal benchmarking and conduct industry surveys to determine what software tools firms are using and the new techniques being utilised, and what the firms require from graduates. A great deal of knowledge exchange also occurs at conferences. This provides the teachers with quite specialised information on the latest innovation in a way not existing in the other two sectors. The nature of the games industry is such that most participants were early adopters of online social networking, and a great deal of learning occurs through this mechanism.

Conclusion

This exploratory case study approach has engaged with the overall question of the role of VET qualifications and ongoing vocational training in the diffusion and implementation of innovations. This and the three more specific questions noted in the introduction to this report have raised many issues of importance which affect policy and practice in the education and training system.

The relationships between the education and training system and innovation displayed quite different characteristics in each of the three sectors studied. This is important because it means that policy that supports the ability of the VET system to adapt to specific sectors must be sensitive to differences in the drivers and patterns of innovation across sectors. To take an obvious example, tradespeople are important to the introduction and diffusion of innovation in the solar energy sector, somewhat less so in mining, and unimportant in computer games. Despite employing some tradespeople, mining companies will source trades workers from other sectors and do not see training apprentices as central in the same way as they do training operators. This is important because the issues concerning the supply of and responsibility for training trade workers are of different importance to different areas. Understanding the specific sectoral dynamics helps to inform policy and to avoid unforeseen outcomes of VET policy. Overall, policy should support a variety of learning modes appropriate to each vocation and sector.

In each sector we found that the skills development system, including VET, co-evolved with innovation in the sector. VET was important in innovation across the three sectors, especially in providing workers with the capability to learn and to adapt to change. Thus, the ability of workers to learn was as important, and sometimes more important, than occupationally specific knowledge gained in formal education and training for innovation. The importance of the formal VET system varied greatly, and the role of qualifications ranged from relatively unimportant to vital. In general, the formal VET system provides underpinnings to the skills used in innovation, while the informal training within each firm developed the actual skills used in innovation.

Education and training providers have to attempt to produce people for future skills needs as well as current ones. In each sector innovation changes the jobs and the skills needed, meaning that educators have to aim for a shifting target. In all three sectors we found that, when considering innovation, managers and teachers said teaching 'theory' was important. Theory, taken in the broad sense of underlying principles, provides people with the ability to learn from and adapt to innovations, as well as to innovate more effectively themselves. This implies that an approach such as competency-based training, where competencies are taken as the current tasks used in the job, will potentially be detrimental to innovation. Our results indicate that, if workers are not trained in fundamentals, they will find it difficult to adapt to and implement innovations. We are unable to make general statements about whether the VET system, given present curricular/pedagogical mandates, consistently delivers this learning-to-learn capability to workers. However, respondents continually raised the issue of workers' inconsistent learning abilities. This perhaps indicates that the VET system currently has a variable focus on teaching fundamental knowledge and skills.

Diffusion of innovations mostly took place through the efforts of individuals and firms, although some innovations were diffused through formal education and training. Some innovations in all three sectors were incorporated into training materials and so graduates would emerge from their courses with knowledge of particular innovations. However, predominantly it was firms and

sometimes individuals who diffused innovations. Whether diffusion was realised through individuals or firms was determined by the nature of the innovation and the scale of resources required. Some innovations are able to be learnt by one individual with deep expertise in that innovation. However, often diffusion requires a diverse array of expertise and/or large resources to understand and thus diffuse an innovation, leading to some diffusion being driven by firms. There are two reasons for this situation: firstly, people undertake a course as a single event and learn of an innovation, but inside firms innovation occurs frequently. That is, people learn particular knowledge and skills and keep that competence, often for decades. Each innovation is, by definition, an abnormal event, which requires learning of new things. Consequently, the actual location of learning about innovations, and thus the diffusion of innovations, is mostly inside firms. Secondly, firms structure their business operations to compete and, in doing so, innovate. Thus, in each sector how the firms innovated was reflected in how they searched for, absorbed and implemented innovations.

In mining this was a formal structure revolving around engineers and lead operators. In solar energy the management of the company structured innovation. In computer games the firms encourage individuals, especially lead programmers and artists, to search for innovations and to bring them into the company. How firms structure themselves for innovation is strongly shaped by the skills available to the firm, which is a reflection of the education and training system. In general, firms used their more experienced and skilled staff to search for and bring in innovations, especially from the broader international context in which each of the three Australian sectors is part. This means that there is typically a long lag between initial education and training and the people consequently trained leading innovation. Thus, the impact of the current education and training system, including VET, on the ability of firms to pick up specific innovations is difficult to gauge. However, without fundamental knowledge and skills, usually learnt in formal courses, people find it hard to achieve the learning involved in innovation over time. The overall conclusion is that the education and training system (especially VET), from the point of view of the diffusion and implementation of innovation, should focus on providing people with fundamental knowledge and skills, which underpin the ability to learn and adapt. The provision of fundamental knowledge and skills serves two purposes: firstly, it supports innovation and so the nation's economic development. Secondly, it provides students with greater employability over time, and thus better wages and career paths. At the VET level, a focus on teaching current on-the-job competences can leave students underprepared for changes in the workplace due to innovation. Thus we strongly argue that it is the ability to learn in each vocation and profession that is vital.

How the VET system affects the abilities of individuals and firms in generating, dealing with, and diffusing innovations

More technically skilled people, who have a better grasp of the fundamentals if their vocation, are better able to generate, deal with and support innovations. There did not appear to be generic innovation skills, but better fundamental knowledge and skills that supported innovation.

Creative and skilled people are at the heart of the innovation process. However, firms structure the array of skills they have for their innovation and operational activities. The stock of skills available in the labour market strongly influences how firms structure themselves. Each firm uses specific technologies in a way that fits its competitive strategy and has novel ways of working, so that the skills developed and the skills used in innovation in each firm are, to varying degrees, distinctive to that firm. The VET system cannot deliver such highly firm-specific and always changing knowledge and skills. But VET can provide people with the capability to learn and adapt to innovation-induced change.

Across the three sectors strategies ranged from rapid innovation reliant on workers with a deep understanding to alter a new technology to the needs of the firm, to those firms that adopted innovations implemented elsewhere in a 'prepackaged' form. This latter 'follower' strategy is much less demanding on skill development than 'leader' strategy. However, from a whole-of-industry perspective, it is the lead innovator firms that drive advance and competitiveness. This situation provides the VET system with an apparent paradox. Many firms simply want current competences from VET training, while the long-term competitiveness of the entire sector may be better served if VET provides individuals with more advanced skills and underpinning knowledge and skills to assist learning.

Each sector we studied had quite different commercial dynamics and patterns of innovation. This drove the skills profile the firms sought in employees, how the firms organised work and innovation, and how they upgraded worker skills. Mining companies controlled innovation in mining operations through engineers and lead operators selecting equipment and then using a structured training program to support that equipment's use. The solar energy firms continually introduce incremental technological improvements and work towards operational productivity improvement. They learn from suppliers, competitors and their own experimentation and rely on their employees' electrotechnology competences to ensure that the work is done properly. The computer games companies rely on individuals for their innovation and support the informal learning and experimentation of these individuals.

The VET system, through training packages, provides a common 'language', skill set and understanding to assist in the supply of suitable skills for innovating firms. This leads to pooled labour markets, where firms know that, within limits, there are potential employees who have suitable skills. Through a common language in a vocation and sector, innovations can be diffused more easily, as more people can understand the logic of the innovation and how it fits in people's work.

In the mining and solar sectors regulations and legislation were vitally important in the relationship between skills and innovation. In mining, regulations determine the specific competence requirements for operators, but not qualifications, except at the supervisory level. In solar energy there is a strong linkage between regulatory requirements for qualifications and accreditation, the education and training system and how firms innovate. In games there was little government regulation of any importance. This indicates that government often has a very strong influence on innovation, through regulation, incentive structures and specific policies. We cannot, however, produce specific findings in this area beyond the sometimes crucial role governments play in the relationship between skills and innovation.

How workers learn for innovation

The knowledge and skills workers typically use in diffusing and performing innovation is learnt on the job, either through specialised training or through experience. The VET system supports the diffusion and implementation of innovation by providing the base knowledge and skills upon which informal learning is based.

Formal courses based solely on the current on-the-job competencies of workers may actually inhibit innovation. This conclusion supports the finding of the recent review of the VET system by the Joint Steering Committee of the National Quality Council and the COAG Skills and Workforce Development Subgroup of the 'need to revise the current definition of "competency" to embody the ability to transfer and apply skills and knowledge to new situations and environments' (National Quality Council 2009). This research suggests that the technical knowledge to learn how to adapt to changes in how a competency is performed is important to the diffusion of innovation and an individual's employability over time.

The nature of the link between formal education and training and the skills used in innovation differs in how it occurs between sectors. Although in mining the companies provide formal training on novel equipment, most learning about new equipment or methods of operations occurred on the job in informal ways, based on 'theory' learnt in formal courses. In solar energy the formal education and training of people provides the ability to learn how to use PV installation technology and to adapt to new equipment and design and installation methods. In games formal education provides understanding of and experience with various tools and ways of working, which assists creativity. Thus, in all three sectors it is the informal skills development system that produces the actual skills used in innovation. Informal learning is broadly considered to include specialised training, mentoring, conferences and social networking and an individual's learning through their experience and experimentation.

Policy attention is usually on the formal education and training system, especially qualifications. Issues such as on-the-job training, the ability of co-workers to mentor, and access to specialised expert training are important to individual development and industrial competitiveness, but currently have less policy attention. Education and training policy, including VET, typically uses qualifications as a key measure of training effort and performance of the education and training system. In the mining (especially) and computer games sectors, firms care about specific skills and competencies more than qualifications. In the solar energy sector regulation requires qualified and accredited workers to do the work, which drives formal qualifications. From the perspective of innovation and how firms compete over time, formal qualifications represent only one aspect of how individuals learn for innovation.

How VET keeps up with innovation

VET teachers keep up to date with innovations in technology and methods using a wide range of linkages to industry. Commonly used sources for keeping up to date include equipment, consumable and software suppliers; industry and trade publications; conferences; web-based media, online social networks; and, of course, informal and formal learning from other teachers. There are differences in the reliance of teachers in each of the three sectors on these different information sources. There are few industry or government bodies involved in assisting teachers to keep up with innovations, and academic research is of little significance in the sectors studied. Previous research has highlighted the difficulties the public sector VET system has in keeping up to date with new technologies. These difficulties are largely due to budget cuts, which limit the purchase of new capital investment and reduce the funding for teachers to be involved in conferences and has led to the decline of central agencies, whose job it was to monitor and disseminate information about new technologies and work organisation practices in industry and to develop new curriculum materials (Toner 2005).

In each sector the strength, attitude, and linkages of the various actors that connect firms to the education and training sector are vital. Some of these bodies, such as industry skills councils, are focused on skills, while others are aimed at general industry advance. The industry bodies tend to reinforce a path of sectoral skill development because they try to enforce a collective view on what skills are important, to whom, and how best to produce these skills. Industry bodies tend to be able to leverage significant resources compared with individual organisations.

Alternatively, individual people and organisations interact with teachers, providing rapid and precise feedback to one another. This individual interaction allows freedom in skills development, especially the acquisition of new skills and innovations.

The VET system, especially the public providers and industry skills councils, were considered by respondents to be slow to pick up on innovations.[11] Whether the slowness of the VET system in this area is a bad thing is debatable. Once the VET system incorporates new competencies, it is locked in to a specific path in training. Often new technologies and ways of doing things emerge, but do not become economically significant. Thus a cautious approach, whereby the VET system waits for a new technology to become significant or dominant in terms of training demand makes sense. Notwithstanding this, competitive advantage in new areas is often driven by the ability to rapidly scale up, which in turn requires a supply of skilled workers. Thus, a conservative approach by VET, whereby they wait for this to occur, may actually block growth. This is an inescapable conundrum in economic development and vocational training (Whittingham 2003).

Finally, these findings suggest two major implications. Firstly, each sector relates to skills development differently, has different needs, and varies in the pace of change. A single model of how VET relates to industry will be mismatched to some sectors. Mechanisms allowing flexibility in how the VET system finds and reacts to industry needs are important. Secondly, in addition to current on-the-job competencies, VET should focus on teaching fundamental knowledge and skills. Changing the focus of VET from current on-the-job competences to include more fundamental knowledge and skills may impact on some courses and require additional infrastructure. Teaching fundamental knowledge and skills provides the basis for informal learning about innovation. The central role of informal skills development to innovation is important for policy-makers to recognise.

[11] This discussion was not focused on fundamental knowledge and skills, as these change slowly if at all.

References

ABS (Australian Bureau of Statistics) 2008, *Digital game development services, Australia*, 2006–07, cat.no.8515.0, ABS, Canberra.

——2010, *Innovation in Australian business 2008–09,* ABS, Canberra.

Baldwin, JR 1999, *Innovation, training and success*, Statistics Canada, Ottawa.

Bekkers, R & Freitas, IMB 2008, 'Analysing knowledge transfer channels between universities and industry: to what degree do sectors also matter?', *Research Policy*, vol.37, no.10, pp.1837–53.

Bruland, K 2002, 'Education', in *The Oxford encyclopedia of economic history*, ed by J Mokyr, Oxford, Oslo.

Casper, S, Lehrer, M & Soskice, D 1999, 'Can high-technology industries prosper in Germany? Institutional frameworks and the evolution of the German software and biotechnology industries', *Industry and Innovation*, vol.6, no.1.

Cohen, WM & Levinthal, DA 1994, 'Fortune favors the prepared firm', *Management Science*, vol.40, no.2, pp.227–51.

Crouch, C, Finegold, D & Sako, M 1999, *Are skills the answer? The political economy of skill creation in advanced industrial economies*, Oxford University Press, Oxford, Eng.

Dearden, L, Reed, H & Van Reeden, J 2006, 'The impact of training on productivity and wages: evidence from British panel data', *Oxford Bulletin of Economics and Statistics*, vol.68, no.4, pp.397–421.

DiMaggio, PJ & Powell, WW 1983, 'The iron cage revisited: institutional isomorphism and collective rationality in organizational fields', *American Sociological Review*, vol.48, no.2, pp.147–60.

Edquist, C 2005, 'Systems of innovation: perspectives and challenges', in *The Oxford handbook of innovation*, eds J Fagerberg, DC Mowery & RR Nelsson, Oxford University Press, Oxford, Eng., pp.181–208.

European Photovoltaic Industry Association & AT Kearney 2009, *SET for 2020*, European Photovoltaic Industry Association, Brussels.

Finegold, D & Soskice, D 1988, 'The failure of training in Britain: analysis and prescription', *Oxford Review of Economic Policy*, vol.4, no.3, pp.21–53.

Freeman, C 1988, 'Japan: a new national system of innovation?', in *Technical change and economic theory*, eds CFG Dosi, R Nelson, G Silverberg & L Soete, Pinter Publishers, London, pp.330–48.

Freeman, C & Louca, F 2001, *As time goes by: the information and industrial revolutions in historical perspective*, Oxford University Press, Oxford, Eng.

Friel, D 2005, 'Transferring a lean production concept from Germany to the United States: the impact of labor laws and training systems', *The Academy of Management Executive*, vol.19, no.2, pp.50–8.

Hall, PA & Soskice, D (eds) 2001, *Varieties of capitalism: the institutional foundations of comparative advantage*, Oxford University Press, Oxford, Eng.

Innovation and Business Skills Australia 2009, *Developing innovation skills: a guide for trainers and assessors to foster the innovation skills of learners through professional practice*, IBSA, East Melbourne.

Jacobsson, S 2002, 'Universities and industrial transformation: an interpretative and selective literature study with special emphasis on Sweden', *Science and Public Policy*, vol.29, no.5, pp.345–65.

Keep, E & Mayhew, K 1999, 'The assessment: knowledge, skills, and competitiveness', *Oxford Review of Economic Policy*, vol.15, no.1, pp.1–15.

Klepper, S 1997, 'Industry life cycles', *Industrial and Corporate Change*, vol.6, no.1, pp.145–81.

Landes, D 1969, *The unbound Prometheus: technological change and industrial development in Western Europe from 1750 to the present*, Cambridge University Press, Cambridge.

Lazonick, W 2005, 'The innovative firm', in *The Oxford Handbook of Innovation*, eds J Fagerberg, DC Mowery & RR Nelson, Oxford University Press, Oxford, Eng., pp.29–55.

Lieberman, MB & Asaba, S 2006, 'Why do firms imitate each other?, *Academy of Management Review*, vol.31, no.2, pp.366–85.

McGahan, AM, Argyres, N & Baum, JAC 2004, 'Context, technology and strategy: forging new perspectives on the industry life cycle', *Advances in Strategic Management*, vol.21, pp.1–21.

Miles, MB & Huberman, AM 1994, *Qualitative data analysis: an expanded sourcebook*, 2nd edn, Sage Publications, Thousand Oaks, CA.

Minerals Council of Australia 2006, *Staffing the supercycle: labour force outlook in the minerals sector, 2005 to 2015,* Canberra.
National Quality Council 2009, *VET products for the 21st century,* final report of the Joint Steering Committee of the NQC and the COAG Skills and Workforce Development Subgroup, National Quality Council, Melbourne.
National Resources Sector Employment Taskforce 2010, *Resourcing the future*, Commonwealth of Australia, Canberra.
NCVER (National Centre for Vocational Education Research) 2008, *Industry and training 2007: mining,* NCVER, Adelaide.
OECD (Organisation for Economic Co-operation and Development) & Eurostat 2005, *The measurement of scientific and technological activities: Oslo manual guidelines for collecting and interpreting innovation data*, 3rd edn, OECD Publishing, Paris.
Perez, C 2002, *Technological revolutions and financial capital: the dynamics of bubbles and golden ages*, Edward Elgar, Cheltenham, Eng.
Pisano, G 1994, 'Knowledge, integration and the locus of learning: an empirical analysis of process development', *Strategic Management Journal,*15, Winter, 1994, pp.85–100.
Prais, SJ 1995, *Productivity, education, and training: an international perspective*, Cambridge University Press, Cambridge.
Tether, B, Mina, A, Consoli, D & Gagliardi, D 2005, *A literature review on skills and innovation. how does successful innovation impact on the demand for skills and how do skills drive innovation?*, ESRC Centre on Innovation and Competition, University of Manchester, Manchester.
Tidd, J, Bessant, J & Pavitt, K 2001, *Managing innovation: integrating technical, market and organizational change,* 2nd edn, John Wiley & Sons, Chichester, Eng.
Toner, P 2005, *Keeping up with technology: a pilot study of TAFE and the manufacturing sector*, NCVER, Adelaide.
—— 2011, Workforce skills and innovation: an overview of major themes in the literature, Vol. Working Paper SG/INNOV(2011)1,Organisation for Economic Co-operation and Development, Paris.
Utterback, JM & Abernathy, WJ 1
975, 'A dynamic model of process and product innovation', *Omega*, vol.3, no.6, pp.639–56.
Warner, M 1994, 'Innovation and training', in *The handbook of industrial innovation*, eds M Dodgson & R Rothwell, Edward Elgar, Aldershott, Eng., pp.348–54.
Whittingham, K 2003, *Going boldly into the future: skills and Australian high technology start-up firms,* NCVER, Adelaide.
Yin, RK 2003, *Case study research: design and methods*, 3rd edn, Sage Publications, Thousand Oaks, CA.

Other publications in the NCVER Monograph Series

01/2009 Leesa Wheelahan, Gavin Moodie, Stephen Billett and Ann Kelly, *Higher education in TAFE*

02/2009 Alfred Michael Dockery, *Cultural dimensions of Indigenous participation in education and training*

03/2009 Kostas Mavromaras, Seamus McGuinness and Yin King Fok, *The incidence and wage effects of overskilling among employed VET graduates*

04/2010 Tom Karmel and Peter Mlotkowski, *The impact of wages on the probability of completing an apprenticeship or traineeship*

05/2011 Barbara Pocock, Natalie Skinner, Catherine McMahon and Suzanne Pritchard, *Work, life and VET participation amongst lower-paid workers*

Appendix 1: Method

This project used the comparative qualitative case study approach for a study into the Australian mining, solar energy and computer games sectors. Our approach is exploratory: even though much is known of education and training and innovation, a great deal is still not understood of the dynamics of education and training in innovation systems. The cases were selected to get a range in the relationship between the education and training system, especially VET, and the specific sector. The mining sector is a long-established sector with strong linkages to education and training. The solar energy sector is based on novel technology, but underpinned by the established electrotechnology education and training infrastructure. The computer games sector is based on novel technology and has recently established linkages with the education and training system.

This case selection provided the researchers with the opportunity to compare and contrast the importance of novelty versus maturity in technology and commercial relationships with the durability and depth of the establishment of education and training in each sector. These contrasting sectors allowed comparison between the different ways in which education and training and innovation interact, which suited our exploratory approach. We used cross-case analysis to ascertain differences and similarities in how education and training functions within these different innovation systems to deepen our understanding of the education and training dynamics in such setting.

The project involved a review of the available literature and statistics, pilot-testing the questionnaire and the main data collection via semi-structured interviews. The literature review (in an accompanying support document to this report) focused on the literature explaining how the education and training system is related to innovation. There are a number of existing reviews of the literature on skills and innovation, all working papers. However, there is no literature specifically on how education and training systems interact with systems of innovation. The literature review used work on all aspects of training and education and innovation, as well as economic development and growth. A number of lessons were drawn from the literature, which informed the empirical research.

Interviews in each sector were undertaken with a range of respondents, representing the core education and teaching and firm players, as well as industry organisations, suppliers and labour market organisations. A total of 66 interviews were undertaken, as shown in table 6. Following ethical clearance, 15 interviews for the pilot were conducted with industry organisations, and leading firms and teachers were identified through public sources or by early respondents. This pilot tested the questionnaires and provided scoping for the main analysis phase. Questionnaires were developed for the following types of respondents: firms, teachers, and industry bodies. The questionnaires were found to be satisfactory, although sector-specific probes were added over time. The main data collection phase followed, with 51 further interviews conducted.

Table 5 Respondents

	Mining	Solar energy	Computer games	Other	Total
Firm	12	10	11		33
Teacher	7	8	9	1	23
Other	3	6	2		11
Total	**22**	**21**[#]	**22**	**1**	**66**

Note: # Three respondents were both a firm and a teacher.

Case and respondent selection followed purposive sampling to improve result validity and generalisability (Miles & Huberman 1994). Purposive sampling involves the deliberate selection of respondents for their interest, expertise and/or position. As discussed, the cases were selected using stratified purposive sampling to identify positions on a spectrum, from new to established sectors, with associated depth of involvement in the VET system and stability in the knowledge base. Respondent selection was initially intensity sampling, where respondents were experts in the relationship between the VET system and each sector. Following this initial sample, snowball and opportunistic sampling were used to locate expert respondents across the full range of actors in each sector. Snowball sampling involves finding future respondents from discussion with current respondents. Opportunistic sampling involves finding respondents as they become available during research due to search and/or fortuitous circumstances. Towards the end of data collection, confirming and disconfirming sampling were used to test findings and enrich understanding. Initial respondents were from the relevant industry skills councils, industry bodies, and industry-recognised leading firms and training organisations. These respondents provided an overview of the state of, and dynamics in, each sector. Following this, other respondents were found either by reputation or through being a representative of significant actors. Some types of actors were found to be important during research, such as equipment suppliers and contract miners in the mining sector. Respondent selection continued until saturation was reached and further interviews yielded no novel information. Within firms, respondents were those responsible for training and/or overall skills in the company. In the large companies this tended to be the training or human resources manager. In small firms this was often the managing director, or equivalent. Teacher respondents, from public and private training organisations, were usually those responsible for coordinating courses, employing other teachers and often marking the course. Other respondents were from various industry bodies and industry skills councils. One respondent was an expert in VET and innovation, but not involved in any of the sectors.

The University of Western Sydney's human research ethics committee provided ethical clearance for the project and the questionnaires (Protocol Number H7331). Particular respondents were approached directly, or the organisation was asked to nominate a suitable person for this research according to criteria we supplied. Potential respondents were provided with information about the project and they were advised that they could withdraw at any time and that there would be no consequences if they did so. All respondents were assured confidentiality.

Our purposive sampling approach led to our respondents covering all major actors in the relationship between the education and training system and innovation in each sector. This research thus has implications beyond the VET system, although VET was the focus of research. We had little difficulty in obtaining suitable respondents, and some respondents were obtained through cold calling, using industry directories. We interviewed 33 firms, 23 teachers and 11 others. There was a much greater variation in firms than in teaching in this research. Different firm sizes, market segments and locations affected the strategy and actions of firms in regard to skilling. We did not attempt to stratify based on innovativeness as that lies outside the study design. Education and training organisations tended to have fairly consistent behaviours and beliefs. The other organisations differed because they occupied an exclusive sectoral position.

The interviews were semi-structured and of one-and-a-half hour's duration, with only a couple being longer. Most were face to face, with some being via telephone due to problems of timing and/or location. Most interviews were with individuals, while eight were with multiple respondents. Interviews were recorded and transcribed later. Qualitative analysis was done using the NVivo program. Statistics from NCVER and the ABS were also used in the analysis, as was available literature on skills development and commercial dynamics in each sector.

Appendix 2: Questionnaires

Firms questions

How did you get this role and can you describe it?

- ✧ Role of VET in the company?
- ✧ Size, product, % VET, % uni
- ✧ Innovation
  - continuous/discontinuous
  - product, process, organisational

How important are VET trained people for this firm?

- ✧ Why? What areas of VET?
- ✧ Quals, ongoing training, experience
- ✧ vs uni, schooling
- ✧ Innovation
  - Continuous/discontinuous
  - product, process, organisational

How do you provide vocational training to employees?

- ✧ In-house → how get trainers, content, link to formal VET system
- ✧ External → who, why, link to VET system
- ✧ What is the company's view toward training?
  - difference to other firms in industry

How do you find VET qualified people?

- ✧ Labour markets, intermediaries, in-house training

How does new technology and methods affect the upgrading of skills and the need for further education and training?

- ✧ Source → own R&D, suppliers, competitors
- ✧ VET plays leading role vs support-technical role.
- ✧ Fundamental knowledge vs specific knowledge
  - ability to fit into fundamental and specific into training
- ✧ Timelines learning vs change in industry
- ✧ Innovation → product, process, organisational

What is the role of VET skilled people in learning to use new technology and methods in your company?

- ✧ vs uni, suppliers, intermediaries

What is the role of VET skilled people in the development of new products and processes in your company?

- ✧ vs uni, intermediaries
- ✧ Leading role vs. support-technical role
- ✧ Need for organisational innovation – impact on skills
- ✧ Fundamental knowledge vs specific knowledge

How does innovation influence your training needs from the education system, especially VET?

- ✧ Fundamental knowledge vs specific knowledge
- ✧ Timelines learning vs change in industry
- ✧ Innovation → product, process, organisational

Do you have links to the VET system to communicate your training needs?

- ✧ VET providers
- ✧ Industry skills councils/through industry bodies, unions etc
- ✧ Personally involved
- ✧ Do you provide/influence the training package, content and delivery of VET
- ✧ Links to unis
- ✧ Mechanism/processes
- ✧ Structured/unstructured in/formal

Do you provide any access to technology or equipment for VET training?

- ✧ What, how, why
- ✧ Expertise as well as technology

Does the VET system improve the competitiveness of the company/industry?

- ✧ How does it do this?
- ✧ What has been the effect of doing this?
- ✧ Has the company's attitude to this changed over time? If so why?

How do you think the VET system in this sector has changed over time?

- ✧ Why has it changed that way?
- ✧ Innovation – product, process and organisational

Trainer questions

How did you get this role and can you describe it?

- ✧ Training modules for which you are responsible
- ✧ Occupations/sector/content
- ✧ Role of the organisation?
- ✧ Scope of training packages/qualifications/other training offered

How do you source content for your courses?

- ✧ Who writes it? – networks, formal vs informal
- ✧ Core firms, suppliers, unions, research, practice
- ✧ Core content, new content, fit into space in course?

- ✧ Why? → changing technology, practice, industry demand
- ✧ Role of innovation in this updating
  - continuous/discontinuous
  - product, process, organisational

What drives demand for training?

- ✧ Skills shortages, increased industry size, incentives, social norms

How important is new technology and methods in the upgrading of skills and the need for further education and training?

- ✧ Research findings, new products,
- ✧ Core content, new content, fit into space in course?
- ✧ Timelines of the VET system
- ✧ Innovation – continuous/discontinuous

What is the role of VET skilled people in innovation in the industry?

- ✧ Product vs process vs organisational
- ✧ Trade quals vs ongoing training

What are the characteristics of the students?

- ✧ Education, experience, core firms, job roles
- ✧ Geographic location

How do the people learn and acquire skills in this industry?

- ✧ Formal qualifications
- ✧ Ongoing training (in house vs through a provider)
- ✧ Experience

What are your linkages to the industry?

- ✧ Do these help in keep abreast of the technological and work environment?
- ✧ Visits, networks, formal processes
- ✧ Core firms, suppliers, unions, research, associations

How does the industry deal with the skills issues around innovation?

- ✧ Difference between players – firms, unions, govt, industry bodies
- ✧ Relation to innovation
  - product, process, organisational
  - continuous/discontinuous

How does access to new technologies, equipment or machinery affect your teaching?

- ✧ Access through firms,
- ✧ Budgets
- ✧ Timeliness

Is there collaboration between players in the industry in developing/identifying training needs?

- ✧ Who, how, why, to what effect
- ✧ Your organisation's collaborations
- ✧ Ongoing vs intermittent, vs projects

Does the VET system improve the competitiveness of the industry?

- ✧ How does VET fit into how the industry learns and advances itself?
- ✧ How does it do this?
- ✧ What has been the effect of doing this?

Industry body questions

How did you get this role and can you describe it?

- ✧ Role of the organisation?

What is the history of the VET training in this sector?

- ✧ Schooling, VET, uni
- ✧ How was it founded, by who and why?
- ✧ Driver – firms, govt, education
- ✧ Funding

Do you influence the content of the education/training packages?

- ✧ Why? → changing technology, practice, industry demand
- ✧ Core content, new content, fit into space in course?
- ✧ Role of innovation in this updating

How important is new technology and methods in the upgrading of skills and the need for further education and training?

- ✧ Research findings, new products, timelines of the VET system
- ✧ Core content, new content, fit into space in course?
- ✧ Competition as driver
- ✧ Timelines of innovation vs. education system

What are the characteristics of the students?

- ✧ Education, experience, core firms, job roles
- ✧ Geographic location

How do people learn in this industry?

- ✧ Formal quals, ongoing training, experience
- ✧ Quality of teaching and learning by VET –
    - fundamental skills vs specific skills
- ✧ Timelines learning vs change in industry
- ✧ Fundamental knowledge vs specific knowledge

What are your linkages to the industry education and training system?

- ✧ Uni, VET, industry skills council, training providers, intermediaries
- ✧ Firms, suppliers, unions, research, other associations

What is the industry's perspective toward training?

- ✧ Compare to other industries
- ✧ Difference between players in industry
- ✧ Relation to innovation

- continuous/discontinuous
- product, process, organisational

Is there collaboration between players in the industry in developing/identifying training needs?

- Who, how, why, to what effect
- Your organisation's collaborations
- Ongoing vs intermittent, vs projects

Has the education and training system improved the competitiveness of the industry?

- How does it do this?
- Has the sector's attitude to this changed over time? If so why?

How do the labour markets work in the sector?

How does VET fit into how the industry learns and advances itself?

- Partners, O/S, competitors, supply chain, researchers, etc

Industry skills council questions

Can we start with you, how did you get this role and can you describe it?

- Role of the organisation?

What is the history of the VET training in this sector?

- How was it founded, by who and why?
- Where did the funding come from?

How do you determine the competencies needed in the training package?

- Industry, teachers, unions, government, consultants/experts, research/uni
- Formal process, informal, networks,
- Core content, new content, fit into space in course?
- Innovation
  - continuous, radical → forecasting/timelines
  - product, process, organisational

How do you source content for the training package?

- Who writes it? – networks, formal vs informal
- Core firms, suppliers, unions, research, practice
- Why? → changing technology, practice, industry demand
- Core content, new content, fit into space in course?
- Role of innovation in this updating
  - continuous, radical
  - product, process, organisational

How important is new technology and methods in the upgrading of skills and the need for further education and training?

- How do you keep abreast (linkages question)
- Research findings, new products
- Fundamental core, new core, extra specialisation, fit into space in course?

- *Timelines* of the VET system
- Australian vs international

Do you get involved in the teaching and learning aspects of delivering the training packages?

- Formal/informal support and interaction with teachers

What is the role of VET skilled people in innovation in the industry?

- Product vs process vs organisational
- Basic schooling vs trade quals vs uni quals
- *Ongoing training*

What are the characteristics of the students?

- Education, experience, core firms, location, job roles

How do the students learn in this industry?

- Formal qualifications
- Ongoing training (in house vs through a provider)
- Experience

What are your linkages to the industry?

- Core firms, suppliers, unions, research, associations
- Formal, informal
- What does the industry skills council do aside from vet work (future studies, coordination, etc)

How is the organisation funded?

- Why is it funded that way? Does this constrain what the organisation does?
- If you had more money what would you do differently?

What is the industry view toward training?

- Compare to other industries,
- Difference between players in industry

Does the industry skills council view itself as improving the competitiveness of the industry?

- How does it do this?
- What has been the effect of doing this?
- Has the organisation's attitude to this changed over time? If so why?

How do the labour markets work in the sector?

Is there collaboration between players in the industry?

- Who, how, why, to what effect
- Your organisation's collaborations
- Ongoing vs intermittent, vs projects

National Centre for Vocational Education Research Ltd
Level 11, 33 King William Street, Adelaide, South Australia
PO Box 8288, Station Arcade, SA 5000 Australia
Telephone +61 8 8230 8400 Facsimile +61 8 8212 3436
Website www.ncver.edu.au Email ncver@ncver.edu.au