Managing educational change in the ICT discipline at the tertiary education level

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Introduction

This report on the Australian Learning and Teaching Council Information and Communications Technology (ICT) Project is a scoping study in ICT higher education. The core focus is the university curriculum and its perceived relevance among ICT stakeholders. The primary ICT stakeholders include high schools, university staff, students, employers, the community, professional bodies, graduates in the workforce and government. ICT also permeates all other disciplines, society, work practices and industry at all levels. Compared to other disciplines, ICT is a field that changes rapidly in response to innovations. The broad range of stakeholders and rapidly changing circumstances require dynamic and responsive high school and university curricula that balance a range of demands.

Initial consultations of the academic community indicated that the main issues and challenges facing the ICT higher education sector could be gleaned from three groups: ICT academic staff, ICT graduates currently in the workforce, and employers of ICT graduates. A broad range of academic staff were consulted, including deans and other senior managers, professional groups, and attendees at a variety of conferences across the ICT spectrum. Recent graduates in the workforce were contacted through university alumni organisations, which invited their relevant graduates to participate in an online survey. Employer requirements of ICT graduates were determined from the literature and a pilot survey of a range of ICT employers.

The findings from each of the three consultations, and the conclusions and recommendations flowing from them, are summarised below.

Academic consultations

Academic consultations were conducted through face-to-face discussions, wider canvassing of statements from these discussions, and written expressions of concerns and priorities facing the ICT sector from professional groups and attendees at meetings and conference forums. These three approaches revealed that there is a broad range of issues and challenges on which there is considerable agreement.

There is much debate about which disciplines comprise the ICT spectrum. Teaching of ICT is done through several different faculties and schools, including engineering, science, and business or economics. Various professional groups are concerned with different parts of this spectrum. In this climate, it is difficult to reach agreement on a single set of disciplines.

Nevertheless, for the purposes of this project, the core disciplines were taken as electrical engineering, computer engineering, telecommunications engineering, software engineering, computer science, information technology, and information systems.

There was widespread concern among academics that the ICT discipline is fragmented and in need of a representative unifying peak academic body such as an ICT council. Such a council was formed in July 2008, and is known as the Australian

Council of Deans of ICT (ACDICT). Participants in the consultations felt that this council would find it challenging to bring together relevant stakeholders (including various professional bodies, high schools, industry and government) and a fragmented community to address the complex issues raised.

The most common area of concern was the fact that the sector is in crisis because of declining student enrolments (and subsequent skills shortage). This situation was attributed to erroneous and poor perceptions of the ICT profession and career prospects among students, high school teachers, career advisors, parents and the general community. One example cited was that the implementation of the Computer Professional Program of the Australian Computer Society is not widely known or recognised, and in any case the name only represents a part of the ICT spectrum.

A major challenge is surviving the downturn in enrolments and any university downsizing, with possible loss of capacity, in an environment with increasing industry demand for skilled ICT personnel. Under these circumstances there was concern over maintaining the quality of ICT teaching in high schools and universities and maintaining an appropriate balance of fundamental knowledge, current technologies, business understanding and generic (or 'soft') skills such as communication and problem-solving. It was broadly felt that the federal government should express more concern for the crisis in the ICT sector, which is a significant and essential contributor to the economy.

There was a strong desire for greater involvement of the ICT industry in marketing the profession and in teaching at all levels. Greater involvement of industry in education would enable the development of industry-relevant curricula; provide more work-integrated learning and authentic (real-world) learning experiences for students, which would improve their employability; and strengthen the teaching–research–industry–learning nexus for the mutual benefit of academia and industry.

Lack of understanding of students amongst academic staff was an issue, particularly in regard to motivation, class attendance and attrition rates (which are apparently higher than in engineering and science) within the context of a mixture of local and international students, uneven workplace opportunities, academically less able students, and the relatively low number of enrolments in ICT by women.

The academic consultations identified several areas of notable good practice in the sector (such as teaching, recruitment strategies and industry associations). Participants felt that identifying and sharing these would benefit the sector as a whole.

Survey of recent ICT graduates in the workplace

ICT graduates employed in ICT jobs over the past five years were surveyed through their university alumni organisation. The survey sought to elicit these graduates' views on the effectiveness of their university preparation for employment in five areas:

- personal/interpersonal abilities
- thinking/cognitive abilities
- business abilities
- technical abilities
- learning and university experience.

The survey yielded 719 valid responses from graduates from 21 Australian universities.

Analysis of the data allowed information to be gathered in several other areas, such as gender differences, workplace experience, the effects of having a higher degree and of studying ICT in high school (both had a positive effect), and a comparison between universities to identify good teaching practices.

The graduates were also asked to provide further qualitative information about their university courses, such as whether they felt their universities prepared them well, what aspects were missing from their courses, what elements were least and most valuable, and how their courses could be improved. There were between 533 and 660 individual responses to each of these open-ended questions.

This study found that graduates consider a range of abilities from the personal/interpersonal, cognitive, business, technical and learning domains to be important for performance of their work. These include communication, teamwork, problem-solving, organisation of information, project management, client liaison and technical expertise. However, there was a significant overall disparity (88%) between the abilities graduates consider to be of high importance for their work and their perceptions of how effective universities are in developing those abilities.

While the majority of graduates seemed to be satisfied with how their universities prepared them for the technical aspects of their work, many felt they were underprepared in terms of personal and interpersonal skills, and business and industry knowledge. Graduates also stated that they would have benefited from more exposure to new and emerging technologies and the technologies used in industry. They suggested that a well-rounded ICT graduate requires relevant technical know-how, workplace experience, problem-solving skills and the ability to work in a team for success in professional employment.

Overwhelmingly (about 70% of free text responses in the survey), the graduates suggested that there needs to be some form of work-integrated learning to address both what was missing from their courses and what needed improvement. The benefits of work-integrated learning to students, industry and the university have been documented elsewhere, including recently by Universities Australia (2008).

The literature was used to interpret identified gender differences in the male-dominated culture of ICT. However, the data from this survey could not point to specific curriculum changes required in this regard, except to imply that a more gender-inclusive pedagogy would be desirable and would probably help with the recruitment and retention of more women.

Analysis of the survey data showed that different universities have different strengths with regard to teaching practices. This provided support to the academic community's view that identifying and sharing good practices would benefit the sector as a whole.

Analysis of the survey data identified the following areas for curriculum reform:

- work-integrated learning for all ICT students
- involvement of industry professionals in teaching
- use of 'real-world' examples, case studies and scenarios
- balancing of teaching up-to-date technologies and practices with fundamental theoretical approaches

- gender-inclusive pedagogy
- identification and sharing of good educational practices
- inclusion of business practices
- development of personal skills, including communication of all kinds
- authentic problem-solving activities
- group work related to industry practices of teamwork
- project work related to industry and project management
- teaching practices that involve more interaction between teachers and students
- clear demonstration of subject relevance to employment.

Survey of ICT employers

The Australian Information Industry Association conducted a pilot survey of employers of recent ICT graduate recruits for this project. The results were compared to employer concerns published in the literature. While there was broad agreement between these, the surveys also provided some new insights.

Most employers reported that graduates met their needs in relevant ICT knowledge, foundation in theoretical principles, literacy and numeracy, computer languages and software applications. The main area of weakness was commercial awareness, again suggesting that this is an issue for curriculum development. Some employers indicated that their needs were met in project management knowledge, written communication skills and understanding of business processes. There seemed to be a more-or-less equal demand among employers for graduates with fundamental knowledge and experience with current technologies.

Less than half of employers were satisfied with the personal qualities and interpersonal skills of their graduate recruits. The areas most in need of improvement were communication and problem-solving skills. Other areas for improvement were self-management, initiative, planning abilities and independent learning. Employers ranked the need for improvement in teamwork very low, which suggests that Australian universities are preparing students well in this regard.

With respect to improving the employability of recent graduates, and in agreement with published findings, employers indicated that universities and the ICT industry need greater cooperation in designing curricula. They also felt that courses should include experience in the industry, and in particular that students need more work placements to gain industry experience, and that teaching staff should also have industry experience.

The time and cost of getting recent graduates up to speed in industry can be considerable: it can take three to 12 months and sometimes longer, and commonly costs in excess of $10,000 for each graduate.

Conclusions and recommendations

Addressing the issues and challenges raised by ICT academic staff, graduates and employers requires action by a national organisation to ensure accountability and responsibility for implementing recommendations. The body created during this project to respond to the academic needs of the entire ICT spectrum is ACDICT. The recommendations from this project are therefore intended to inform the work of ACDICT. It is hoped that these nine recommendations will assist ACDICT in formulating the most appropriate responses.

There was widespread support from the academic community for the formation of a national representative ICT council to address the fragmentation of the sector. Now that ACDICT has been formed, it needs to focus on promoting unification, engaging the community, and establishing itself as the peak academic body.

> ***Recommendation 1***
> ACDICT should establish a relationship with relevant stakeholders (including various professional bodies, high schools, industry and government) to consult with and provide advice on the issues raised during this project.

Improving the perceptions of ICT in many areas of the general community is seen by most academics as the main avenue for resolving the ICT crisis.

> ***Recommendation 2***
> ACDICT should work with industry and key professional bodies to investigate, develop and implement strategies for improving community perceptions of the ICT profession and career prospects.

> ***Recommendation 3***
> To enhance the standing of the ICT profession, ACDICT should work with the Australian Computer Society and other stakeholders to improve the relevance and recognition of the Computer Professional Program qualification for the whole ICT spectrum.

Respondents generally felt that there was a deficiency in understanding students and their needs in the ICT context, and that ICT is a male-dominated field. Relatively high attrition rates and the lack of women are symptoms of the problem.

> ***Recommendation 4***
> To help understand students better, ACDICT should support research into student motivation, class attendance, attrition rates, the enrolment of women in ICT, and gender-inclusive pedagogy in relation to a range of demographic variables and contexts**.**

The three perspectives (academics, graduates and employers) had much in common and provided solid evidence for improvements. One area in which there is strong agreement is the need for greater university and industry collaboration. Graduates in the workforce strongly recommended it and a willingness to collaborate was expressed by academia and industry. While this desire is apparently broadly felt, and therefore seemingly achievable with the appropriate actions, possible reticence on the part of industry may have been revealed by the relatively small number of employer participants in this survey and in an earlier employer survey that also had low participation (Hagan 2004). Rhetoric, commitment and action need to be brought together through the leadership capacity of ACDICT.

The employer survey and the literature indicate that employers value recruits with industry experience – whether or not they have only recently graduated. This is confirmed by recent graduates in the workforce, who overwhelmingly say workplace experience is missing from their education and that the curriculum is most in need of improvement in this regard. The implication is that the marked disparity between what graduates say they need in the workplace and what is provided by universities to prepare them for the workplace could be addressed in large measure by appropriate workplace experience.

The dissatisfaction with the personal qualities and interpersonal skills of graduate recruits expressed by employers could also be mitigated by workplace experience. Universities Australia (2008) has advocated a national internship scheme that would improve the employability of all graduates and also benefit universities and industry. ICT graduates in the workforce and ICT employers have identified common deficiencies (such as communication skills, business awareness and problem-solving abilities).

> ***Recommendation 5***
> ACDICT should establish a relationship with ICT industry leaders to develop strategies for greater university and industry cooperation in the design, implementation and teaching of an industry-relevant curriculum that meets the needs of graduates in the workforce and employers.

> ***Recommendation 6***
> ACDICT and industry leaders should investigate the possibilities for greater work-integrated learning by all students of ICT, and develop a scheme that has local and national applicability.

Graduates in the workforce reflected on their experience of university teaching and made several suggestions for improvement. Consideration and adoption of these suggestions may address motivation and retention issues, as well as address concerns that ICT teaching is in need of improvement.

> ***Recommendation 7***
> ACDICT should encourage teaching staff to:
> - demonstrate subject relevance,
> - have interactive sessions with students,
> - use real-world examples and case studies,
> - keep up to date with technology changes,
> - provide group work related to industry practices, and
> - design meaningful problem-solving activities
>
> in order to improve university teaching.

Understanding and strengthening the teaching–research–industry–learning nexus that seems to be at the heart of ICT learning and teaching would lead to curriculum improvements.

> ***Recommendation 8***
> To fully understand the teaching–research–industry–learning nexus in the ICT context, ACDICT should support research into clarifying perceptions and identifying best practices for the mutual benefit of academia, students and industry.

Analysis of the data from the survey of graduates in the workforce showed that different universities had different strengths in the teaching of ICT. As noted by academic staff during the consultation process, it would be beneficial to identify and share good teaching practices.

Recommendation 9
ACDICT should facilitate the documentation of good teaching practices and the dissemination of this information across the sector.

These recommendations have far-reaching consequences for academia, students and industry and, even if only partly adopted, have the potential to revolutionise the ICT curriculum.

Introduction

The following sections describe the project's parameters, outcomes and methodology and provide background on the scope of ICT, the ICT crisis, university ICT education, and the ICT industry.

Project parameters

This report on the Australian Learning and Teaching Council Information and Communications Technology Project is a scoping study in ICT higher education. The core focus is the university curriculum and its perceived relevance among ICT stakeholders.

Figure 1 shows the range of stakeholders in the ICT curriculum. There are clear links between these stakeholders – for example, the student journey from high school, through university to employment in industry. The pathway is influenced by government policy, professional body accreditation, the academic culture, and the needs and perceptions of the community within a global context. This broad range of stakeholders means that the university curriculum has to be dynamic and responsive while balancing a range of demands.

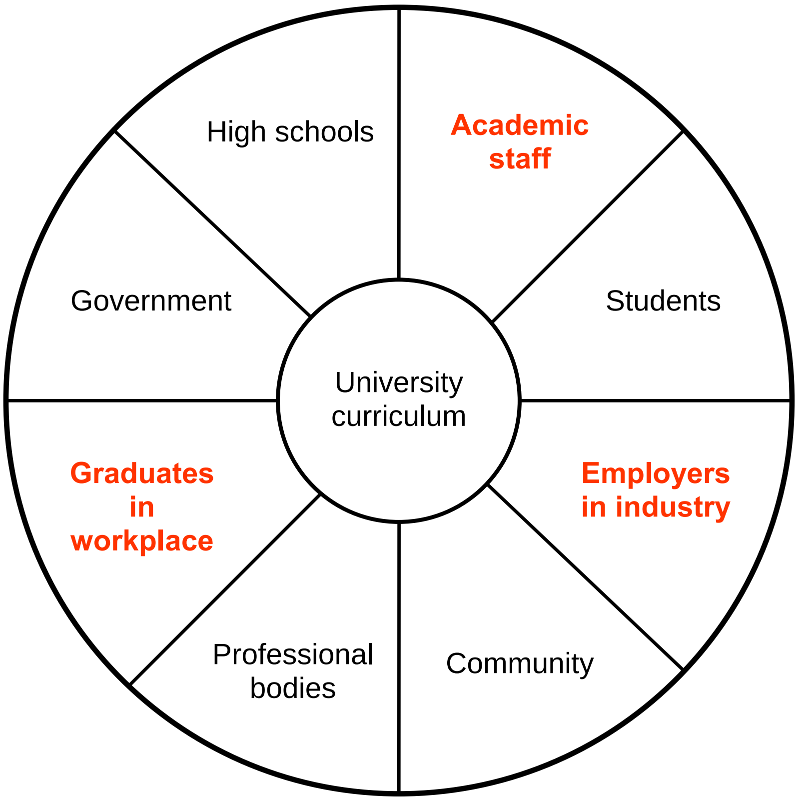

Figure 1: Stakeholders in the university curriculum, with the groups featured in this study in bold

For this study, the three groups consulted were ICT academic staff, graduates of ICT in the workforce; and employers of ICT graduates. These three groups were chosen to indicate the main issues and challenges facing the sector with respect to ICT higher education. The broad academic consultations at the start of the project provided suggestions and directions that helped shape the project and made the establishment of a formal reference group unnecessary. In fact, the academic community was the *de facto* reference group that provided the impetus for the establishment of an ICT council (the Australian Council of Deans of ICT, or ACDICT), the survey of recent graduates in the workforce, and the emphasis on greater industry liaison that led to the survey of employers.

Project outcomes and deliverables

The main outcomes of the project are:

- identification of the key issues and challenges affecting the higher education ICT curriculum in Australia and recommendations for addressing them
- establishment of an Australian Council of Deans of ICT representing all national ICT tertiary academic units. This council provides a sustainable framework for disseminating and addressing the recommendations
- broad consultation with stakeholders and dissemination of findings through consultations, meetings, conferences and publications.

The deliverables are:

- the results of a consultation process with a broad range of academic staff concerned with the teaching of ICT in higher education
- a national view from ICT graduates in the workforce in relation to their curriculum and how it met the needs of their job
- a view from a range of ICT employers on the capability needs of graduates
- recommendations to address identified issues.

Methodology

The methods used to achieve the outcomes included:

- development of processes for engaging with key stakeholders to gather information to derive a national perspective on the university ICT curriculum
- liaison with:
  - heads of ICT in Australian universities
  - heads of ICT industry
  - alumni organisations at Australian universities
  - conference and meeting organisers.
- consultation with a broad range of academic stakeholders and professional groups to obtain a representative view of the key issues and challenges in ICT higher education
- survey of ICT graduates with one to five years' experience in the workforce with respect to their current employment needs and the extent of university preparation for those needs
- survey of employers in relation to the capabilities they require from recent graduates
- synthesis of these diverse views to develop recommendations for the benefit of universities, students and industry.

Figure 2 shows the three areas consulted with respect to the university ICT curriculum.

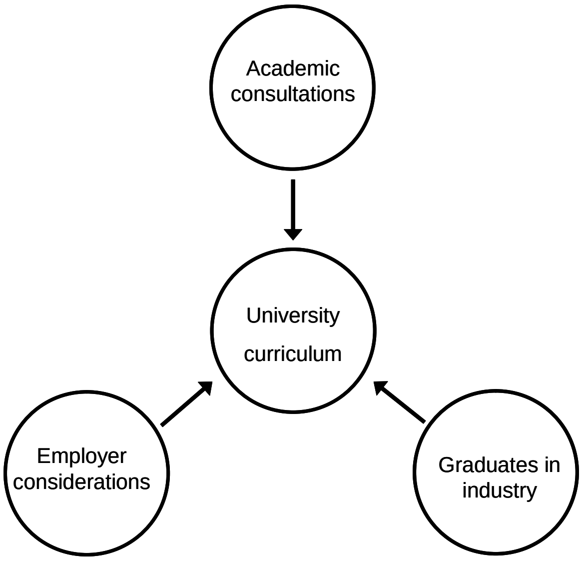

Figure 2: The three areas of consultation in relation to the university curriculum

The findings from these consultations are discussed in chapters 1 (Academic consultations), 2 (ICT graduates in the workforce) and 3 (Employers of ICT graduates). Further details of the methods used are given in the relevant chapters and appendixes.

Scope and distribution of ICT

In contrast to more established disciplines such as arts, engineering and science, there is no unified definition of the ICT discipline and the employment opportunities it offers. Currently, a diverse range of courses and degrees within higher education fall into the ICT arena. With the evolution of the discipline, the terminology used to refer to it has also changed. While ‘information and communications technology’ is now the dominant term, organisations such as the Institute for Electrical and Electronics Engineers Computer Society and the Association for Computing Machinery still refer to this discipline as ‘computing’, reflecting its original roots in computer science.

A simple and practical definition given by Dixon (2002, cited in Scholarios, Van der Schoot and Van der Heijden, 2004) for an ICT professional is one whose job involves ‘designing, developing, producing, installing, managing, maintaining or supporting systems for other people to use’. This definition is broad enough to suit most ICT people; however, it is also applicable to an Engineer.

For the purposes of this study, the disciplines in the ICT spectrum were taken to be electrical engineering, computer engineering, telecommunications engineering, software engineering, computer science, information technology and information systems. This selection is based on Tucker and Wegner (1996), with the addition of telecommunications engineering. There is agreement and disagreement with this list which is indicative of the breadth of the spectrum. ACDICT have since added electronics engineering and computer systems engineering to the list. The ICT disciplines, and their overlap with engineering and commerce, are shown in Figure 3.

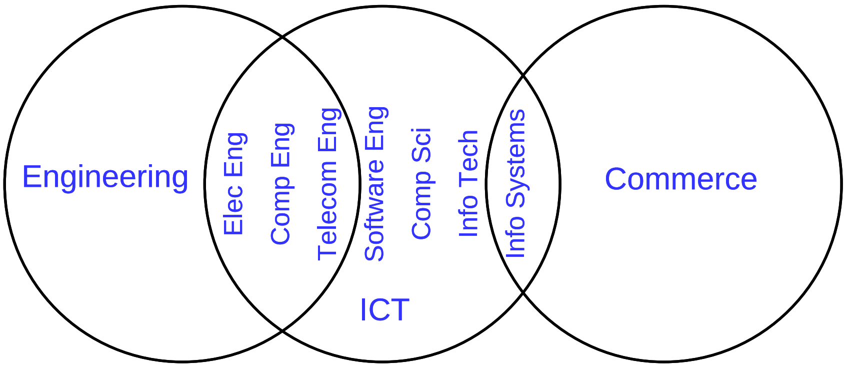

Figure 3: The range of disciplines within the ICT spectrum, showing the overlap with engineering and commerce

The boundaries shown in Figure 3 are not distinct and there is no hierarchy of ICT disciplines. Furthermore, the spectrum grades from hardware on the left, through hardware and software in the centre, to organisational needs on the right.

A different but broadly similar perspective on the ICT spectrum was given by the Monash University ICT-Ed Project (AUTC, 2001) which identified six broad categories of ICT courses:

- communications technology
- computing technology, at the electronic and circuit development level
- computer science and software engineering
- information systems within business commercial computing
- multimedia and multimedia systems
- information management

These categories can all be incorporated into the spectrum shown in Figure 3 even though it may be argued that multimedia should be seen as distinct. Again this illustrates the diversity of opinions in the ICT sector as to its precise composition, which is perhaps not surprising in a rapidly evolving field.

ICT teaching is distributed across different faculties and schools in most Australian universities, including engineering, science, business, commerce, and faculty of IT, and the extent of the range differs between universities. This has given rise to an ICT academic sector that is decentralised and fragmented. Before this project there was no peak representative academic body for the whole of ICT.

Crisis in ICT

The current crisis in ICT is generally attributed to falling enrolments since 2001 (DEEWR, 2008a) and the related skills shortage (NICTA, 2007). The number of high school students interested in working in ICT has been decreasing over the last few years. This is reflected in the number of enrolments in the ICT degrees offered by universities. Nationally, in 2008 (DEEWR, 2008a), there were 4,978 eligible applicants (compared to 14,642 in 2001), 4,923 offers and 3,716 acceptances for the field of 'information technology'.

There is general agreement among all ICT stakeholders – including governments, leading industry and professional associations, employers and the education and training sector – that a more effective approach to encouraging school students to pursue ICT courses and careers is required. There have been notable recent Australian studies in this regard (MMV, 2004a, 2007a; Raison and Etheridge, 2006), and successful approaches to increasing ICT enrolments in the United Kingdom by making ICT more relevant and meaningful to high school students (e.g., Curzon, McOwan and Black, 2008).

In 2007, the total number of students enrolled in 'information technology' in all Australian universities was 50,733, which was 8.9% less than in 2006. An unknown number of students in 'engineering and related technologies' would be part of ICT as defined above. The total number of students in this group for all Australian universities was 69,642 in 2007, which was a 5.2% increase from 2006 (DEEWR, 2008b).

The issues of falling enrolments, student recruitment and the negative perceptions of ICT by high school students and the general community are outside the scope of this project, which is primarily concerned with the university curriculum.

University ICT education

Compared to other fields, there is a short time lag between the foundations of ICT and its research and application in industry. Hence ICT curricula, particularly in computer science and engineering, have been under constant pressure to keep up with new concepts, developments and frameworks (Alford et al., 2004). At the same time, ICT has continued to be a rapidly changing sector. Skills can become obsolete very quickly (Weiss et al. 2006), requiring constant updating of knowledge, skills and competencies by professionals (Stucky and Weiss, 2008). The fast rate of change in ICT also requires constant updating by academic staff. The overall outcome has been rapid obsolescence of the curriculum. An additional challenge is the development of generic skills (i.e., non-discipline specific skills) in the curriculum to meet the needs of employers (AC Nielsen Research Services, 2000; Graduate Careers Australia, 2008).

In spite of the diversity of training in ICT and the many different pathways to an ICT career, universities remain the major providers of training of ICT professionals. At present, the cycle of development, implementation and review of ICT curricula in universities ranges between five and eight years. This is a significantly longer time frame than the pace of technological developments in ICT. Such misalignment has serious implications for the ICT curriculum.

One solution is to focus the ICT curriculum on providing fundamentals and foundation skills rather than specialised skills which become outdated with changes in market demand. However, this can make graduates less attractive for employers, as they may not be of immediate use unless they are further trained. Maintaining a balance between fundamentals and specialised skills in the curriculum is a challenge.

Universities have used a variety of approaches to address this misalignment:

- providing education and training across a number of technological platforms in the curriculum – for example, offering training in Microsoft applications as well as open-source software such as Linux
- covering fundamentals and basic concepts in lectures, and providing practical skills and experience through laboratory work
- focusing on industry placement as the essential element of the degree. This has been implemented in various ways, for example, as a subject or one-year

industrial experience in sandwich courses (e.g., working in industry for the third year of a four year course) . Such programs can be challenging to maintain in the event of an industry downturn. It is noteworthy that Universities Australia (2008) has advocated a national internship scheme to enhance the skills and work-readiness of Australian university graduates.

- providing double degrees by combining ICT with commerce, arts, law and other disciplines. This provides greater flexibility and certainty in employment for ICT graduates and also adds value across sectors.
- increasing the international focus of the ICT degrees to help students be more culturally sensitive and globally prepared for employment in other countries. The globalisation of ICT is a growing industry trend (Houghton, 2006). This may also make ICT courses more appealing to overseas students.

Overall, the ICT courses in universities can be categorised as technically ‘hard’ courses that include computer science and engineering, and technically ‘soft’ courses typically known as information technology (IT). As noted above, in most Australian universities these courses are distributed across different faculties and schools, and solutions to an optimal ICT curriculum are necessarily related to the location of the university (e.g., rural or city), particularly if courses are associated with local industries.

ICT industry

The ICT industry has evolved over the last 30 years at an unprecedented pace. In spite of the non-linear nature of this growth, the sector has become quite robust with high resilience. The depth to which information technology has permeated every aspect of society has been the biggest factor driving the industry. The use of ICT in industry generally gives productivity benefits to employers (O’Mahony and Robinson, 2003; Turcotte and Rennison, 2004; Clayton, 2005; Draca, Sadun and Van Reenen, 2006), even though skilled ICT staff with appropriate skills may be difficult to find (Forth and Mason, 2004 and 2006) because of the global ICT skills shortage (Harris, 2007; KPMG, 2008).

Apart from the ‘dot.com’ and telecommunications crashes in the opening years of the 21st century, growth has been positive, requiring a constant flow of skilled human resources into the sector. Despite the recent global financial crisis, Taranto (2008) and CeBIT (2008) believe that the ICT sector will continue to grow. Likewise, LeMay (December 2008) believes that there is little evidence to warrant the cutting of jobs in the Australian ICT sector. However, job cuts in ICT are expected in other parts of the world such as the United Kingdom (Lomas, 2009).

According to a recent Australian Government (2006) report, the ICT industry profile was as follows:

- In 2004–05, total revenue in Australia from the production of ICT goods and services was $54.4 billion.
- Sixty per cent of this revenue was from telecommunications services.
- ICT industries in Australia earned a total income of $103.3 billion in 2004–05; ICT specialist firms accounted for 89.1% of this total.
- In 2002–03, ICT accounted for 4.6% of Australia’s total gross domestic product (GDP).

There were approximately 371,150 people employed in ICT-related positions across the economy in August 2006, 84.5% of whom were men. Between 2002 and 2006 the ICT vacancy index has demonstrated a clear upward trend, rising by over 200% to 304.9 (November 2002 = 100). The Australian Computer Society reported that there were 514,000 people performing ICT technical and professional tasks in the country (ACS, January 2008), which shows that the ICT industry is a major employer. Despite the recession and ongoing ICT skills shortage, Australian-owned ICT companies are apparently still growing. These data underscore the importance of the ICT curriculum in providing skilled graduates to support the substantial and evolving ICT industry. The strongly male-dominated workforce also implies that a more gender-inclusive curriculum may be desirable to address the gender imbalance.

Chapter 1: Academic consultations

Introduction

This chapter reports on the results of the consultation with a broad range of academic staff, which aimed to uncover the issues and challenges facing ICT education. These consultations took place between August 2007 and March 2008. Three types of consultation were undertaken:

- Deans' consultation – consultations with senior individuals and groups from nine Australian universities
- Canvassing of deans' statements – canvassing of statements arising from the deans' consultation among various other groups
- Free-text responses – written expressions of major concerns from a broad range of groups.

The consultation process included interviews and surveys, mostly conducted face-to-face. The University of Wollongong Ethics Committee did not express any concern over the way the consultation data were collected or were to be used. Those consulted included:

- for the deans' consultation, small groups consisting of the dean, usually a head of school and various other staff from nine Australian universities (this also included consultation with various heads of school of ICT, usually where the dean was not an ICT person)
- the Australian Council of Professors and Heads of Information Systems (ACPHIS)
- the heads and professors of the Computing, Research and Education Association (CORE)
- other members of CORE who responded to an email request for information by the CORE President
- attendees at various conferences covering the ICT spectrum.

Forums were held at a range of conferences: the Australasian Computing Education Conference (ACE); the Australian Software Engineering Conference (ASWEC); and the International Conference on Engineering Education and Research (iCEER). In addition to the forum at ASWEC, a panel session entitled 'Issues in ICT Education' was also held at the conference, which was recorded and transcribed. In total, 112 written submissions were received, over 20 interviews were conducted, and 30 people participated in the ASWEC panel session.

To determine whether the views expressed in the deans' consultation process were widely held, a selection of 24 common statements was abstracted. These were given to the other stakeholder groups to gauge their agreement and to gain wider input. The participants in each group forum were asked to provide written responses. In addition, all these groups were asked to write down their main concerns about ICT education and the outcomes they would like to see from the project.

During the consultation activities, individuals and groups were asked to name relevant stakeholders in ICT. A large list was compiled after the first few consultations, and subsequent groups were asked to pick the most important five (voting system) in an attempt to identify the most relevant stakeholders for inclusion in the project. The most relevant stakeholders became obvious by the frequency they were mentioned in discussions and these corresponded to the outcome of the voting system. For the sake of completeness, some background information has been provided in this chapter for the major stakeholders identified.

Further discussion of the methods used in the academic consultations and the refined results of these consultations are presented in Appendix 1.

Results and discussion

Deans' consultation

Table A1.1 in Appendix 1 gives a compiled summary of the discussions held with deans, heads of school and other academic staff at various universities under 14 categories. The key points under each category are discussed in turn in this section. The categories do not exist in isolation and there is an unavoidable (if not desirable) degree of overlap across many of them.

Project emphasis and main concerns

This category sought people's views on what the priorities for this project should be.

Many felt that the university ICT sector was fragmented and lacked an overarching representative academic body. Academics generally thought that such a body was needed to liaise with industry and the government and that a useful project outcome would be the creation of such a peak body.

Various stakeholders were identified with whom the project (and peak body) should engage, notably the Australian Computer Society (ACS); the Australian Information Industry Association; Engineers Australia; the Computing, Research and Education Association; and the Australian Council of Professors and Heads of Information Systems. The contribution of these professional bodies to the university curriculum is discussed later in this chapter under 'Stakeholders in the university curriculum'. The association of universities with industry was seen as essential to help provide a relevant student experience and enhance employability.

It was widely thought that the project should not just focus on universities but adopt a holistic approach to include all relevant stakeholders, including high schools, industry (employers), professional bodies, the government and students at all levels, including graduates in industry. It was suggested that the project build on recommendations from the earlier Monash University study (AUTC, 2001). Several recommendations from that study were concerned with seeking input from graduates in the workforce as well as identifying employer needs.

Many said that ICT education is in crisis and that the project should be concerned with improving student recruitment. A major reason for the ICT education crisis is declining enrolments (Dobson, 2007), despite increasing industry demand (Davidson, 2005; Foresighting Working Group, 2006; Australian Government, 2007; ACS, 2008). The ACS (2008) predicts that the ICT skills shortage will grow 29% by the year 2010 to just over 14,000 jobs unless immediate action is taken. A recent report (Winterford, 2008) indicates that the Australian ICT jobs market is still buoyant, and growth is expected to continue into the foreseeable future despite the global financial crisis. The statistics given by Dobson (2007) illustrate a marked average decline in enrolments of over 18% in the period 2002 to 2005, and recent Australian Government figures indicate that the rate of decline of eligible applicants is showing signs of slowing, with a decline of only 11.4% between 2006 and 2008 (DEEWR, 2008a. The decline in enrolments has led to downsizing of several university ICT schools and departments.

It was felt that the decline in enrolments is largely because of what happens in high schools because that is where student perceptions of ICT and an ICT career are formed (MMV, 2004a, 2007a). The recent research showed that a major barrier to further ICT study was the perception that a job in ICT involves sitting in front of a computer all day and that an ICT career would be boring. Participants stressed the need to improve perceptions of ICT and career prospects in the general community.

The quality of ICT teaching in high schools was also thought to be less than it should be. There was support for industry playing a more active role in education at all levels.

Participants felt that identifying best practices and sharing them across the ICT higher education sector would also be valuable.

Major achievements
The major university achievements with respect to ICT education include working with industry and providing students with relevant, authentic learning experiences to prepare them for the workplace. Real-world engagement was a common theme (see also Bruce et al. 2006). The teaching of fundamental principles and development of generic skills relevant to the particular discipline were also seen as essential to producing versatile and adaptable graduates in a rapidly changing industry.

Forming partnerships between related disciplines and keeping existing ICT groups together were cited as common strategies in a sector that is perceived to be fragmented.

Challenges
Numerous challenges were expressed, many of which relate to the suggested project emphasis discussed above. The challenges include:

- creating an effective, representative, unifying council that is able to liaise with relevant stakeholders and organisations
- combating the erroneous and poor perceptions of ICT and job prospects in schools and the community at large
- reversing the decline in student enrolments (particularly among domestic students and women) and the consequent loss of university capacity to maintain quality and survive the downturn
- increasing the involvement of industry in education at all levels and clearly expressing skill requirements by industry for the future
- establishing better links with high schools and having more influence on their curriculum, especially with respect to complementary subjects (such as science and maths) for ICT.

The nature and status of the ICT profession was a major concern. It was often compared with engineering (probably because ICT has some overlap with engineering) and ICT was thought to be a less well-defined profession in contrast. A common suggestion was the development of a chartered professional status, and that the ACS should be pursuing that. However, because it is computer science oriented, the general feeling was that the ACS did not fully represent the ICT spectrum and was therefore not as effective as it might be. It was suggested that the ACS should partner with Engineers Australia for greater scope, effectiveness and credibility.

University courses were thought to face many challenges in a depressed market, particularly in relation to rapid industry changes and uncertainty about precisely what industry and student needs are. An issue on which views were polarised was the proliferation of degrees, which was done for marketing purposes, even when the large number of degrees had much in common and some were barely distinguishable. Several participants called for simplification of the degrees – for example, a core generic degree with a major in special fields – to make them clearer to employers.

Gaining a better understanding of students was an issue, particularly in regard to motivation, class attendance and attrition rates. This may be linked to the claim that ICT attracts academically less able students and/or the problem of blending local and international students, and possibly includes the gender imbalance in ICT. There is a general concern about attrition rates in Australian universities (Universities Australia, 2008b). While attrition rates vary considerably across institutions and student groups, rates in the first year are generally double those in the second year (DEST, 2004). There is general concern about attrition rates from ICT, including among of women (Sheard *at al*., 2008). A national study found that information technology has a higher attrition rate than the following fields of education: engineering and related technologies, natural and physical sciences, medicine, dentistry, veterinary science, law, health (excluding dentistry, medicine, veterinary science), and management and commerce (McMillan, 2005). Further research is required on this issue with respect to the ICT spectrum.

Learning and teaching challenges included expanding the scope of workplace learning especially for the benefit of poorer students; adopting enquiry-based learning; developing business skills; and addressing the time lag between industry innovations and their inclusion in the curriculum. These challenges were connected with a general desire for greater industry collaboration in education at all levels and in providing all ICT students with workplace experience to develop industry-ready skills. Collaboration would also help alleviate the negative industry perceptions held by students and the general community.

The challenge of achieving greater collaboration with industry was likewise expressed for high schools. The links between universities and high school teachers are often minimal. This leads to uncertainty among academics about what is being taught in high schools, what high school teachers' attitudes are, and what advice is being given to students. The general feeling was that the quality of ICT teaching in high schools is poor. Influencing the high school ICT curriculum was seen as challenging, as was involving the deans of education to help improve the general situation.

The future of the discipline was seen as being under threat from several quarters. Because ICT is an enabler for many disciplines, its teaching is being taken over by some of those disciplines, which erodes central expertise and weakens the discipline as a whole. The ICT spectrum overlaps with other disciplines, notably engineering, and this was perceived as an amalgamation threat due to the downsizing and restructuring that occur in response to declining student enrolments.

On a national scale, survival of the discipline was seen as threatened by a lack of senior academic leaders and recruitment into academia. Also seen as a threat was the fragmented nature of the ICT sector and lack of consensus as to what ICT includes – for example, views were polarised as to whether or not the ICT engineering subjects are integral to the ICT spectrum.

Industry connections and influence on the curriculum
The involvement of industry was seen as important in student learning and academic staff professional development. Students may become interested in ICT through industry products, such as graphics and animation they see in movies. Industry is involved through student placements, collaborative student projects, research projects and advisory boards. These placements and collaborative projects can provide authentic experiences for students and staff. Industry influences the curriculum through the demand for certain graduate attributes as well as requiring fundamental and up-to-date knowledge. Achieving the optimal balance between these can be challenging.

However, industry engagement was generally considered inadequate because industry is not involved in curriculum design and there are no mechanisms for it to provide regular feedback on the curriculum. Industry requirements were not always clear in the face of rapid technological changes. It was also thought that industry should provide more funding for projects.

Curriculum and staff flexibility
Flexibility is concerned with adapting the curriculum to keep up with rapid changes in technology. It was reported that most staff are flexible and that ICT curricula generally change more quickly than in other disciplines, even though the university system was seen as a barrier to rapid change and flexibility. Staff flexibility is enhanced through industry relationships and association with young staff recruits.

Teaching and research connection
Several participants reported that there was really a three-way connection, as shown in Figure 1.1, where teaching, research and industry are interrelated. They noted that industry is often at the forefront of ICT research, which impacts on academic teaching and research through different pathways, such as collaboration in a Cooperative Research Centre. Industry usually feeds research into academia (and vice versa) through collaborations and joint research projects with staff and students.

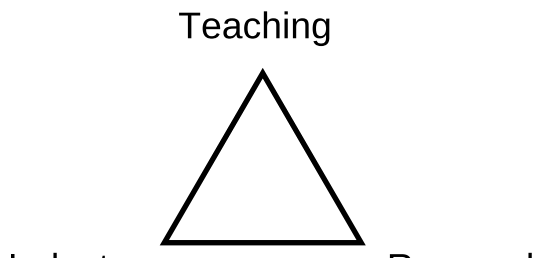

Figure 1.1: The teaching, research and industry nexus

There has long been a broad range of views as to how the teaching–research nexus is manifested in higher education (e.g., Neumann, 1992; Trowler and Wareham, 2008), and the views expressed in the consultation process reflect that diversity. Various connections expressed between teaching and research included research changing teaching and being brought into lectures; summer scholarships directly involving students in research projects; and undergraduate students undertaking research projects as part of their coursework. Lack of agreement was evident in that some people noted that the connection was a long tradition and others that it was in its infancy.

Enquiry-based learning (EBL, which is active learning where students pursue enquiry while drawing on the knowledge they have and identifying what they need to learn, e.g., Kahn and O'Rourke, 2005) was mentioned by some participants. A few expressed a desire to engage with it, while some said it exists in a few pockets and others that it is being widely practised. Likewise, problem-based learning (PBL) was reported as being tried in a few areas. This seems to be in contrast to the trend in engineering education (which overlaps with ICT), where PBL is being actively promoted (e.g., de Graaff and Kolmos, 2007; King, 2008).

Research into teaching is occurring in some locations and practiced by some staff, but it is apparently not the norm.

Vision for the next few years and long term

The vision for the future of ICT was generally optimistic. Respondents were hopeful that the perception of ICT will improve among students, job vacancies will be filled, and enrolments will increase, and ICT will be established as a well-respected profession. Other expectations were that ICT itself would evolve, such as becoming more focused on the development and system level and more service oriented, and that changes would create jobs that do not exist today.

There was also optimism about forging better links with government, industry, high schools, and the technology and engineering sectors. This was despite the concerns about the current lack of a vision from industry, the education sector and government regarding the future of ICT. It was felt that there should be wider acknowledgment of ICT's role in driving business and creating new economic prosperity.

Participants expected that there would be continual improvements in teaching, including:

- joint degrees (integrated) as well as double degrees, which are common but currently tend to be separate with minimal overlap
- more emphasis on innovation, creativity and critical thinking
- greater engagement through experiential learning as well as internships in industry for all undergraduate students
- continual development of multidisciplinary skills in graduates in terms of knowledge and industry needs
- greater involvement by industry in teaching.

Participants in discussions also expected an increase in postgraduate students and felt that the teaching of ICT would increase in other disciplines such as medicine and law.

Research would be more use-inspired (i.e., meeting community needs) which would have a greater impact in industry and society. The expected expansion of industry partnerships with Cooperative Research Centres would improve research and education.

At the time of interviews there was no mention of emerging 'green ICT' developments, although the Australian Information Industry Association (AIIA) had it on its agenda (Michel Hedley, AIIA Executive Officer, personal communication). Since then there have been many developments, such as the ACS policy statement on green ICT. This policy is concerned with reducing carbon dioxide emissions from ICT usage, which are greater than the national emissions from civil aviation (ACS, August 2007). ICT usage accounts for approximately 2% of global carbon dioxide emissions, which needs to be reduced. There is also a huge potential for ICT to significantly contribute to reducing the remaining 98% of emissions from other activities and industries (Mingay, 2007). This presents an enormous opportunity for research and industry linkage.

Benchmarking – university comparisons

It was generally thought that benchmarking was a necessary and valuable process, and that national and international comparisons should be made to improve standards and performance. Comparisons with and between various groups were suggested, such as the Australian Technology Network of Universities (ATN), Group of Eight Universities (Go8), and Universitas 21. The UK model for external examiners of courses was thought desirable, particularly for cross-fertilisation between universities. The UK Teaching Quality Assessment process was thought useful for identifying best practice.

Although it was not mentioned during formal consultations, it would be worthwhile to examine the impact of the UK Higher Education Academy's Subject Centres on the quality of ICT higher education in the United Kingdom. The Information and Computer Sciences Subject Centre (ICS, 2008) supports learning and teaching in ICT at a national level, and the discipline has issues and challenges that are very similar to those facing the ICT sector in Australia (Koppi et al., 2008).

Curriculum: industry-ready graduates

It was generally thought that graduates were adequately prepared for industry because their comprehensive training in fundamental principles made them adaptable. However, it was acknowledged that most graduates needed further training once they are working in industry. It was noted that current employability was high because of the skills shortage and industry demand, and that good students have little problem gaining employment.

Comments were made that students with workplace experience (e.g., industry placement for several months) have an advantage. Real-world experience is recognised as important and is provided by students working in teams on authentic industry projects as undergraduates. It was thought by some that there was close industry involvement in curriculum development through faculty advisory committees. However, others thought that the industry contribution to the curriculum was minimal.

High school – university – employment links

While it was acknowledged that industry makes valuable contributions to marketing and adds real-world value, it was generally felt that links were weak and that the relevant parts were not working strongly together. Some felt that the potential to educate young students in the opportunities of ICT as a career was not being realised.

Cross-discipline links

The ICT spectrum overlaps with engineering (electrical, computer and telecommunications engineering) and commerce (information systems, or IS) (see Introduction, Figure 2). However, the integration of IS with business groups was thought to be not as strong as it could be. Other parts of the ICT spectrum were also said to have links, such as computer science and engineering. Cross-discipline examples included biosciences, economics and aviation.

It was also observed that other disciplines were taking on their own ICT teaching, such as computers and geosciences, computational physics, civil engineering, and digital media in arts. This was seen by some as a threat. Alternatively, ICT service teaching was provided centrally for a number of faculties, but that was not without the difficulty of meeting the needs of small disciplines. A possible barrier to greater cooperation between disciplines was the erroneous perception by other academics that ICT is all about programming.

Double degrees in ICT and other disciplines are common, but these were often seen as occurring more in parallel than being fully integrated. More integration was seen as a desirable future development.

Examples of good practice

Generally, participants felt that identifying and sharing good practice in ICT teaching would be desirable for the sector. Some noted that this was already happening in limited ways, such as through local showcases and support websites. It was suggested that an indicator of good practices and educational trends would be a public website showing the internally and externally (e.g., Australian Learning and Teaching Council) funded ICT education projects. Examples of good practices included developing generic attributes through small group projects, and employing authentic problem-solving activities related to industry.

Council of Deans and Heads of School

During the consultation phase of the project, the Australian Council of Deans of ICT (ACDICT) had not been formed. An interview question was concerned with the value or usefulness of a peak academic body, tentatively named the 'Council of Deans and Heads of School'.

Generally, participants felt that a unifying body was desirable. Existing professional bodies of academics such as the Computing Research and Education Association and the Australian Council of Professors and Heads of Information Systems were seen as too parochial. The general feeling was that existing organisations did not, and could not, represent the spectrum. However, considerable reservation was expressed about the ability to form an effective unified body because of the fragmented nature of the sector.

High school teacher links

Generally it was felt that links with high school teachers could be improved and that direct links between ICT high school teachers and universities were poor to non-existent. There are outreach programs for students, but few if any professional development opportunities. It was noted that university marketing organisations made contact with careers teachers and others who provide career advice to students rather than contacting ICT teachers themselves.

Conclusions from the deans' consultation

The sector is in crisis because of declining student enrolments and the erroneous and poor perceptions of the ICT profession and career prospects. The lack of an academic representative peak body is contributing to the fragmentation of the sector. Such a peak body is required to provide a unified voice for key stakeholders, including professional bodies, high schools, industry and government, in relation to ICT education. However, formation of such a peak body may be difficult in a fragmented sector.

It is worth noting the similarity between Australia's situation and the ICT situation in New Zealand as reported by McCallum (2006, p. 6), who concludes: 'At this stage industry and academia need to be working together to develop more solutions, and to approach central government to assist in implementing some of these solutions.'

A major challenge is surviving the downturn in enrolments, and any industry downsizing with possible loss of capacity, in an environment with increasing industry demand for skilled ICT personnel. Establishing better links with industry would enhance research and professional development opportunities for university staff, provide further workplace and authentic experiential learning opportunities for students, and facilitate the development of relevant curricula and industry-ready graduates.

Perceptions of the ICT profession need to be clarified and improved. Apparently the implementation of the Computer Professional (CP) Program of the ACS following extensive consultation with ACS members, industry stakeholders and academia (ACS, September 2006; ACS Staff, Information Age, 2006) has to date had little recognition or impact. This indicates that communication between the ACS, academia and the general community needs to be improved. More recently, the ACS has taken steps aimed at developing an international accredited IT professional status (ACS, March 2007). Providing such professional status (similar to other disciplines such as engineering and accounting) would improve and strengthen the perception of ICT professionals in the community at large and help alleviate threats of amalgamation, loss of discipline teaching, and further capability attrition and fragmentation.

The nature of the teaching–research nexus needs clarification, particularly in terms of student learning processes and the use of enquiry-based or problem-based learning techniques, which is increasing in related disciplines such as engineering. Such teaching processes that improve student responsibility for learning and focus on generic attributes may enhance the development of industry-ready graduates and their employability. Better identification and sharing of good teaching and learning practices in the sector would help clarify the issues.

Probably because of the rapidity of change in ICT, limited connections between relevant parties, and financial and institutional constraints, the quality of ICT education may be less than optimal in some high schools and universities. Greater liaison between high schools, universities and industry would help alleviate shortcomings and facilitate staff development opportunities.

Canvassing of deans' statements

Members of the academic community were canvassed with a paper-based survey to gauge their level of agreement with 24 of the opinions expressed during the deans' consultation process. Participants included various academic groups and conference attendees. Details on participants, the 24 statements and the compiled results are provided in Appendix 1.

There was strong agreement about the necessity of improving the perception of the ICT profession among students and the general public. Most respondents also strongly agreed that high school careers advisors need to be better informed about the ICT profession. It seemed ironic to many that ICT, which is ubiquitous in society and plays an essential role in most businesses and everyday technologies, needs to improve its image.

Also high on the agreement list was the statement that links between high schools, universities and industry should be strengthened. Most respondents agreed that industry should engage more in ICT teaching at all levels (although more with universities than with high schools), and that currently industry does not play an integral role in teaching and research. There was also strong agreement about the need for industry to support education to give students workplace experience and opportunities to work on authentic industry projects.

There was relatively strong agreement that former graduates can provide valuable perspectives on their curriculum, and that graduate students in ICT employment should be consulted about improving their degree experience.

The statement that this project should be concerned with improving learning and teaching was on average about halfway down the list. This indicates that there are broader issues affecting ICT education than the implied focus of improving classroom teaching. This would also explain why the statement about student opinions leading to curriculum improvements was on average below halfway on the list: there are wider issues impacting on ICT educational improvements than gathering or even acting upon student opinions. Likewise, the statement that ICT education issues can be addressed by research-driven learning and teaching was also relatively low on the list, indicating that other factors affecting education are at least as important. Similarly, the statement ‘Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research’ was relatively low on the list, indicating that other factors affecting ICT education are perceived as more important under current circumstances. Respondents’ strong disagreement with the statement that the project should focus more on universities than anything else also supports the theory that ICT educational improvements depend significantly on external factors.

While the deans’ consultation indicated that a representative peak body to address sector fragmentation was important, support for this in the canvassing was not as uniformly strong (it ranged from 6th to 19th on the list of 24 items). However, there was strong agreement that the sector needs to identify and share good educational practices. The implications of this are that sharing does not happen because the sector is fragmented and/or because of the lack of a credible representative academic body to facilitate the process.

Perhaps surprisingly, the statement that the deans of education have a responsibility for ICT teaching in high schools was very low on the list. While it would probably be acknowledged that the deans have some responsibility for preparing high school ICT teachers, the general belief seems to be that any perceived deficiencies with high school ICT teaching lie outside the deans’ sphere of influence.

Support for benchmarking with overseas educational practices was moderate, averaging about halfway down the list. Perhaps this reflects the feeling that the considerable Australian challenges should be addressed at the local level first.

There was a divergence of opinion regarding the proliferation of ICT degrees, which was very low on the list. Apparently the proliferation is seen as a necessary marketing exercise to attract students, even though having many degrees with different names may be confusing for employers.

Conclusions from canvassing of deans’ statements

There was broad agreement between the canvassed groups and those consulted in the deans’ consultation process. This confirms that there are common concerns across the sector.

The consultation process identified the main factors that affect ICT higher education and the further canvassing of these views by a paper-based survey allowed a hierarchy of concerns to be constructed. These are summarised and grouped into a dependent hierarchy of 10 factors in Figure 1.2, which, like Maslow's hierarchy of human needs (Maslow, 1943), requires the basic needs (lower ones) to be satisfied before the higher ones can be entertained. For example, at the bottom of the hierarchy, if the public perception of the profession and career opportunities is inaccurate, then accurate career advice cannot be given to students in high schools. Similarly, working up the hierarchy, there will not be sufficient enrolments in ICT in universities until the perception is improved, career advice is accurate, and there is good teaching of ICT in high schools.

Figure 1.2 shows that consideration of the improvement of university learning and teaching does not occur until passed half way from the bottom because the sector remains in crisis until the first six items are resolved. The quality of university learning and teaching cannot be improved nationally if there are no enrolments and the sector is too fragmented to be efficient.

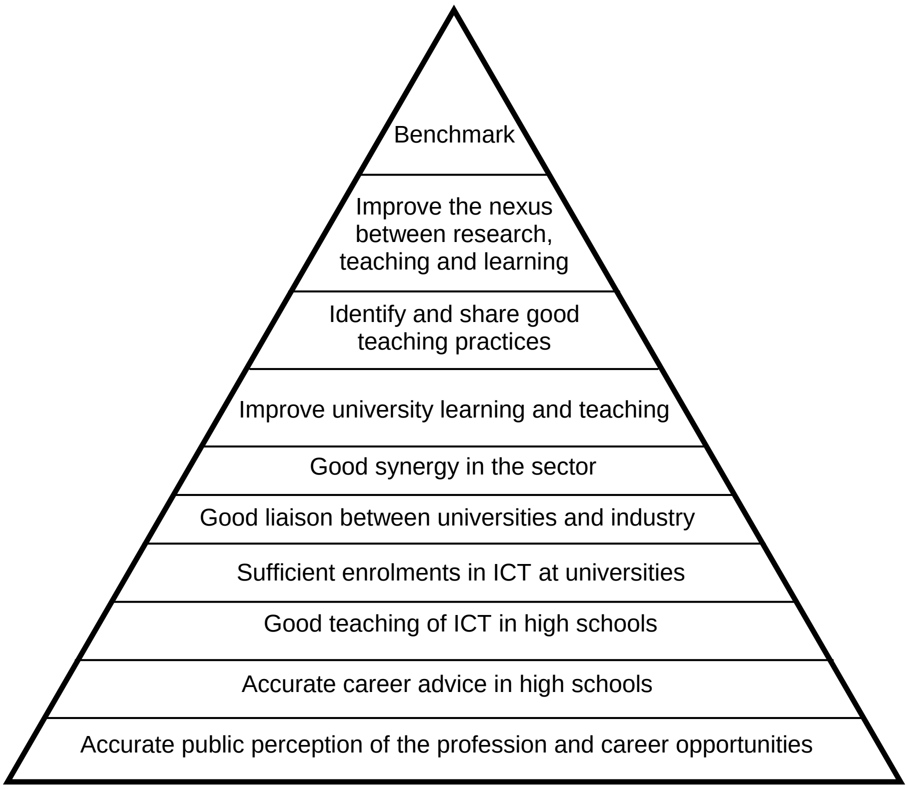

Figure 1.2: A hierarchy of priorities for ICT education, which starts at the base and progressively requires the lower levels to be satisfied before moving up to the higher levels

Moving progressively upwards through Figure 1.2: when the sector is thriving and good learning and teaching practices are identified, these can be shared among the community. Higher-level thinking about improving the research–teaching–learning nexus can be developed when identified good practices have been analysed. It would then be possible to benchmark by comparing and evaluating local, national and international practices. Figure 1.2 illustrates a sequence of identified issues that need to be addressed in ICT higher education.

Free-text responses

This section summarises the findings from the processed free-text (handwritten) responses from ACPHIS, professors and heads of CORE, other CORE members, combined conference forums (iCEER, ACE, ASWEC) and a transcript of the recorded ASWEC panel session.

Poor perception and understanding of ICT and the profession
Participants expressed a general concern about the misunderstanding and misperception of ICT and its component disciplines and career prospects among students, parents, women, career advisors, teachers and the broader community. It was felt that this problem rests with high schools, universities, government, industry, ACDICT and the ACS. Respondents saw a need to clearly define and better market the profession, preferably through an orchestrated process involving the various stakeholders.

Suggested activities included developing a better understanding of students by academic staff, and the relationship between their perceptions and enrolments, and providing a single comprehensive source of information (such as a website) on degrees, career prospects and remuneration, including the essential and global role of ICT. It was also noted that developing a common language across the ICT spectrum would be beneficial, particularly if a central website is developed. It was also recognised that to get people more interested in ICT study and change perceptions of the field would require a culture change across several levels, including high schools and government.

The ICT profession itself was thought to be vague, not clearly established, lacking accreditation and recognition, and in need of better definition – although it was acknowledged that this may be difficult because of rapid change. The profession was compared with engineering, which was generally thought to offer better accreditation and professional status.

Fragmented community
The sector (comprising universities, industry, government, TAFE, ACDICT and the ACS) was seen as fragmented and requiring better liaison and unity of purpose between the relevant stakeholders. The relationship between universities and industry was thought to require improvement in both teaching and research, particularly in the contribution made by industry. Communication was thought to be lacking at all levels: between the disciplines comprising the ICT spectrum within universities; between ICT disciplines and other disciplines using ICT; between universities; and between universities and other stakeholders.

In general, the ACS was not thought to represent the whole ICT spectrum. Participants noted that the ACS excludes the overlap with engineering, and they felt that to be more effective and representative the ACS would need to work with Engineers Australia.

Expectations of ACDICT
It was seen as a challenge for ACDICT to control a sector that is fragmented, diversified and replete with competing technologies, ideologies and opinions. As well as providing opportunities, such as a lobby group for ICT higher education, government and industry, ACDICT was thought to present risks. For example, it could contribute to the fragmentation of the community if it were not representative of a diversified sector and did not have broadly achievable objectives. It was stressed that ACDICT must be inclusive of industry (or at least have a practical working relationship with industry) and consider and act upon industry recommendations.

ACDICT would need to represent the sector and provide appropriate advice on ICT education and what is taught at different levels. To be effective, it was suggested that

ACDICT needed to gather a range of reliable information, including employer and graduate requirements, and what universities would like high schools to teach, to better prepare students for ICT higher education. With reliable information it was expected that ACDICT would improve teaching and also change the perception of ICT in the wider population.

Educational quality in schools and universities

Participants expressed widespread concern about the quality of education in high schools. High school teachers were thought to be poorly informed about ICT, not always appropriately qualified (because of a shortage of suitably qualified teachers) with inadequate resources, and using outdated teaching approaches that do not match university requirements. It was suggested that these teachers need to liaise more with universities regarding the curriculum, with the aim of emphasising how ICT affects society at many levels and making ICT learning more enjoyable. Prospective ICT students were also thought to be lacking depth, particularly in maths, because of high school teaching deficiencies. School leavers were thought to have developed negative qualities at school, such as distaste for rigorous methods, a belief that there is little more to learn about ICT, and erroneous perceptions about a career in ICT.

Improvements in high school ICT teaching would help to improve some of the misperceptions of ICT expressed by high school students (MMV, 2007a). There are several possible mechanisms for changing perceptions of ICT. For example, a website, and associated magazine (cs4fn, 2008), developed by Queen Mary, University of London, have been used in high schools in the United Kingdom with a positive effect on student perceptions and engagement with ICT and subsequent university enrolments (Curzon et al., 2008).

The quality of ICT education in universities was also of concern. It was observed that keeping up to date with rapid digital advances may be a problem for academic staff. This was seen as an aspect of professional development for ICT academic staff that deserved as much attention as ongoing professional development in learning, teaching and supervision. Furthermore, in a rapidly changing environment, academic staff may not always be up to date with industry requirements. It was suggested that academic staff, like students, would benefit from industry placements. Working collaboratively with industry on various projects would also enable academic staff to keep abreast of developments.

It was suggested that university teaching quality could be raised by lessening teachers' workloads, providing more reward and recognition for good teaching, encouraging innovation in teaching approaches, and conducting research into teaching. Suggested research topics included action research onsite with industry to analyse projects and outcomes; studio learning; problem-based learning; and appropriate assessment methods.

The university ICT curriculum was thought to be in need of improvement in several respects. Because of declining ICT enrolments, a drop in entrance requirements attracts students of lesser abilities, which could threaten quality standards. Also of concern was the trend towards offering lower-quality courses to attract overseas students. Benchmarking degrees across the sector and the greater involvement of a broad range of industry groups in curriculum development were suggested as means of maintaining standards. It was also suggested that, as well as meeting the needs of industry, curricula should also integrate with high schools and society.

To develop adaptable, industry-ready graduates with flexible career options, it was suggested that curricula need to include fundamental knowledge and skills and business understanding, and to incorporate new areas such as business applications, multimedia, social media and creativity. Generic attributes were also noted as being essential, including good social skills, critical thinking capabilities and communication skills. It was acknowledged that an appropriate balance of knowledge, skills and attributes was necessary and that there was a tension between university curricula and industry requirements. Alignment of curricula with international standards, such as the Skills Framework for the Information Age (SFIA, 2008), could be of benefit.

Other suggestions for improving the curriculum were making courses more transparent and outcomes based, and providing more double majors to include the business perspective. Consideration of the student perspective was also thought to offer improvement opportunities, such as finding out why students withdrew from courses, and identifying problems with teamwork, motivation and attendance.

Declining enrolments

Several people expressed the view that it was of no consequence how good the teaching methods were if there were no students. Many people were of the opinion that the focus should be on high schools, although TAFE was also noted as an intake source for universities. It was suggested that information about ICT careers should be more accurate in high schools and that ICT courses should be more relevant to students. The government was seen as taking little interest in or action on the low numbers of ICT students in higher education, despite the increasing industry demand for skilled ICT professionals. It was suggested that remedial strategies, including additional funding, were required.

In association with ACDICT, it was suggested that industry should lobby the government and market ICT at the school level. Industry was also thought capable of delivering a national ICT advertising campaign for the community at large. It was also suggested that the ACS should contribute to marketing the profession, and enlist its younger members to promote ICT to students.

As well as ensuring that universities provide relevant courses to students, ACDICT was perceived as having the potential to develop a unified higher education sector by developing working relationships with key stakeholders, such as industry and the ACS, and to contribute substantially to the development of a marketable profession.

The relationship between industry and universities

There is clearly a tension between how and what universities want to teach and the perceived requirements of industry. For example, industry was accused of being more interested in skills and competencies than knowledge and education, and of being remote from and sceptical about university education. It was observed that to clearly identify what capabilities industry requires of graduates, the relationship would need to be better.

There appeared to be considerable willingness on the part of academia for industry to be more involved with education. Participants were also interested in engaging with industry to gain a better understanding of the skills and knowledge required for particular professions, and to develop more industry-integrated curricula that included optimal work experience practices for students. More involvement by industry with the curriculum would ensure that universities are producing tomorrow’s business owners and leaders in meeting the requirements of industry-ready graduates. It was felt that industry could do more to promote and market ICT as a worthwhile career to students.

Once the inertia of working together was overcome, it was felt that industry could also play a bigger part in research. It was noted that this would require more financial investment in universities by industry, but that there would be mutual benefits. For example, academic researchers would be brought up to speed with commercial advances in ICT, and academia would be generally better informed about industry requirements.

Other industry issues

Apart from the industry–university relationship itself, other issues were raised regarding industry and its impact on universities. Despite the increasing industry demand for skilled ICT workers, it was felt that there is a shortage of sensible career paths for today's graduates. One reason given was the increasing trend of sending ICT jobs offshore. The ACS predicted a substantial net loss of ICT jobs (particularly the more highly skilled jobs) in Australia by 2009 due to offshoring (ACS, May 2004). Others have reported that offshoring is on the rise (Staff Writers, ZDNet Australia, 2004). To stem this trend, it was suggested that local graduates need more opportunities for advancement, such as through greater job diversity (with less product specialisation) and an increase in the number of research and development jobs. It was emphasised that building internal capacity was a preferred long-term solution, rather than bringing people in from offshore or outsourcing to offshore.

It was suggested that improvement in the management of industry-related projects was necessary. Projects were said to be poorly conceived and run for graduates, students on placements and those working on industry-linked projects.

Concerns were expressed about the quality of ICT professionals in industry from a number of perspectives. Providing more career development opportunities to ensure skills are up to date could involve mentoring of staff in the workforce. This could also help to alleviate staff shortages and retaining of staff. It was also felt that industry should increase its commitment to internships, graduate recruits and mentorship and also that the work environment should be more inclusive of women.

Survival of ICT schools in universities

Despite the increasing demand for more skilled ICT workers by industry, it was noted that the downturn in enrolments threatens jobs (downsizing having occurred in several universities), provides less money and leads to lower capabilities. The problem was seen as further exacerbated by the resulting trend of accepting lower quality students, which may present a threat to standards. Strategies for surviving the downturn are required as well as a viable plan for the future, where there may not be another boom. It was noted that survival depended on the university sector receiving increased funding. A solution commonly offered was to tackle the negative perceptions of the ICT profession and career prospects.

Conclusions from free-text responses

Addressing the poor perception of ICT, the status of the profession, and declining enrolments requires a concerted effort by all stakeholders and amounts to a culture change. A web portal for the whole ICT spectrum that uses clear and consistent language would be beneficial, as would a marketing strategy.

Regarding the desire for greater professional status, the national Computer Professional Program of the ACS (ACS, September 2006; ACS Staff, Information Age, 2006) and steps towards an international accredited IT professional status (ACS, March 2007) seem to have had little recognition or impact. This indicates that communication between relevant stakeholders could be improved.

The fragmentation of the ICT community makes it difficult to counter poor perceptions and hampers the ability to address the issue. ACS does not represent the whole ICT spectrum and needs to liaise with Engineers Australia. ACDICT could provide unifying leadership and contribute to the improvement of education at all levels, provided that it is representative, liaises with industry, government and professional bodies, and acts upon reliable information.

Better liaison between high schools, university and industry would improve ICT education and perceptions of the profession and provide benefits to students and staff at all levels. A relevant, balanced curriculum needs the input of academics, students, employers, graduates and professional bodies. Greater collaboration between academia and industry in work placements and joint research projects would benefit students, academics and industry workers.

Stakeholders in the university curriculum

The stakeholders identified through the consultation process include professional bodies and the government at national and state or territory levels (Figure 1.3). Collectively, they have considerable influence on the university curriculum in terms of the broad learning and teaching content and processes and the student experience.

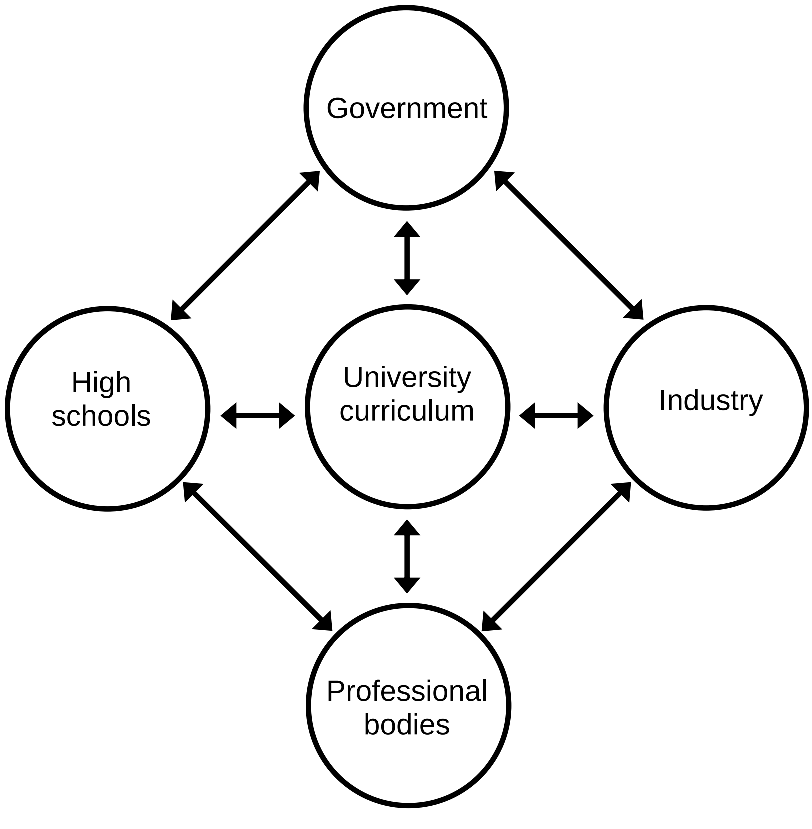

Figure 1.3: The stakeholders are all linked with each other, directly or indirectly, and contribute to the university curriculum

High schools, universities and industry have been discussed elsewhere in this report, and this section focuses primarily on relevant stakeholders (professional bodies) and the government, as illustrated in Figure 1.3. This project excluded further work with high schools primarily because the appropriate focus is higher education and the Industry Leadership Group was engaging in that activity (ILG, 2006).

Professional bodies and the university curriculum

The main professional bodies identified from the list of stakeholders (Appendix 1, Table A1.13) nominated during the consultations process were:

- Australian Computer Society
- Engineers Australia
- National ICT Australia
- Australian Information Industry Association
- Computing Research and Education Association
- Australian Council of Professors and Heads of Information Systems
- Australian Council of Deans of ICT

A brief description of each of these professional bodies and how they contribute to university education and the development of the curriculum is given below.

Australian Computer Society

The ACS was founded in 1966 with a mission to advance professional excellence in information technology. It operates various chapters, special interest groups (e.g., Information Technology in Education), boards (e.g., Young IT Board), annual conferences, and a professional development program. The ACS is responsible for several publications, including its official publication, *Information Age*, and other scholarly peer-reviewed international journals.

The ACS Computer Professional Education Program is an online program available to graduates. The program includes subjects such as business, legal and ethical issues; new technology alignment; business, strategy and IT project management; IT service management; and adaptive business intelligence. The ACS also manages a Diploma of Information Technology (DIT), which takes 12 to 24 months to complete. Subjects include systems analysis, programming, computer organisation, data management, object-oriented systems development, computer communications, professional practice and systems principles. The diploma entitles a candidate to credit equivalent to one academic year of a Bachelor of Information Technology at several Australian universities.

In 2006, the ACS implemented the Computer Professional Program following extensive consultation with ACS members, industry stakeholders and academia (ACS, September 2006; ACS Staff, Information Age, 2006). More recently, the ACS has taken steps towards developing an international accredited IT professional status (ACS, March 2007). Providing such professional status (similar to other disciplines such as engineering and accounting) should improve and strengthen the perception of ICT professionals in the wider community.

Apart from the contribution to education through journals, courses and professional accreditation, the ACS accredits university courses and thereby directly affects the ICT curriculum in all Australian universities.

Engineering, which is a substantial component of the ICT spectrum, lies outside the educational jurisdiction of the ACS and is in the realm of Engineers Australia. During the consultation process, the view was often expressed that the ACS and Engineers Australia need to work together to provide a uniform and consistent approach to ICT education.

Engineers Australia
Engineers Australia (EA) is the trading name of the Institution of Engineers Australia. The institution was founded in the late 19th century and held its first council meeting in 1919. Engineers Australia represents the engineering part of the ICT spectrum.

Engineers Australia offers a range of postgraduate professional education programs, particularly the Chartered Status, which is a professional competency-based credential for the experienced practitioner. Following the attainment of Chartered Status, practitioners partake in Continuing Professional Development and practice requirements that are subject to regular auditing. Through these programs, participants maintain up-to-date technical skills and knowledge of processes, technology and legislation.

In Australia, Engineers Australia is responsible for accrediting undergraduate engineering programs offered by universities and other educational providers. This accreditation has international recognition and provides graduates with the first stage of professional status as an engineer with admission to Engineers Australia. It is also a critical component of certification to governments, industry and licensing bodies. There are three types of accredited program at this level: Professional Engineer, Engineering Technologist and Engineering Officer. Through this accreditation process, Engineers Australia influences the curriculum of the engineering part of the ICT spectrum.

National ICT Australia
During the consultation phase of the project, the role of National ICT Australia (NICTA) as a stakeholder was either made as suggestion or a question concerning its role in the sector. NICTA describes itself as Australia's ICT Research Centre of Excellence (NICTA, 2008), and as such, research is its primary focus.

NICTA is involved in some educational activities, primarily at the PhD level. It also supports short-term research projects for undergraduates, assists with undergraduate thesis supervision, supports the placement of research students in industrial and research internships, and provides short courses for graduates in industry. NICTA supports outreach programs to attract more high school students (including a special focus on women) into ICT studies.

NICTA has a role at the national policy level in ICT education through its collaboration with industry, universities and government agencies such as in the development of an eGovernment vision and practice. However, NICTA seems to have been excluded from the recent national leadership group to encourage participation in ICT skills and work (ILG, 2006), which would include educational aspects.

Australian Information Industry Association
The AIIA ‘represents 450 ICT member companies, from individual consultants to the world's leading multinational corporations’ and its mission is ‘to lead and represent the ICT industry in Australia to maximise the potential of the Australian economy and society’ (AIIA, 2008).

As part of implementing its mission, AIIA is concerned with the preparedness of ICT graduates to meet the needs of employers. AIIA therefore has a vested interest in university education. In this capacity, and in collaboration with this project, AIIA has prepared and made available a survey for employers regarding their perception of the readiness of recent graduates for industry. The results of the AIIA pilot survey are presented in Chapter 3 and Appendix 3 of this report. The AIIA has thus contributed substantially to academic considerations of the ICT curriculum. Continuing input of the AIIA to curriculum development depends (at least in part) on its having an ongoing relationship with ACDICT, whose formation the AIIA strongly supported.

Computing Research and Education Association

CORE is an association of university departments of computer science and information technology in Australia and New Zealand. The term 'computer science and information technology' denotes the science, technology, engineering and application of computers and allied technology (CORE, 2008). CORE's members include academic staff, postgraduate students, and staff from research institutes such as the CSIRO and NICTA. CORE's purpose includes the advancement of teaching in computer science and information technology in higher education. As such, members of the organisation play a direct role in the design and development of the university curriculum.

Australian Council of Professors and Heads of Information Systems

ACPHIS provides a forum for the development of the information systems discipline and collaboration between relevant departments (ACPHIS, 2008). As an exclusively academic organisation, ACPHIS is able to directly influence the curriculum. However, during the consultation part of this project, many ACPHIS members expressed the view that the ICT disciplines that overlap with engineering should not be part of ICT.

Australian Council of Deans of Information and Communications Technology

This peak national academic organisation for ICT was formed in July 2008. ACDICT is concerned with promoting and advancing ICT education, research and scholarship on behalf of Australian universities. The council represents the entire ICT spectrum and has the potential to have a unifying influence on the sector and on curriculum development. ACDICT has one member from each of the Australian universities.

Conclusion regarding professional bodies

The professional bodies that influence the university ICT curriculum are represented in Figure 1.4. The large circle is the curriculum, and the figure shows the degree to which each body overlaps with that sphere. The only professional body with the same scope as the curriculum is ACDICT. The diagram also illustrates the groups with which ACDICT should form a relationship.

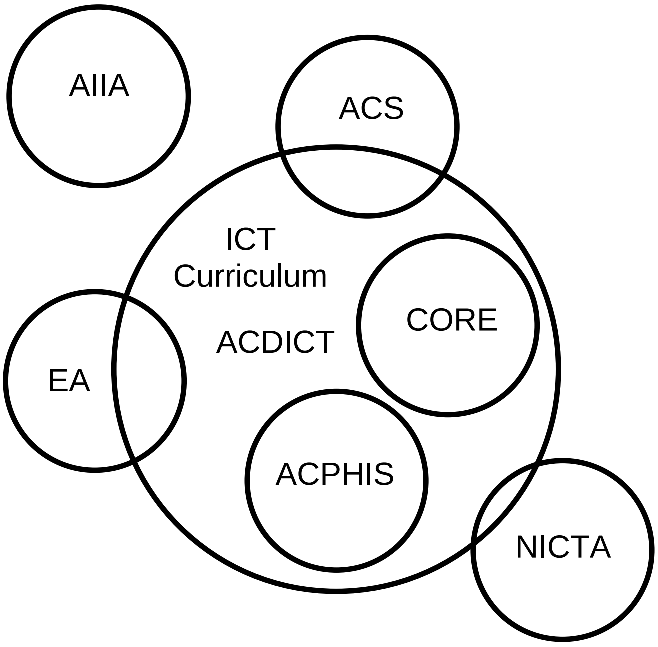

Figure 1.4: The professional bodies that influence the university ICT curriculum, which is shown as the large circle

The professional bodies whose particular spheres of interest lie entirely within the university sector are CORE and ACPHIS. The professional accrediting bodies ACS and Engineers Australia partly – and mostly separately – contribute to the university ICT curriculum, although both do so to a greater extent than NICTA.

The industry association (AIIA) generally has little or no influence on the curriculum, even though industry is the major recipient of the graduates. Industry members of the ACS also seem to contribute little if anything to the curriculum.

The academic professional bodies appear to work largely in isolation, although there have been recent attempts to establish a relationship between CORE and ACPHIS, for example.

The amount of influence these professional bodies have on the curriculum depends on their relationship with each other as well as their relationship with universities. There is also a certain degree of overlap between the academic bodies (e.g., some members of CORE and ACPHIS are also members of ACDICT).

Government and the university ICT curriculum

During the consultation process, 'government' was often named as an important stakeholder that needed to be more active in ICT education. As indicated in Figure 1.3, government, at the federal and state and territory levels, influences the university ICT curriculum in terms of broad learning and teaching content and processes and the student experience.

Opinions and concerns expressed during the consultation phase of the project indicated that government's role in the ICT context includes:

- declaring that ICT is in crisis and offer financial support to address falling enrolments
- developing strategies to address low numbers of domestic and international ICT students

- providing more support and policy to improve the educational quality in schools and universities
- providing financial and policy support for professional development
- helping to reverse the poor perceptions of ICT in the broad community
- addressing the ICT skills shortage
- providing better leadership, policy and investment to address the fragmentation of ICT sector.

This section presents a brief review of current national and state government education policies and practices that may have a bearing on the concerns expressed during the consultation process.

Federal government

The federal government contributes, directly and indirectly, to the ICT curriculum through policy, organisations and funding mechanisms.

There are numerous national ICT policies concerned with a variety of education and training issues (DEST, 2008). These include hardware and telecommunications, the knowledge-based economy and services. Relevant examples from this list and other web searches are given below.

Hardware and telecommunications national policies and activities include:

- Australian Access Federation (2007), which is concerned with provision of internet connections between higher education and research institutions both locally and internationally as well as with other organisations
- Broadband Connect and Australia Connect (2007), which are concerned with Australia-wide network and infrastructure; and
- the Clever Networks Program (2006), which is designed to expand tele-medicine, e-learning, and community education programs outside urban areas.

Knowledge based economy national policies include:

- the Asia–Pacific Economic Cooperation Leaders' Declaration (APEC, 2006), which reaffirmed the importance of ICT for realising the Asia-Pacific Information Society
- the Learner Identity Management Framework (2006), which recognises the increasing importance in lifelong learning, given that educational achievement occurs in a broad range of locations (including university and work environments) over long periods.

Several strategies and organisations are aimed at professional development for improving the use of ICT for learning and teaching in schools and universities. An example is the Australian Learning and Teaching Council (ALTC, 2008), which supports professional development in higher education, including the use of ICT for learning and teaching.

In early 2005, the then federal Minister for Information Technology and the Arts established the ICT Skills Foresighting Working Group to examine the Australian ICT labour market. The report, which was endorsed by the Minister, made seven recommendations (Foresighting Working Group, 2006):

1. Establish an industry leadership group
2. Improve market intelligence of the ICT jobs market, particularly skills in demand, and implement a national ICT job description framework
3. Establish an open access national ICT skills tracking and monitoring system

4. Improve access to quality data and analysis on ICT skills and jobs
5. Conduct additional research into staff retention, retraining and up-skilling issues and practices
6. [Facilitate] government, industry, the education and training sector and state/territory governments working together to re-focus the way ICT is presented
7. Review and enhance the teaching of ICT in schools.

These recommendations address many of the concerns expressed during the consultation phase of this project. In late 2006, the first recommendation was acted upon and an Industry Leadership Group was established, with representation from federal and state governments, schools, vocational education and tertiary education providers, ICT and business associations, the ICT research community, and women in ICT. However, at the time of writing, no published outcomes from the activities of this group were available, and original web links are no longer functional. It seems that another initiative (Skills Australia, discussed below) has replaced this one.

Following a discussion paper (Skilling Australia for the Future, 2008) which was primarily concerned with the vocational education and training (VET) sector, the federal government established Skills Australia to provide advice on current and future demand for skills and investment of public funds in training (Skills Australia Act 2008). ICT is widely acknowledged as being part of the skills shortage and this body has functions that include broad analysis, research and consultations to provide expert and independent advice for ongoing reforms to the education and training sector.

Skills Australia is described as ‘an independent statutory body, providing advice to the Minister for Education, Employment and Workplace Relations on Australia’s current, emerging and future workforce skills needs and workforce development needs.’ (Skills Australia, 2008).

It is unclear how the activities of Skills Australia will impact on the university sector and contribute to the development of ICT graduates for industry. The relationship between the VET and university sectors in relation to industry needs for ICT skills is yet to be clarified.

There is no specific recent national government policy concerning ICT university education. The development of such a policy might be expected following the deliberations of Skills Australia (itself very recently established and apparently concerned with the VET sector) and the outcomes of the review of higher education (Bradley, 2008; Bradley et al., 2008).

State and territory governments

There are numerous state ICT policies concerned with a variety of education and training issues (DEST, 2008). Most state governments utilise ICT opportunities for a broad range of activities – e.g., Information Economy SA (2008), which also includes hardware, telecommunications, social and education considerations. Many of the state ICT education policies include schools, their connectivity and enhancing learning and teaching, (e.g., the Department of Education and Children’s Services SA, and SmartONE Victoria). Technical and Further Education (TAFE), which can articulate with university studies, and offer workplace flexibility and lifelong learning, are also the responsibility of state governments.

The Ministers of Australian Education and Training recently issued a joint national vision statement supporting technology-enriched learning environments across all sectors of Australian education (Joint Ministerial Statement, 2008). This activity was facilitated by the Australian Information and Communications Technology in Education Committee, which provides a national policy forum and advisory and advocacy role. While this initiative is concerned with improving learning and teaching with ICT and not directly with the university ICT curriculum, it does propose broad collaboration between ICT educators, which could have a wider impact.

Among the state and territory governments, only Victoria has a Minister for ICT (currently John Lenders), who has responsibility for Multimedia Victoria (MMV, 2008), a state government department promoting ICT growth for industry. MMV has investigated young people's attitudes towards ICT study and careers over the years. The most recent study (MMV, 2007a) concerned 14- to 19-year-old Victorians (years 9–12). While this group of young people showed a range of positive attitudes towards ICT, a major barrier to further ICT study was the perception that a job in ICT involves sitting in front of a computer all day and that an ICT career is boring. A further finding was that students were more likely to be interested in study or a career in ICT if they had early exposure to ICT (particularly in Years 9 and 10).

An earlier MMV research project (MMV, 2004b) examined the collaboration between tertiary institutions (38 university/TAFE) and ICT businesses (223 small to medium-sized enterprises). This study concluded that there were mutual benefits for each sector, provided the incentives, perceived cultural differences and expectations could be managed.

MMV is working with the Victorian Information Technology Teachers Association (VITTA) to tackle the ICT skills shortage. VITTA was the first group to organise a State ICT Week in 2007 (MMV, 2007b), before the first National ICT Week of 2008. VITTA supports ICT teachers at primary and secondary schools as well as universities and other tertiary education institutions by providing resources, professional development, workshops and conferences.

Conclusions regarding government

A national government policy on ICT university education may result from the activities of the recently established Skills Australia (if ICT outcomes of both the VET and university sectors are linked to ICT industry needs) and the outcomes of the national review of higher education.

There is no national policy governing the relationship between the ICT industry and the suppliers of ICT workers, particularly universities, TAFE and other providers.

The State of Victoria offers a model for Australia in having a Minister for ICT who supports Multimedia Victoria in helping to grow the ICT sector by collaborating with key stakeholders to tackle the major issues and engaging in informative research.

Apart from the ICT skills shortage, and opportunities for professional development (national, state and local), there is apparently a national support and policy vacuum to address most of the concerns expressed during the consultation phase of the project.

General conclusions from academic consultations chapter

There was considerable agreement among the diverse groups consulted on several major issues. The general issues and concerns are summarised below.

ICT discipline

- There is a poor perception and awareness of ICT study, the discipline and career prospects among students, career advisors, parents and the general community.
- The sector representing the ICT spectrum of disciplines is fragmented and requires a peak academic body that can liaise with key stakeholders, including professional bodies, high schools, industry and government.
- Awareness and recognition of the ICT professional status for the whole ICT spectrum is unclear.
- There is a lack of government support or policy for a field that is of broad national importance to the economy.
- Research is needed into national issues and perceptions at various levels.
- There is uncertainty about how the national ICT skills shortage is being addressed.

ICT education

- Despite increasing industry demand for skilled ICT workers, there are declining student enrolments in ICT in higher education, which threatens sustainable capacity locally and nationally.
- ICT educational quality in high schools and universities is in need of improvement.
- There is a need to develop a better understanding of students amongst academic staff, particularly in regard to motivation, class attendance and attrition rates.
- The balancing of fundamental knowledge, skills, current technologies, business understanding and generic attributes in the development of an industry-relevant curriculum.
- The content, processes and participants involved in the teaching–research–industry–learning nexus needs clarification and dissemination.
- Greater industry contribution to education is desirable and welcomed by academia.
- Academic staff and curricula may not be up to date with industry requirements or advances in the rapidly changing ICT discipline.
- The professional development of ICT teaching staff may be suffering because of the crisis in the sector and local circumstances.
- The hierarchy of priorities for ICT education (Figure 1.2) indicates that:
    - there are many factors affecting the quality of education other than direct educational ones
    - these factors can be arranged in a hierarchy where the upper ones depend on the lower ones
    - improving ICT higher education as a whole requires first addressing the factors below it on the hierarchy.

ICT industry

- The relationship between industry and academia needs improvement for mutual benefit.
- Industry should be more involved in education at all levels.
- Work-based learning for all ICT students would enhance their learning experience and employability.
- The communication to academia of industry requirements is in need of improvement.

Chapter 2: Perspective from ICT graduates in the workforce

Introduction

There have been many recent surveys of graduates in the workforce (e.g., Chartered Institute of Personnel and Development, 2006; Allen and van der Velden, 2007; Gresty, 2007; PricewaterhouseCoopers, 2008), but they contain little, if anything, specific to ICT graduates in relation to their university curriculum. This lack of information about university ICT curricula from graduates in the ICT workforce has been addressed in this project.

For this project, recent graduates who have been in the workforce from one to five years were asked about their curriculum in an online survey. The purpose of the survey was to inform the university ICT curriculum with respect to developing work-ready graduates. Such a survey was recommended by the earlier Monash University study of ICT higher education (AUTC, 2001).

The survey was designed to elicit from graduates in the workforce the abilities they consider important for successful performance in current professional work, and their perceptions of how well their university course prepared them. The graduates were also asked about what was missing from their university courses, what were the most and least valuable parts of their courses, how courses might be improved and what other aspects of their university experience affected their professional preparation. This chapter builds on an earlier analysis of a smaller data set (Koppi et al., 2009). The results of the survey will inform universities in the development of a curriculum that better prepares their students for employment in the ICT sector. A similar but smaller and narrower study was carried out by Sumner and Yager (2008) in the United States on perceived differences between what Management Information Systems (MIS) graduates learned in their degree program and the requirements of their jobs.

The views of these graduates in the workforce shed light on industry's requirements of university curricula. Any discrepancy between these requirements and the perceptions of university preparation to meet them would reveal a gap between academia and industry. Such a gap was identified by Yen et al. (2003) and Nagarajan and Edwards (2008). Another perspective of graduate suitability for the workplace is given by employers (such as reported by Hagan, 2004) in Chapter 3 of this report.

The survey yielded 719 valid responses from graduates from 21 Australian universities. Details of the survey methods and results are presented in Appendix 2. This chapter summarises the main findings.

Design of the online survey

The survey questionnaire was developed by the project team. The survey's design was based on Scott (2003) but modified for the purposes of this study to give quantitative data and qualitative text responses. The survey questionnaire was approved by the University of Wollongong Ethics Committee and trialled with graduates and academics before release. Graduates were notified of the survey through local university alumni offices.

The categories under which the survey questions were devised were:

- personal/interpersonal abilities
- thinking/cognitive abilities
- business abilities
- technical abilities
- learning and university experience

Each category contained statements of specific abilities. Participants were asked to rank each statement against two criteria: the importance of that ability in current professional work, and the extent to which the university course focused on developing that ability. Comparing these rankings reveals how well the curriculum is integrated with the requirements of professional practice. There was also a series of statements regarding preparation for work and expectations of work duration.

Text entry boxes were provided at the end of each category for respondents to add any comments and other information they thought would be helpful.

Results and discussion

Several statistical analyses were carried out on the quantitative data, and the open-ended text responses were analysed for common responses. The purpose of the analyses was to elicit information that would inform relevant curriculum development.

Tables 2.1–2.6 present the results of the comparison between the workplace requirements (left-hand column) and the perceived university preparation for those abilities (right-hand column). The results are presented as percentage values and they are ranked by the high score of the left-hand column. All data were analysed using the statistical analysis software package SPSS and the distribution of responses relating to current professional work was compared to that of university preparation using the Wilcoxon Test. The number of open-text responses at the end of each quantitative ability category ranged from 54 to 129 and representative quotes from the respondents are given. A regression analysis was carried out on an item considered to represent university satisfaction to identify the key items associated with satisfaction (Table 2.7).

Other quantitative analyses of the data were carried out, including gender differences (Table 2.8); internship or workplace learning (Table 2.9); bachelors degree and masters degree (Table 2.10); study of ICT in high school (Table 2.11); and comparison between universities to identify good practice (Tables 2.12 and 2.13).

Responses to open-text questions were analysed and quantified as far as possible. Data were gathered on perceived university preparation for professional work (Table 2.14); missing aspects of university courses (Table 2.15); the most valuable course(s)/topics at university (Table 2.16); the least valuable course(s)/topics at university (Table 2.17); and suggested improvements for university courses (Table 2.18).

The large number of text responses to the open-ended questions (these ranged between 533 and 660) were manually categorised, coded and counted to provide as quantitative an analysis as possible. Quotes from the respondents are given in support of the responses, categorisation and analysis. The manual quantitative approach involved printing all the responses and reading through them several times to identify categories before coding and counting. These were then checked on the digital file by using the 'Find' tool in Microsoft Word to identify key words and verify the counting done on paper. This process was continued iteratively (paper–digital) until no further refinement was possible.

Personal/interpersonal abilities

There were 12 statements of ability in this category. The percentage responses are shown in Table 2.1. The results are ordered on the left column (high responses) for the importance for professional work. For all statements, the graduates gave a higher rating for the importance of the ability for successful performance of professional work than the extent to which the university course focused on this ability. These differences were significant according to Wilcoxon tests. There were 129 open-text responses to this category.

Table 2.1: Personal/interpersonal abilities responses given as percentage and ranked in order of importance (high score) in current professional work

Importance of this for successful performance in my current professional work						Extent to which my university course focused on this ability				
5 high	4	3	2	1 low		5 high	4	3	2	1 low
59	32	8	1	0	Ability to remain calm under pressure or when things go wrong	10	24	32	22	13
53	34	11	1	1	Ability to contribute positively to team-based projects	28	37	23	8	4
51	30	14	4	2	Ability to speak to groups of people effectively	12	30	31	17	11
50	32	14	3	1	Ability to communicate effectively in writing	21	36	27	12	4
49	41	9	2	0	A willingness to face and learn from my errors and listen openly to feedback	18	31	31	14	7
46	33	15	4	2	Ability to communicate effectively and appropriately using electronic media	19	34	28	14	5
46	29	17	5	2	Ability to work productively with people from a wide range of cultural backgrounds	24	27	28	12	10
45	40	12	2	1	A willingness to consider different points of view before coming to a decision	17	34	29	14	7
32	30	27	7	3	Ability to communicate effectively in visual or graphical formats	14	31	31	16	8
29	28	22	11	11	Ability to consider the impact of my actions on the environment	7	16	30	22	25
28	33	22	10	7	Ability to consider the impact of my actions on people in the broader community	8	18	34	22	18
13	13	16	13	45	Ability to communicate in languages other than English	4	8	13	13	62

Remaining calm under pressure or when things go wrong was clearly seen as the most important ability in the work environment. It was ranked highest by 59% of the respondents. Linking this with the statement about learning from errors, a respondent noted:

> '[These abilities] are extremely critical, in cases where the real life project may seem to be failing, very often it is up to the individual (or team) to be creative and come up with ideas to turn things around.'

There were several comments of a general nature regarding these ‘soft skills’, all of them noting the benefits for the workplace, e.g.:

> ‘More emphasis on the soft skills [is] essential.’

> ‘I guess these skills are very important in the work environment (communication, understanding people from various backgrounds, etc.). International students would benefit if there was more focus in soft skills, either through a unit every semester or in each projects/assignments.’

Some of those comments noted that universities were generally not good at developing these skills, e.g.:

> ‘University has not focused on interpersonal skills to the extent it should have focused.’

> ‘University was generally poor in these personal abilities.’

> ‘… the [Bachelor of Computer Science] I completed was extraordinarily lacking in personal/interpersonal skills focus.’

Other graduates noted that these abilities were developed in extra-curricular activities, such as in university clubs and societies, and also in part-time jobs, through work experience, or in their current job. Participation in extra-curricular activities to develop interpersonal skills has also been advocated by the engineers for the development of their graduates (King, 2008).

The ability to contribute positively to team-based projects is a high priority in professional work, as indicated by more than half of the respondents. Taft (2007) and Nagarajan and Edwards (2008) also reported that teamwork is an important requirement at work. A positive comment noting the importance of teamwork and university contribution from a respondent:

> ‘Team based assignments where individuals were scored on their contribution to the work were very important to ensure one person didn't ‘carry’ the group, but was also not penalised for others short-falls. In IT today, it is rare to be working solo on a piece of work. More and more employers are asking for self-starting team based players, as more companies adopt the Agile project methodology.’

However, in explaining the significant difference between the importance of teamwork for professional work and university preparation, others said that universities were not fully effective in developing teamwork skills. A variety of reasons were cited, including differences in ability, experience (noted by mature-age students), attitude and behaviour among the students within an environment that is different to that of the workplace.

Communication (written and oral) was also ranked high by more than half of the respondents and low for university preparation. Taft (2007) noted that programming students needed to acquire strong communication skills and Nagarajan and Edwards (2008) reported that the dominant skill requirement at work was communication (both verbal and written). Many respondents agreed with the importance of communication skills (especially for those of non-English speaking backgrounds), and commented on the lack of development of presentation abilities while at university.

> ‘Basically the skills have two parts 1) Communication Skills and 2) Subject Skills. Nowadays companies are looking for both kinds of skills.’

> 'Communication is a major part of my workplace as I need to communicate to a lot [of] people from different cultural backgrounds.'

> 'Communication skills are extremely important – written and oral. Graphical presentations is something that could be developed more at university – Excel spreadsheets etc.'

> 'I am a Chinese student graduated in year 2003. I got some Chinese friends [who] suffer a lot in communication with local people, when they are studying in [university] … I believe it is a most important issue for overseas student, how to make them feel confidence and try to speak "louder".'

> 'My current employment involves liaison with customers and employees so good communication skills [are] essential. The work for my degree was more practical (programming) and did not focus on communications as part of the studies.'

> 'Presentations were usually done in Tutorials – while the first thing I came across (and I told myself I wish we were trained on this at [university]) was speaking to over 300 people.'

> 'I also learned the importance of being able to consult effectively through presentation and confident speaking. I am still working on these skills and had I realised the importance in uni I would have given more of an effort in presentations etc.'

> 'I think more presentation skill should have been taught in university. In the first few subjects there should have been more importance on presentation.'

One university was praised and thanked by a respondent for the valuable relevant training received in communication units. However, a few respondents thought that universities should not be attempting to teach interpersonal skills, e.g.:

> 'I believe that university subjects in my field should be technical and such interpersonal skills should not need to be taught at uni. They are a function of maturity, personal development and life experience.'

> '… however work experience is the best way to develop sound interpersonal business skills, which is why I believe that it shouldn't be too much of a focus at university.'

Thinking/cognitive abilities

Table 2.2 shows the thinking/cognitive abilities ranked in order of high importance in professional work. There were eight statements in this category. In each case, graduates gave a higher rating for the importance of the ability for successful performance of professional work than the extent to which the university course focused on this ability. These differences were significant according to Wilcoxon tests.

Table 2.2: Thinking/cognitive abilities responses given as percentage and ranked in order of importance (high score) in current professional work

Importance of this for successful performance in my current professional work						Extent to which my university course focused on this ability				
5 high	4	3	2	1 low		5 high	4	3	2	1 low
60	29	9	2	1	Ability to diagnose what is really causing a problem and test this out in action	19	33	30	13	6
55	31	12	2	1	Ability to identify the core issue in any situation from a mass of detail	18	31	32	14	5
53	38	8	1	0	Ability to access and organise information effectively	27	37	26	7	3
48	40	10	1	0	Ability to bring a creative approach to problem solving	19	37	30	10	5
43	41	14	2	1	Ability to synthesise information into appropriate formats	20	37	32	8	3
43	39	16	2	1	Ability to keep up to date with relevant developments	17	32	30	16	6
41	34	19	5	1	Ability to represent and interpret information in a variety of formats (e.g., graphical, text or multimedia)	22	34	31	10	3
34	34	18	9	4	Ability to work equally well in paper-based and electronic-based formats	22	34	30	10	4

Out of the 54 written responses, several respondents stated that these cognitive/thinking abilities are probably the most important part of the university experience and of high relevance to professional work, e.g.:

> 'The things that I use most from my university education are the personal skills and thinking skills. Very little of the content of my degree do I use in my present role.'
>
> 'Considering my present job, most of the factors listed above are definitely significant to me!'

Almost two-thirds of respondents thought that the ability to diagnose what is really causing a problem and test this out in action was of high importance, and more than half of the respondents thought that the ability to identify the core issue in any situation from a mass of detail was also of high importance. These problem-solving abilities were generally not considered to have been well developed at university. Some typical responses:

> 'Diagnosing problems is a highly developed skill, but was not "taught" at all. We each practiced it on our [own] solutions, but weren't given the skills.'
>
> 'It would be worthwhile in some of the problem-solving subjects, providing opportunities to students to complete the same task using different approaches would prove useful in training creative thinking.'
>
> 'I felt somewhat guided at university as to the solution to a problem especially if it was related to a specific topic. Generally I have little or no information and very vague descriptions of the problem.'
>
> 'More real world examples of problems would be useful in ICT courses.'

Keeping up to date with recent developments (innovations) in ICT was considered important, and several respondents commented that their university courses were somewhat dated and lacking relevance, e.g.:

> 'I found a lot of the information I was taught at uni to be out of date. When I broached the issue with lecturers, they weren't interested. If universities want to encourage students to keep up with the latest developments, they really should practise what they preach.'

> 'I found through doing my degree, courses frequently were taught in dated technologies that the lecturer was comfortable with.'

> 'The professors were not as well learned in the ICT field as they should have been. This is a typical problem with all ICT environments. Many of the teachers are older and unfamiliar with technology.'

> 'In a degree that is meant to reflect an industry that is constantly changing and evolving, not teaching only the most relevant concepts that are useful by business is unacceptable.'

> 'Frankly, I had to scale back creativity in all my work for the university because the faculty was so far behind the curve of modern thought and ideas.'

> 'I was taught COBOL which I don't feel was particularly relevant or practical and is a good example of older technology used where a more relevant one should be.'

Business abilities

Table 2.3 shows the business abilities ranked as being of high importance in professional work in this category. There were eight statements in this category. In each case, graduates gave a higher rating for the importance of the ability for successful performance of professional work than the extent to which the university course focused on this ability. These differences were significant according to Wilcoxon tests.

Table 2.3: Business abilities responses given as percentage and ranked in order of importance (high score) in current professional work

Importance of this for successful performance in my current professional work						Extent to which my university course focused on this ability				
5 high	4	3	2	1 low		5 high	4	3	2	1 low
61	27	9	1	2	Ability to understand, appreciate and meet the needs of your clients	16	29	29	17	9
54	37	7	1	1	Ability to set and justify priorities	20	31	30	15	5
53	35	8	1	2	A willingness to take responsibility for projects including their outcomes	22	35	29	9	5
51	35	11	3	2	Knowing how to manage projects into successful implementation	19	34	30	13	5
49	37	10	3	1	Ability to estimate the time required for work-related tasks	19	30	27	16	8
42	35	16	4	3	Having an understanding of how your organisation functions as a business	10	19	30	23	19
38	31	19	7	5	Ability to be flexible and adaptable to frequent changes of employment	10	18	27	24	22
26	32	24	11	7	Ability to translate innovation into a viable business plan	10	20	30	22	19

Many of the 48 text responses in this category noted the importance of business skills in ICT employment and commented on the necessity of business components in their degree, or lamented the lack thereof. Some illustrative responses:

> ‘I score 5 for all of the items because today's competitive [job market] is very tight. All are necessary.’
>
> ‘Business skills are essential to *thrive* (not just survive) in the IT industry. While uni graduates continue to under-perform in this area, the degrees they showcase will continue to be under-valued and discounted as mere bits of paper.’
>
> ‘Aside from 3rd and 4th year projects, I found business skills to be lacking from my degree. When I started to manage projects for my company, I found these things difficult and had to learn very quickly from my mistakes.’
>
> ‘Understanding the business context is essential however I really only did one subject that required this but in my programming work that I am doing I *must* speak the same language as the business and demonstrate that I understand their business from their perspective.’
>
> ‘… making a full business plan for a real life scenario. It was a required unit for Biotech, but was not even a recommended elective for CS [computer science]. I think that unit, or one like it, would be very useful for IT majors.’
>
> ‘In addition to generic business skills, ICT are often required to deal with accounting information systems, accounting reports etc. I suggest a course in accounting would be useful for any ICT student intending to work in business.’
>
> ‘My main concern was the isolation in IT where everything is presented in a crystal clear best case world. I've found “close enough is good enough” and business constraints impact far more than technology.’

However, while acknowledging the importance of business skills, other respondents commented that universities have other important roles and are not necessarily the best place to acquire business related skills, e.g.:

> ‘Some of these I wouldn't expect from an ICT degree. Three years is a short time to pack in as much technical problem solving skills as possible.’

> ‘However, it's crucial to have a deep theoretical framework to build on, from the outset. And there's not so much luxury to get this in the chaos of working life. That's where time at uni is such a crucial window of opportunity for learning theory and concepts.’

> ‘I did not do a business or management related degree. I did a technical degree where I would not expect these things would need to be covered. I had gained previous business experience which I use for my current job.’

> ‘… it would be more beneficial to have a subject give you a grounding in the principles of the different [project management] methodologies, rather than trying to teach you to 'be' a PM on day 1.’

> ‘Again, I agree that many of these skills are absolutely crucial to success. However I don't think that the university degree is the best place to focus on these skills... There is time enough to learn that in life!’

> ‘A lot of employment related events can't be acquired in university or when schooling. You will only learn that it's a different world out there when you are in it.’

> ‘I’m not too sure how the above criteria would be useful to teach in great detail at university level. It can only really be gained from work experience. Having a solid technical understanding should come first.’

Taft (2007) notes that there is a gap between the business capabilities of programming graduates and the business skills required by industry.

The gap between university and industry is also illustrated with respect to flexibility and adaptability, e.g.:

> ‘Again flexibility and adaptability to changes in employment is really not emphasised at uni a[s] the lectures tend to be evangelists for a set of technologies, e.g. Java, and do not effectively provide a curriculum that covers many technologies and common concepts between them.’

The challenge for university teachers seems to be achieving a balance between developing generic attributes and teaching business skills that help prepare graduates for industry. One respondent seems to be indicating that one university at least got the balance and methodology right:

> ‘Most of the flexibility and “business skills” I learnt stems from the demands of the computer science course I went through itself and not from active soft skills development through the course itself.’

Technical abilities

Table 2.4 shows the technical abilities ranked as being of high importance in professional work in this category. The extent to which university courses focused on these abilities is significantly different in each case according to Wilcoxon tests.

Table 2.4: Technical abilities responses given as percentage and ranked in order of importance (high score) in current professional work

Importance of this for successful performance in my current professional work						Extent to which my university course focused on this ability				
5 high	4	3	2	1 low		5 high	4	3	2	1 low
52	33	11	3	2	Having the technical expertise relevant to my work area	22	32	28	11	8
42	40	14	3	2	Having the practical skills to generate creative solutions to abstract problems	17	33	30	13	7
37	39	19	3	2	Having a critical understanding of theories and principles in a discipline area	26	40	25	7	3
34	32	21	8	5	Having experience with industry-based project work	13	19	26	24	18
27	27	24	13	10	Having exposure to ICT professionals prior to my current job	10	19	30	22	20
26	32	27	9	6	Having numerical skills	19	31	29	13	8
25	24	17	13	21	Being able to program in relevant languages	18	32	28	13	10
22	25	30	13	10	Being familiar with current technologies rather than fundamental theories	9	17	36	22	15
14	21	35	18	12	Having a firm grounding in fundamental theories rather than being familiar with current technologies	16	30	35	12	7

Technical expertise and practical skills in solving problems were rated as the most important in the workplace. There were 62 text responses in this category and many of them commented that a focus on new technologies and practicalities relevant to the workplace is required. Some typical comments:

> ‘A focus on new technologies available would be good even if it was a brief overview before leaving university to get a job.’
>
> ‘Creative solutions required by my job also weren't encouraged in my view as the problems and assignments tended to be very sandboxed in ideal worlds.’
>
> ‘Although the theory of a concept is important, [I] believe that more time/focus should have been provided for the application of the particular theory.’
>
> ‘Most of the course dealt with theory in depth – and failed to provide the practical skills relevant for work.’
>
> ‘As an engineer, practical skills are paramount. Going to uni you become a theoretical engineer and not a practical engineer… Practical skills would give more rounded engineers who are able to make the leap from university to industry a lot more seamlessly.’
>
> ‘Need both theory and practical skills in current technologies and this was the strength of the course I did.’

Some respondents commented on the value of a cadetship or workplace learning, e.g.:

> ‘I learned far more practical skills through the cadetship than I did through the university.’
>
> ‘I was lucky in that I worked in the industry while studying, so my full time job was not a huge shock and developed a lot of the required skills outside of my course.’

> 'Much of my industry experience and exposure to ICT professionals came through self-initiative to seek internships as well as partake in [an] industrial research project with one of the lecturers during study semesters (which was purely voluntary).'

Other respondents noted the relevance of fundamental theories, e.g.:

> 'Nevertheless, I feel the theoretical background I got at uni has put me in a very good position for adopting new technologies.'

> 'I've found a solid understanding of core theories/technologies is better than knowing the latest and greatest technology, if you have the overall basics, then current technologies are easy to learn.'

> 'University is not TAFE, you should be learning more fundamental theories than current technologies.'

> 'Technical relevancy is well behind in university. Theory is usually good though and that is where I'm ahead of those that did not go to uni.'

Several respondents noted the importance of specific industry skills and qualifications and how university teaching should be related to industry needs, e.g.:

> 'Programming is not a large part of my job however scripting is. Advanced scripting in PHP/Bash/Perl would have been useful to me.'

> 'In my two years of full-time employment I have been exposed constantly to the .NET platform which was never even considered during my university career.'

> 'There is too much focus on programming, whilst other important technological abilities are overlooked. Would be nice to have hands-on experience with things like servers, networking, etc.'

> 'During my course, I was introduced to ASP.NET, VB, C# and SQL. While this is good and relevant, it should be noted too that PHP is dominant in the real world.'

> 'One of the issues I had with my degree was the fact that the computer science department decided that Linux/Unix was industry standard. Entering the workforce, I hardly see Linux/Unix being used and discovered that Microsoft platforms were more industry standard. I understand that there are companies that have Linux platforms but exposure to all different platforms would have been highly beneficial in terms of keeping up to date with the latest technology/developments.'

> 'I found it particularly useful to have gone through my degree while the university was still teaching in multiple programming languages – this gave me exposure to Pascal, C, C++, Java, perl, XML, assembly language, etc. rather than only Java and perhaps one unit of C. A variety of languages is far more useful, and gives you far better employment prospects, than only learning one language, even if that means you're not as expert with any one language.'

> 'Programming in C++ is extremely irrelevant, programming PLCs is important. I only heard PLCs mentioned in my fourth year but they are everywhere in industry and it is a major disadvantage to not be able to use them or program them.'

> 'I work with mainframes that do a large percentage of the world's computer processing. Mainframes barely got a mention in my [degree]. About 5% of the [degree] was directly relevant to my work.'

‘It would be hugely useful to introduce students to *both* ASP.NET and PHP as that would be a lot more relevant to the real world. I'm taking this survey only because I wanted to make this point – it’s from experience and I know others who share the same sentiments.’

‘The technical skills need to be accredited industry skills. Universities need to realise that learning the fundamentals at university is not up to the standard required by the workforce.’

‘Universities have essentially dropped the ball in producing high quality software developers. Simplistic languages are used that hide computer complexity and important concepts that [affect] performance and quality of solutions.’

As with communication development offerings at university, which were not always appreciated by students at the time, fundamental technical teaching was not always appreciated:

‘Being able to recognise and program in any language even if you’ve never seen it before. I found that I underestimated the importance of universal programming fundamentals.’

These diverse opinions of ICT graduates in the workforce emphasise the challenge that university teaching staff have in finding the optimal balance between fundamental theory, practical application to solve problems, and industry requirements.

Learning experiences at university

Table 2.5 shows a range of 15 learning experiences at university. In this case, the comparison between the workplace and university is not as straightforward as comparing how much the university practice contributed to current work performance. Caution is therefore required in interpreting this information. The results are ranked according to high importance in professional work in this category. The extent to which university courses focused on these practices is significantly different to workplace needs in nine cases. The cases for which there were not significant differences are marked with [ns] after the statement.

Table 2.5: Responses to university practices given as percentage and ranked in order of importance (high score) in current professional work (ns = no significant difference between current professional work and university preparation)

Importance of this for successful performance in my current professional work						Extent to which my university course focused on this ability				
5 high	4	3	2	1 low		5 high	4	3	2	1 low
55	33	10	2	1	Problem-solving activities on my own	28	38	24	7	3
46	33	15	3	3	Examples from the real world	17	28	34	16	7
43	37	14	4	2	Problem-solving activities in a group	23	35	27	10	5
42	32	17	4	4	Information available online [ns]	37	36	18	7	2
41	30	19	4	6	Working on projects relevant to industry	14	24	28	20	15
38	32	17	9	4	Giving presentations	23	32	25	12	8
36	29	19	6	10	Interviewing clients to ascertain their ICT needs for a project	9	19	25	25	22
32	31	21	10	6	Researching publications to prepare documents/reports/presentations [ns]	31	36	22	7	5
31	30	19	10	11	Laboratory classes where theory was put into practice [ns]	24	33	22	11	10
30	27	21	10	12	Placement in industry	12	18	21	15	34
22	30	26	10	13	Tutorials with group work [ns]	18	35	28	10	9
20	29	28	12	12	Tutorial with new material [ns]	16	32	35	10	8
18	30	30	11	11	Lectures that included class discussion [ns]	21	30	26	15	9
18	26	29	13	14	Tutorials which were used for revision purposes	19	36	31	6	8
14	23	30	17	16	Information delivered via lectures	34	36	19	5	6

There were six statements for which there was no significant difference between workplace needs and university preparation. It seems that information being available online is as important at work as it was at university. The use of laboratories by universities to put theory into practice appears to have been at the right level, as was the basic academic activity of researching publications for various reports. Tutorials with group work and where new material was introduced, and lectures that included discussion, also seem to have been appropriate in preparing graduates for the workplace. In contrast, information delivered via lectures seems to be of significantly less importance for the workplace.

Of those items for which there were significant differences between workplace requirements and university preparation, problem-solving abilities rank highly for professional work, and it appears that being able to solve problems on one’s own is relatively more important than problem-solving in a group. Giving examples from the real world is ranked highly, with the implication that universities should do more of it. The same applies to working on projects relevant to industry. Giving presentations is relatively important in the workplace and universities apparently fell short in preparing students for this, but nowhere near as much as in preparing students for interviewing clients. Similarly, placements in industry through universities are shown to be very low in comparison to a perceived need.

Table 2.6 shows the responses to a further set of statements relating to the university experience and employment expectations. Students were generally positive about their university experience. While some text responses stated that university teachers were not always up to date with technological advances, Table 2.6 shows that a majority of graduates in the workforce (62%) agreed to some extent that the technical content of their degree was current. Some text responses also indicated that university courses did not prepare students well for their work; however, 62% of respondents agreed that they were well prepared for work. Furthermore, 61% indicated that they consider their ICT qualification has an advantage over qualifications from other disciplines.

Several text responses noted that part-time work (of various kinds) contributed positively to preparation for the workplace. While 26% of these graduates apparently did not have part-time work, more than half of the remainder indicated that part-time work helped prepare them for the workplace.

Table 2.6: Responses to aspects of the university experience and employment expectations given as percentage and ranked on agree total (sum of Likert 5 and 4)

	5 Strongly agree	4 Somewhat agree	3 Neutral	2 Somewhat disagree	1 Strongly disagree	Not applicable
My university courses prepared me well for my work	27	35	18	11	6	3
The technical content of my degree was always up to date	24	38	16	14	6	3
My ICT qualification has an advantage over qualifications from other disciplines	30	31	19	10	5	5
My part-time job helped me prepare for the workplace	25	17	17	6	10	26
My company expects me to move on after a few years	15	16	21	19	21	8
I expect to change jobs frequently	11	19	26	22	18	4

For a variety of professional jobs, it seems that short-term contracts have become the normal entry mode for graduates (Oliver, 2006). However, results from this survey reveal that more respondents disagree with the statement that their employer expects them to move on in the short-term than agree with it (Table 2.6). Similarly, the minority of graduates expect to change jobs frequently. Perhaps this is a reflection of the ICT skills shortage and the desire by employers to keep their skilled staff.

There were 124 text responses for this section on learning experiences and employment expectations at university. These responses were wide-ranging with diverse views, including about the quality of university teaching, relationship with industry, real-world experience, teamwork and distance education.

Positive comments on university teaching focused on academic staff who were enthusiastic and knew how to engage with students; had relevant and recent real-world experiences and used them as examples in their teaching; used discussion and small group work to solve real-world problems; engaged in effective dialogue rather than reading from notes or PowerPoint slides; gave informative feedback; provided comprehensive course resources that were available outside work hours; and were responsive to suggestions from students. The negative side of the university experience was centred on academic staff who lectured from notes or slides without discussion; were out of touch with recent technological advances or business practices; used an obviously dated curriculum; encouraged rote and memory learning; gave problems that were not challenging or had simple solutions; did not engage in discussions online or offline; and gave group exercises that were unclear or only designed to enable marking rather than dealing with realistic issues. Examples of comments include:

> '….some of my lecturers were very dedicated to maintaining an up-to-date working knowledge of the leading technologies, and I appreciated their efforts to impart this knowledge to students through meaningful examples and challenging but relevant assignment work, which was a refreshing break from the over-simplified, trivial assignments in some subjects.'

> 'Most of the units in my degree were great. But some units had lecturers that would focus on rote learning and memorisation – these were worthless.'

> 'Lectures were usually pedagogically poor, lab classes unstructured, and tutorials almost non-existent. Lectures rarely used discussion, problem solving, or anything interactive.'

> 'It is difficult to rate my university course because the subjects which made up the course were high[ly] variable in terms of quality. Some were excellent, others terrible. I think universities as a whole need to get their act together regarding course quality issues. Some lecturers do a fantastic job, others seem to do a rubbish job year after year and seem to have little interest in being responsive to changing requirements or in improving their performance.'

> 'While I understand why my course required me to form teams to work on projects, this does not at all emulate the real work environment… In a real work environment, non-performing members tend to be removed very fast if they do not buck up… I have worked on numerous team-based projects at work – the course does not at all – not even remotely – mimic what happens in the real world.'

> 'Although there was a lot of focus on classroom discussions during lectures, I am inclined to rate it lower as class participation was low/passive and most lecturers make little effort to encourage class participation.'

> 'I feel most of the times you learn more not from the subject you take but the process of working on that subject, and that part is way more useful and related for real live working requirements.'

Concerns were expressed that university courses were of touch with workplace practices or out of date, and many respondents suggested that there should be closer liaison with industry and more of a focus on real-world issues, e.g.:

> 'I feel that a large part of the technical content of my degree is out of date. When students know more about a subject than lecturers there is a problem.'

> 'The uni curriculum is still in the late 90s or so and so much has happened and is happening that it is almost irrelevant beyond the fundamentals that were passed onto me.'

> 'In the information systems units I undertook, there is an over-emphasis on book learning and abstract theory, and no real injection of professional practice or industry expertise. The university should team more closely with industry.'

> 'My experience at uni did not have a significant relation to life in the real world.'

> 'Have more practice on real life software. Learn on up to date programs, not what the university thinks they can give to their students. There [is] so much happening out there that the university have *no* idea on what is happening.'

> 'Students need lectures from real-world projects. Lectures that relate to solving problems from experienced implementations teach volumes of learning that can be easily applied in a classroom environment. Lectures can focus on real-world case studies. The outcome of the case study is not important but the learning processes that is acquired.'

> 'The university needs to be more real world focused and business driven over IT focused and theory driven. No one wants to hear stories all day of a lecturer's experience over 10 years ago, times have changed and the lectures are behind.'

> 'The courses that were really helpful were those that were focusing on real word issues… And the major project where I picked what I wanted to do gave me a real advantage in understanding real life expectations.'

> 'The degree I studied was good with theory and technical, but lacked up-to-date industry relevance a little … my degree could have helped me by being more "workplace relevant" or "real life".'

> 'Too much theory based and insufficient emphasis on the real world. Maybe this is because most of the academics have never been in the "real world".'

> 'University curriculum should have been even more industry focused.'

While respondents appreciated fundamental theories, many stated that their courses should have been more applied and practical, e.g.:

> '… you're probably better off learning more theoretical stuff while you've got the time at uni – you'll never get a chance to get more in-depth than at uni.'

> 'Fundamental knowledge of underlying technology need[s] to be strong, while training must focus on new techniques and skills.'

> '95% of my units I will never use the material from. Only benefit is "learning how to think". [It is] better for undergraduate courses to focus on practical and relevant skills. So many times I have seen a TAFE student knowing more than a university student when it comes to fixing a PC or programming. Save research and high level theory for research degrees.'

> 'Needed more practical/hands on real world examples of what programs … are used in the real world.'

> 'More practical skills, *real* world examples and longer work placement/interaction with industry.'

> 'Universities still suffer from far too much theory and not enough practice… Half of the solutions to common problems were meaningless to us without having experienced the problems. The disconnection between units only served to worsen the situation.'

As in some statements above, several respondents commented on the value and importance of industry experience for their university studies, particularly those that included business aspects, e.g.:

> 'I worked full-time for an ICT company while studying, so in a lot of ways my work helped to prepare me for university as much as university helped to prepare me for work.'

> '[An ICT] degree has an advantage over others because of its strong focus in both business and technology disciplines – I can move between the two disciplines or combine them in my role as business analyst.'

> 'General business acumen units need to be made a core part of an IT degree. They are essential. As a person whose responsibilities include hiring/selecting team members, I am fed up with interviewing applicants with masters degrees in technology but no general understanding of how a business works. If not for my industry employment during my studies I too would have been underprepared.'

Many respondents commented on the 'soft' or generic attributes, mostly in favour of them being included in university courses, e.g.:

> 'I feel I got a solid technical base from the computer science degree, which is highly valued by my employer. The other skills – organisation, communication, etc – are to a stronger degree intuitive or learnt in the workplace, so I strongly feel like the focus is in the right place in the degree.'

> 'Learning skills and attention to detail are critical in the IT industry. Uni courses should place greater focus on helping students understand the value of building reports and compiling information. Most graduates would see report writing and information gathering/research as 'administrative' boring work, rather than work of high strategic value.'

> 'Suggest the inclusion of compulsory study units relating to Problem Solving, Report Writing, Presentation, Decision Analysis, Negotiating etc.'

> 'University should spend more time in teaching soft skills (e.g., people skills, dealing with pressure, managing priorities) rather than hard skills.'

Several respondents had completed their studies by distance. Their comments indicated that this can be a satisfying experience, provided that there are opportunities for contact with fellow students and teaching staff. These interactions are essential components of distance education (e.g., Bates, 2005). Others commented that ICT is particularly well-suited to distance learning, and that they enjoyed the independent learning opportunities it provides. Some examples:

> 'All my studies were done externally so there was no face-to-face contact with either lecturers, tutors or other students. But I utilised electronic contact to a great extent and gained huge benefits from open discussion, sharing of thoughts, experiences and brainstorming. External study made me more self-reliant and a more effective independent researcher. It allowed me to achieve confidence in my *own* abilities.'

> 'Doing external study has the benefit that you learn how to solve all problems by yourself even if you have to use the alternative texts or the internet to get alternative approaches. I found that fun.'

> 'I was studying part time and as a distance education student. There was no group work nor direct access to lectures. However, the online nature of the degree was excellent and improved over time. As well, lecture notes were comprehensive and valuable for a distance education student. Learning how to code is easy as a distant education student – its all about the text book and the software. However, it would have been good to have greater interaction to discuss innovative solutions and different ways to achieve the same outcome as part of the course work.'

In summary, the essential feedback from the graduates regarding teaching and their university curriculum can be summarised as:

- being up to date
- engaging in dialogue with teachers and between students
- using authentic industry examples ('real-world')

- engaging in authentic problem-solving activities
- providing industry experience
- including business capabilities and related generic attributes
- balancing fundamental theories with relevant practical application.

Regression analysis for items contributing to satisfaction

To identify items related to 'satisfaction' with university courses, the item 'My university courses prepared me well for my work' was compared with the responses given to university preparation (columns on the right in Tables 2.1–2.5). A stepwise regression analysis yielded five significant ($p < 0.05$) items which are shown in Table 2.7.

The significant ability to contribute positively to team-based projects in the workplace on general satisfaction with university courses is supported by the many text responses that noted the importance of teamwork in professional practice. Taft (2007) also notes how essential teamwork is in the corporate world. However, many text responses also criticised how teamwork is practiced in universities.

An ability relating to general satisfaction is that of problem-solving. This is supported by many text responses, indicating the importance of problem-solving capabilities in the workplace. It seems that university courses that include problem-solving activities lead to better prepared professionals. This is also recognised for the engineering profession (King, 2008).

Graduates also seem generally satisfied with the technical abilities they developed at university, even though some expressed support for more current technologies and others for more fundamental theories. The negative correlation of satisfaction with the ability to work equally well in paper-based and electronic-based formats indicates that respondents do not consider this ability important.

Since none of the business items produced a significant influence, it would seem that whatever business skills these graduates learned or did not learn at university, business skills did not feature in their general satisfaction with their university courses. Because many of the graduates commented on the lack of business abilities they learned at university, this lack of correlation with a measure of satisfaction may be taken as support for their comments.

Table 2.7: Regression analysis results relating general satisfaction with university courses (item 1 in Table 2.6) with university preparation for the workplace

Extent to which my university course focused on this ability	Standardised Beta	t	Significance (p value)
Ability to contribute positively to team-based projects	0.158	3.022	0.003
Ability to keep up to date with relevant developments	0.177	2.468	0.014
Ability to work equally well in paper-based and electronic-based formats	–0.095	–2.099	0.036
Having the technical expertise relevant to my work area	0.177	3.409	0.001
Problem-solving activities on my own	0.116	2.414	0.016

Gender differences

Twenty-five per cent of respondents were female, which indicates that a larger proportion of women responded to the survey than men. Australian Women in Information Technology (OzWIT, 2006) reports that 15% of ICT workers were female and that the trend in female ICT workers is downwards, with similar numbers and trends in Europe (Valenduc and Vendramin, 2005). Lewis, McKay and Lang (2006) report that women account for less than 15% of enrolments in many ICT courses in Australia.

An analysis (Mann-Whitney Test) of significant gender differences with respect to the questionnaire statements is given in Table 2.8, which shows the higher ranking of a statement for gender for 17 items. This section discusses the significant differences between male and female ICT graduates found in this survey and attempts to relate the findings to published literature.

There has been a long debate about gender differences being attributed to nature, nurture or a combination of both (e.g., Lippa, 2002). Nature (biological) influences on gender differences can be attributed to hormones (e.g., Hines et al., 2003) and there is also neurological evidence that there are differences between the brains of men and women that lead to different behaviours (Cahill, 2006). Nurture influences different behaviours according to how society teaches men and women to behave, and as society changes, so do the differences in gender behaviour (Lippa, 2002). However, there seem to be differences in male and female personality that social and cultural factors cannot alter (Lippa, 2008). That this survey revealed gender differences is not surprising since ICT is reported to have a deeply ingrained masculine culture (Moore, Griffiths and Richardson, 2005; Lewis, McKay and Lang, 2006), including in the overlap with engineering (Naghdy, 2001).

The importance of communication with groups of people (including clients), in writing and in giving presentations, is ranked more highly by women than men in the workforce (Table 2.8). Many theories have been proposed to explain the differences in communication between men and women (e.g., Wood, 2005; Monaghan and Goodman, 2006; Still, 2006). The ‘two culture’ theory is advocated by Gray (1992) and Tannen (2001), for example. These authors suggest that men and women grow up learning different rules about communication and behaviour and these are expressed in adulthood: women seek close relationships by conversation and non-confrontational styles, whereas men are more competitive and seek to dominate in conversation. Mulac (2006) notes that men typically talk about themselves and use judgmental language, whereas women’s speech is more tentative, elaborate and emotional. Perhaps because of these differences, women in the male-dominated ICT profession regard the importance of effective communication more than their male colleagues do. However, the precise reasons why women regard communication more highly than men in this context would require further research, particularly in the light of Hyde’s (2005) meta-analysis which showed that gender differences in most aspects of communication are small but very context dependent.

Women in the ICT workforce rank ‘a willingness to consider different points of view before coming to a decision’ (Table 2.8) more highly than men. This may be related to different communication styles or perhaps it relates to men (especially younger ones) being more prepared to take risky decisions than women (Gardner and Steinberg, 2005), which would be the case if all viewpoints had not been considered. In general, women seem to be more risk averse than men, with the exception of professional men and women (Croson and Gneezy, 2004). Women are thought to be more cooperative (Furnham, 2005) and communal (Carli, 2006) in the workplace and their consideration of different points of view is part of being cooperative and communal.

Table 2.8: Significantly ($p \leq 0.05$, Mann-Whitney Test) higher rankings of statements by gender (F = female; M = male) for the importance of abilities in the workplace and university preparation ([a] $p = 0.059$; [b] $p = 0.052$)

Workplace importance		University preparation
F	Ability to speak to groups of people effectively	
F	Ability to communicate effectively in writing	
	Ability to communicate effectively in visual or graphical formats	M
F[a]	A willingness to consider different points of view before coming to a decision	
F	A willingness to face and learn from my errors and listen openly to feedback	
	Ability to remain calm under pressure or when things go wrong	M
F	Ability to access and organise information effectively	F[b]
F	Ability to synthesise information into appropriate formats	
F	Ability to work equally well in paper-based and electronic-based formats	
F	Ability to set and justify priorities	
F	Ability to understand, appreciate and meet the needs of your clients	
	Having a firm grounding in fundamental theories rather than being familiar with current technologies	M
M[a]	Having experience with industry-based project work	
M	Being able to program in relevant languages	
M	Having numerical skills	
F	Giving presentations	
F	Researching publications to prepare documents/reports/presentations	

Why women in the workforce rank ‘a willingness to face and learn from my errors and listen openly to feedback’ more highly than men (Table 2.8) is unclear. Several explanations for this have been proposed. For example, Broos (2005) found that women tend to have greater anxiety towards computers than men, even when they are experienced users. Similarly, Beyer et al. (2003) found that male students of computer science had more confidence in using computers than female students. Perhaps this anxiety and lack of confidence even applies to female ICT graduates in the workforce and suggests an acceptance of making errors and having them corrected even though they may not actually be making more mistakes than their male counterparts. Alternatively, if men are more competitive and status-oriented than women (Tannen, 2001), they may be less willing to admit to mistakes.

Table 2.8 also shows several other workplace practices that women rank more highly than men. These fall broadly under the category of work-organising abilities, and include organising and synthesising information, working equally well in paper or electronic formats, and researching for the preparation of various documents. One purpose of these organisational activities is to enhance communication, which women rate more highly than men (as noted above). There does not appear to be any innate reason why women would rank these other abilities higher than men do, and the explanation may be contextual. These differences may be because the roles of recent ICT graduates in the workplace are different according to gender. Still (2006) has reported that women in the workplace often adopt support roles rather than pursuing management or leadership roles, and the work-organising abilities noted here can be considered as support activities. This theory is supported by Crump et al. (2007), who reported that in New Zealand ICT there was a gender differentiation in the workplace, with most technical positions being held by men while women worked mainly in other roles. In the United Kingdom, the majority of women in the ICT industry are in operator and clerical roles, with a minority in technical and managerial roles (Griffiths and Moore, 2006; Keogh, Tattersall and Richardson, 2007).

In the survey, men ranked programming in relevant languages, having numerical skills and 'having experience with industry-based project work' more highly than women. Since these may be considered as technical skills, the implication is that men are more concerned with the technical side of the work than women. Men also ranking their university preparation in communicating effectively in visual or graphical formats (which may be considered as technical abilities) more highly than women. Similarly, men ranked 'having a firm grounding in fundamental theories rather than being familiar with current technologies' more highly than women in their university preparation, and this also concerns technology. The technical side of ICT in the workplace has been characterised as 'masculine' with fewer women working in this area (Moore, Griffiths and Richardson, 2005).

The ability to remain calm under pressure or when things go wrong is ranked more highly by men than women in the university preparation for this ability. Remaining calm under these circumstances may be linked to aggression and self-control. Lippa (2008) cites large-scale studies on personality traits in which men scored much higher than women on aggressiveness and women scored moderately higher than men on self-control. If these apparent personality traits are applicable in the university context, it would appear that men are acknowledging the importance of this aspect of their university preparation.

Internship or workplace learning experience

About 40% of respondents had participated in an internship or workplace learning. While all the respondents were in the workforce, those with an internship or workplace experience should be in a stronger position to indicate the importance of the abilities listed for the workplace because of their relatively greater industry experience. An analysis of responses from those with an internship or workplace learning and those with no internship or workplace learning is given in Table 2.9.

Table 2.9: Significantly ($p \leq 0.05$, Mann-Whitney Test) higher rankings of statements by people with an internship or workplace learning (IWL) and those with no internship or workplace learning (NIWL) for the importance of abilities or experience in the workplace and university preparation

Workplace importance		University preparation
IWL	Ability to speak to groups of people effectively	
IWL	Ability to communicate effectively in writing	
IWL	Ability to communicate effectively in visual or graphical formats	
IWL	Ability to communicate effectively and appropriately using electronic media	
IWL	Ability to contribute positively to team-based projects	IWL
IWL	A willingness to face and learn from my errors and listen openly to feedback	
IWL	Ability to synthesise information into appropriate formats	
IWL	Ability to identify the core issue in any situation from a mass of detail	
IWL	Ability to represent and interpret information in a variety of formats (e.g., graphical, text or multimedia)	
IWL	Ability to understand, appreciate and meet the needs of your clients	
IWL	Having exposure to ICT professionals prior to my current job	
IWL	Having the practical skills to generate creative solutions to abstract problems	
IWL	Having experience with industry-based project work	IWL
	Having numerical skills	IWL
NIWL	Lectures that included class discussion	
	Giving presentations	IWL
IWL	Researching publications to prepare documents/reports/presentations	

With only one exception, Table 2.9 shows that people with an internship or workplace experience ranked the 17 abilities shown as higher in either the workplace or university preparation or both. People with an internship or workplace experience also significantly indicated: ‘My part-time job helped me prepare for the workplace’. Communication in all forms and formats (including client liaison) was ranked higher by those with workplace experience, including the preparation for giving presentations while at university. Perhaps it was the workplace experience that contributed to a greater appreciation of university efforts in this area. The importance of teamwork in the workplace and preparation for it while at university was ranked higher by those with workplace experience. The value of teamwork in the workplace was also noted by Taft (2007) and Nagarajan and Edwards (2008). Those with workplace experience also give greater importance to problem-solving abilities which were indicated by ‘Ability to identify the core issue in any situation from a mass of detail’ and ‘Having the practical skills to generate creative solutions to abstract problems’ and to some extent by ‘Ability to represent and interpret information in a variety of formats’. The importance of problem-solving abilities is also supported by many text responses.

People with workplace experience indicated the importance of that experience by ranking highly their exposure to ICT professionals prior to their current job, as well as having experience with industry-based project work (in the workplace and while at university) and stating that their part-time job (apparently of any kind) helped in workplace preparation.

From many perspectives, it seems that internships and workplace learning contribute to the preparation of work-ready graduates, particularly with respect to communication and problem-solving. Perhaps a greater maturity is also developed, as indicated by the high ranking of a willingness to face and learn from errors and listening to feedback.

Bachelors and masters degrees

About 25% of respondents had a masters degree. Table 2.10 shows the significant differences in ranking of abilities between bachelors and masters respondents.

Table 2.10: Significantly ($p \leq 0.05$, Mann-Whitney Test) higher rankings of statements by people with a bachelors (B) and masters (M) degree for the importance of abilities or experience in the workplace and university preparation

Workplace importance		University preparation
	Ability to communicate effectively in writing	M
	Ability to work productively with people from a wide range of cultural backgrounds	M
M	Ability to consider the impact of my actions on the environment	
	Ability to keep up to date with relevant developments	M
	Ability to access and organise information effectively	M
M	Ability to work equally well in paper-based and electronic-based formats	M
M	Ability to set and justify priorities	
	Ability to translate innovation into a viable business plan	M
	Being able to program in relevant languages	B
	Having numerical skills	B
M	Information delivered via lectures	
M	Lectures that included class discussion	M
M	Examples from the real world	
	Interviewing clients to ascertain their ICT needs for a project	B
M	Working on projects relevant to industry	
M	Giving presentations	
M	Researching publications to prepare documents/reports/presentations	M

Most of the 17 items shown in Table 2.10 were ranked higher by people with a masters degree. Apart from the ability to keep up to date with relevant developments at university, none of the other items ranked higher by people with a masters degree are of a technical nature. They are more concerned with communication and work performance, such as effective writing, giving presentations, working with people from a range of cultural backgrounds, organising information effectively in paper or electronic formats, setting and justifying priorities, and researching publications. People with a masters degree also significantly rated ‘My ICT qualification has an advantage over qualifications from other disciplines’.

As may be expected from masters graduates with more university experience, they ranked more highly the ability to consider the impact of their actions on the environment, and their university preparation for developing a business plan. Conversely, bachelors graduates ranked technical programming and numerical skills higher. It is not clear why the bachelors graduates would rank the university preparation of interviewing project clients more highly than the masters graduates. That the bachelors graduates also ranked more highly their part-time job in preparing them for the workplace may be because the masters people considered that their postgraduate qualification would have prepared them for the workplace to a greater extent than a part-time job.

On the whole, it seems that graduates with a masters degree have a greater appreciation of other than technical abilities that are required for work performance.

Study of ICT in high school

About half of the respondents had studied an ICT subject at high school. An analysis of response differences between those who did and did not study ICT in high school may reveal any benefits to studying ICT at high school. Table 2.11 shows the significant differences in ranking of abilities of those who did study ICT in high school (YHS).

Table 2.11: Significantly (*p* ≤ 0.05, Mann-Whitney Test) higher rankings of statements by people who studied ICT in high school (YHS) for the importance of abilities or experience in the workplace and university preparation

Workplace importance		University preparation
	Ability to speak to groups of people effectively	YHS
	Ability to communicate effectively in visual or graphical formats	YHS
	Ability to work productively with people from a wide range of cultural backgrounds	YHS
	Ability to contribute positively to team-based projects	YHS
	A willingness to consider different points of view before coming to a decision	YHS
YHS	Ability to remain calm under pressure or when things go wrong	
	Ability to translate innovation into a viable business plan	YHS
	Ability to understand, appreciate and meet the needs of your clients	YHS
YHS	Being able to program in relevant languages	
YHS	Laboratory classes where theory was put into practice	
	Giving presentations	YHS

Eleven items were ranked significantly higher (mostly concerning university preparation) by people who had done ICT at high school (Table 2.11), and no items were ranked significantly higher by people who had not done ICT in high school. It is possible to interpret these data in a positive or negative way. From a negative perspective, it could be argued that if the high school ICT experience was poor, the university preparation may be perceived relatively more favourably and ranked higher. However, Multimedia Victoria (2007a, p. 7) reports that ‘students who had exposure to ICT at secondary school (particularly in Years 9 and 10) were more likely to be interested in exploring the possibility of further study and/or a career in ICT'. According to that study, these findings here could be interpreted as showing that students who had studied ICT in high schools were more favourably disposed to further study in ICT.

People who had studied ICT in high school ranked several items concerned with communication (speaking to groups, using different communication formats, and presentations), contributing to team-based projects, and willingness to consider different viewpoints more highly for their university preparation. Perhaps this was because they were primed for these activities in their ICT subjects in high school. However, it is likely that other subjects would also have prepared students (who may not have include an ICT subject in high school) for the same generic abilities, which makes it unclear why these particular items were ranked more highly by people who had studied ICT in high school. Similarly, the ability to remain calm under pressure or when things go wrong is not unique to ICT, yet people who had done ICT in high school ranked this more highly in workplace importance than people who did not do ICT in high school.

Two items that can be considered as ICT-specific are the development of a business plan, and understanding clients. Both were ranked more highly in university preparation by people who had done ICT in high school. Perhaps high schools had prepared ICT students in these abilities, thereby enabling them to better develop these abilities in universities. Similarly, perhaps high schools had prepared ICT students for a programming career, thereby leading them to rank this ability more highly in the workplace than people who had not done ICT in high school. The same might be said for high school ICT laboratory classes.

Workplace graduates who had done ICT in high school also rated significantly 'My part-time job helped me prepare for the workplace'. This may be an indication that doing ICT in high school encourages students to find part-time work in ICT which has been of benefit to their career development.

Whatever the interpretation of the data in Table 2.11, it does seem that having done ICT in high school has led to a perceived positive development of the abilities needed by graduates in the workplace.

University strengths relevant to the curriculum

An analysis of university differences according to the survey respondents should identify good practices and provide the potential for sharing and improvement across the sector. A comparison of significant differences between 'Group of Eight' (Go8) universities (about 25% of respondents) and non-Go8 universities is shown in Table 2.12. (The universities that participated in the survey are shown in Appendix 2, Table A2.1; most of the Go8 responses were from Monash University.) For the majority of items, the Go8 and non-Go8 universities are indistinguishable.

Table 2.12: Significantly ($p \leq 0.05$, Mann-Whitney Test) higher rankings of statements by people from Go8 or non-Go8 for the importance of abilities or experience in the workplace and university preparation

Workplace Importance		University preparation
Go8	Ability to speak to groups of people effectively	
	Having the practical skills to generate creative solutions to abstract problems	Go8
	Information delivered via lectures	Go8
	Giving presentations	Go8

As shown in Table 2.12, the respondents from Go8 universities ranked four items higher than non-Go8 respondents. The fact that graduates from the Go8 universities ranked the importance of effective verbal communication in the workplace highly could indicate a successful university preparation program for that ability, even though the preparation itself was not rated higher than for other universities. In this area (communication) the university preparation for giving presentations was ranked higher by Go8 graduates. A comparison of teaching approaches to the development of communication abilities between universities may identify effective practices. Similarly, a comparison of approaches to developing problem-solving skills may be worthwhile, because Go8 graduates ranked the preparation of skills for creative solutions higher than graduates of other universities.

The higher ranking of delivering information by lectures among those from Go8 universities may indicate that these universities use a more traditional teaching approach than other universities.

Go8 university respondents also significantly ranked ‘I expect to change jobs frequently’ higher than respondents from non-Go8 universities. This may reflect what Go8 students were taught or that Go8 graduates have different expectations. Go8 university respondents also significantly ranked ‘My ICT qualification has an advantage over qualifications from other disciplines’ higher than respondents from non-Go8 universities. This indicates a confidence by Go8 graduates in their ICT degree.

To identify good practices in preparing students for the workplace, a further comparison between universities was made. This comparison included only those universities from which there were 20 or more respondents. This made for a short list of eight universities (see Appendix 2, Table A2.4). The Kruskal-Wallis Test was applied to rank the eight universities for significantly different ability items, and 45 significant differences were found. The universities (from these eight) that ranked highest for university courses in preparing students for the workplace for each significantly different item are abstracted and presented in Table 2.13.

It is worth noting that for these eight universities, there was apparently no difference between the universities in the development of thinking/cognitive abilities (items 13–20) and business abilities (items 21–28) (see Appendix 2, Table A2.2), which many respondents considered essential to successful performance at work.

Table 2.13: Items with universities (from eight shown in Appendix 2, Table A2.4) that ranked top of the list for university courses in preparing students for the workplace for each significantly different ranking item ($p \leq 0.05$, Kruskal-Wallis Test)

Ability, university practices and experience	University at top of ranking for preparation
Personal/interpersonal abilities	
1 Ability to speak to groups of people effectively	UOW
2 Ability to communicate effectively in writing	QUT
5 Ability to work productively with people from a wide range of cultural backgrounds	UTS
6 Ability to communicate in languages other than English	CUR
7 Ability to contribute positively to team-based projects	UTS
8 A willingness to consider different points of view before coming to a decision	UTS
10 Ability to remain calm under pressure or when things go wrong	UOW
11 Ability to consider the impact of my actions on the environment	CUR
12 Ability to consider the impact of my actions on people in the broader community	UOW
Technical abilities	
29 Having the technical expertise relevant to my work area	UTS
31 Having exposure to ICT professionals prior to my current job	UOW
32 Having the practical skills to generate creative solutions to abstract problems	MON
33 Being familiar with current technologies rather than fundamental theories	UTS
35 Having experience with industry-based project work	UTS
36 Being able to program in relevant languages	QUT
37 Having numerical skills	CUR
University practices	
38 Information delivered via lectures	UTS
42 Problem-solving activities on my own	USQ
43 Problem-solving activities in a group	UTS
44 Laboratory classes where theory was put into practice	UTS
45 Tutorials which were used for revision purposes	QUT
47 Tutorials with group work	UTS
48 Interviewing clients to ascertain their ICT needs for a project	UTS
49 Working on projects relevant to industry	UTS
50 Placement in industry	UTS
51 Giving presentations	UTS
52 Researching publications to prepare documents/reports/presentations	USQ
University experience and employment expectations	
54 My university courses prepared me well for my work	CUR
55 My ICT qualification has an advantage over qualifications from other disciplines	MON

UOW = University of Wollongong; QUT = Queensland University of Technology; UTS = University of Technology Sydney; CUR = Curtin University of Technology; MON = Monash University; USQ = University of Southern Queensland.

Table 2.13 indicates that different universities have different strengths in preparing their students for professional work. For example, with respect to communication, the University of Wollongong (OUW) leads with speaking to groups of people, Queensland University of Technology (QUT) leads with effective writing, Curtin University of Technology (CUR) leads with multilingual communication, and University of Technology Sydney (UTS) leads with giving presentations. With respect to considering the impact of actions on a broader scale, CUR leads with the environment and UOW with people in the community. In regard to problem-solving, MON leads with the ability to generate creative solutions to abstract problems, USQ leads with individual problem-solving activities and UTS leads with problem-solving in a group. USQ leads with researching publications for preparing documents, reports and presentations.

UTS appears to be the leading institution with respect to student–industry interaction: it leads with student experience with industry-based project work, working on projects relevant to industry, placement in industry, team-based projects, tutorials with group work, and considering a range of viewpoints before making a decision. Perhaps this industry association also accounts for UTS leading with being familiar with current technologies (rather than fundamental theories), which many respondents noted as being necessary for their current work. This may also be linked to UTS being the lead in relevant technical abilities. In addition to industry association and emphasis on group and team work, UTS also leads in imparting information via lectures and in laboratory classes where theory was put into practice. However, CUR has the overall lead in university course preparation for work, and MON students ranked their university highest in their perception that their ICT degree has an advantage over other disciplines.

While there were only eight universities in this comparison, it would be informative to the ICT sector at large to identify and share the different approaches used by these universities to address the same issues. From the observations above, it can be inferred that in addition to technical abilities, an appropriate combination of practices includes a mixture of problem-solving skills, communication skills, industry work, teamwork, practical application, research work, and acquisition of didactic information. It is also clear that different universities have different approaches to offer.

Preparation for professional work

Item 59 in the open text responses (Appendix 2, Table A2.3) was: ‘In what ways did your university course(s) prepare you well for professional work?’ There were 660 responses to this question. Only 5% of respondents remarked that their degree was of little or no use in preparing them for their professional work.

Most of the responses to this question were relatively brief. The responses were categorised and quantified, and are summarised in Table 2.14. Many of the categories of responses shown in Table 2.14 were given in various combinations such as theoretical and technical abilities, and presentation and communication skills. These combinations (double counting) and rounding account for the total responses being 110%, which is an acceptably small error for such a text analysis. In any case, it is the overall picture that is important.

Table 2.14: Categories, description and frequency of response of perceived good university preparation for professional work

Category	General expressions used by respondents for good professional preparation	Response %
Theory and fundamental	Theoretical basis; fundamental theory; fundamentals; theory and concepts	18
Technical abilities	Technical abilities/skills; technical aspects; technical business knowledge; technology background/knowledge/understanding; technical base; programming (database, web, methodology, process, languages, skills, ability, technologies)	13
Team and group work	Working effectively as part of a team; team player; teamwork; how to work in a group; group work; working in groups; group assignments	12
Real-world experience	Case studies based on the real world; real-world assignments; lecturers with real-world experience; exposure to relevant real-world issues; learning to prepare for the real world; industry-based learning (IBL); cadetship; working on real industry projects; industry placement	11
Problem solving	Developed/taught problem-solving skills; problem-solving methods; ability to respond to new problems; problem analysis; how to face and solve problems	8
Presentations	Presentation practice; doing/giving presentations; presentation skill; group presentations	7
Business skills	Interpret business needs; business analysis; understanding business systems; understanding business and IT perspectives; technology and business; business case development skills; ICT in business environment	6
Writing	Report and essay writing; written communication; report writing skills; write technical documents; writing ability	6
Thinking and analysis	Ability to think; thinking and analytical skills; learn and think; learning to think; critical thinking; think widely; logical/structured thinking	5
Communication	Verbal and oral communication; communication skills; communication in different languages and with different cultures; communicating in different ways; communicate effectively	4
Research	Research skills; ability to research; conduct research; researching; research methodology	4
Practical skills	Practical skills; putting theory into practice; relevant practical subjects; practical work; practical projects/assignments; practical labs; practicum experiences; practice focus; practical case studies	4
Time management	Time management; manage time; working under tight timeframes and pressure; preparing materials in a timely manner; time estimation; manage timeline	3
Projects	Final year project; project related; real-world projects; industry projects; group/own projects; project management; extent of projects; project design; research project; project analysis	3
Well-rounded	Elaborated below	3
Independent learning	Elaborated below	3

Table 2.14 gives the theoretical and fundamental knowledge as the most important preparation for professional work (18% of respondents). As noted by several respondents, the theoretical basis has a longer currency than the technology, which changes rapidly. Nevertheless, technological capabilities are ranked next in importance (13% of respondents) because they are required in their current jobs. Teamwork and group work are ranked next in importance (12%). Real-world experiences were regarded as important for workplace preparation by 11% of respondents. This can be coupled with project work (3%), which is usually related to an authentic problem.

Including team and group work (12%), nearly half of the responses are concerned with the universities preparing graduates well in the generic attributes that are perceived as being of relevance to the workplace. Of these, problem-solving abilities (8%) are ranked as the second most important.

A few respondents (3%) gave expanded responses about how their university had prepared them for work in a well-rounded way, e.g.:

> ‘My course prepared me by teaching me; 1) essay writing, 2) technical writing, 3) programming, 4) group work, 5) presentations and public speaking, 6) how to convey my ideas verbally and in writing, 7) how to be a salesman, 8) how to [be] innovative, 9) how [to] work effectively in groups, 10) how to write reports, 11) how to dress in the corporate world, 12) how to write a resume/CV, 13) how to take part in a business meeting etc.’

> ‘Showed me to think in a logical and structured manner, so that when I need to plan for new situations and upcoming projects, I know exactly how to go about it. Gave me such a broad range of topic knowledge, I can understand and communicate with professional people from many disciplines e.g. finance, marketing, IT.’

> ‘Provided strong theoretical background and reasonable technical skills and exposure to a wide range of technology. Introduced social skills and ability to speak in front of groups of people. Left me confident exploring new technologies due to strong researching skills and strong fundamental understanding of IT systems.’

> ‘I developed skills in time management, research, independent thought, decision making, presentation etc. I learnt how to quickly identify the core needs of a project and to develop logical and progressive pathways to problem solving and project design. I also strengthened my skills of both self evaluation and outcomes assessment.’

> ‘Skills in 1 presentation, communications. 2 research skills 3 fundamentals (theory, base lines of technology (although outdated)).’

> ‘The courses were designed to give you theoretical and practical knowledge about the software and hardware. It also taught me how to meet deadlines and manage time more effectively, communicate effectively.’

> ‘The university course(s) actually prepared me [in] the personal/interpersonal skills and working methods, such as team work, presentation skills, research and self-study skill etc.’

A few respondents (3%) noted how university had helped them with independent learning and ‘learning how to learn’, which they considered to be an important ability in a rapidly changing world, e.g.:

> ‘A university degree teaches you how to learn and think by yourself, it, for the most part, does not teach the job specific skills/experience required to do your job.’

> ‘Apart from my qualifications my university course prepared me for work by learning to think for myself, manage my time appropriately, solve problems, have confidence in my abilities.’

> ‘Provided me with an environment in which I could develop many cognitive and personal skills that I utilise on a day to day basis. I have heard it said that university teaches you how to learn. This is what I have gained from my degree. The technical content has turned out to be irrelevant to my current employment. By the time I move into an area that is relevant to the technical content of my degree, the technical content will probably be outdated.’

It was noted occasionally that universities cannot be expected to fully prepare someone for the workplace, e.g.:

> ‘Realistically, I don't think any university course can fully prepare any person [for] the real world. The individual has to come to terms and realise that once he/she enters into the job market, it is a whole new learning process again, exactly like entering into the 1st year of uni.’

Aspects missing from preparation for professional work

Item 60 in the open text responses (Appendix 2, Table A2.3) was: ‘What aspects were missing from your university courses that you needed for work preparation?’ There were 612 responses to this question. Only 4% of respondents said there was nothing missing from their courses.

Responses to this question were categorised and quantified, and are summarised in Table 2.15. Where there were combinations of responses (such as real world and practical), responses were placed in the most appropriate category (or two categories if they were distinctly separate points).

Table 2.15: Categories, description and frequency of response of missing aspects of university courses in preparation for professional work

Category	General expressions used by respondents for aspects missing from courses	Response %
Industry and real-world experiences	Industry-based learning/courses; close industry work; real-world experience; industry involvement/exposure; industry practice and connections/liaison; industry-related curriculum and projects; industry relevant; industry standard work; real life industry specific; working with industry experts; industry placement/experience; real-world case studies; job/work placement; internship; cadetship; networking with industry	34
Up-to-date	Up-to-date technologies and business methods; rapid changes need frequent updating; out-of-date courses/information/curriculum; outdated practical work; outdated languages; market-used technologies; up-to-date industry trends; up-to-date examples/research; up-to-date teaching staff	17
Business	Business with clients; business processes/flows; business acumen/knowledge/thinking/skills; business considerations/orientation/focus; business exposure; alignment with business; business relevance; business analysis and project management; business implementation; business management; technologies and business	14
Practical skills	Practical content from the real world; hands-on practical work/skills; theory linked to practice; practical experience/application	12
Teaching issues	Relevant industry programming languages; industry problem solving; sufficient interaction with teaching staff; industry/workplace aware teachers; up-to-date teachers; understanding accents	4
Group work	Working in groups; group discussions/interaction; group assignments; group project work; group learning	4
Transition issues	Transition subject for workplace; job guidance; existing IT markets; post-course mentoring; real-world expectations; career counselling	2
Presentations	Business/professional presentations; giving presentations; presentation skills; feedback from oral presentations	2
Communication	Communication skills; business/practical communication skills; communication opportunities [distance students]; diverse communication methods/tools; communicate with stakeholders; effective communication	2
Research	Research teaching; knowledge of researchers; research projects; research methods; market research; adequate research labs	1

Lack of association with industry and real-world experiences was the dominant criticism of university courses. One-third of respondents commented on this, sometimes quite forcefully, e.g.:

> ‘Better to have industry based learning, e.g. engage in real project work or work closely with the industry.’

> ‘More hands-on on technical and industry related curriculum’

> ‘Courses must be more real life industry specific.’

> ‘I would like to see university courses more aligned with industry. University courses should not be designed by academic educators, but by industry experts who know what's going on out there. Due to the changing nature of IT, the subjects should be updated every couple of years.’

> ‘*Industry placement* – I cannot stress that enough… This stemmed directly from recruiters preferring students with industry experience.’

> ‘Strong logical skills, real world examples. less of a focus on the “real world common knowledge” basics such as scholarship skills and social sciences, and more focus on the required skills and methods of problem solving. Ask for real world problems and solutions, from real industries, and then teach students how to solve these and discuss the real problems.’

The next most common criticism of university courses was they were not up to date (17%). Respondents felt that technologies, industry relevance and teacher knowledge were lacking or inadequate. Fourteen per cent of respondents noted how important business skills are and that technical competence alone is not sufficient in the workplace.

Closely related with industry and real-world experiences are the practical applications of theory to the workplace (12%). About 70% of the responses were concerned with industry and workplace aspects. However, there were a few counterbalancing comments in this regard, e.g.:

> ‘Not sure – maybe more practical work but the theory is essential as it stands the test of time where practical work can be outdated by new technology.’

> ‘I believe you will always need to retrain a graduate. The investment is in their ability to understand and work through complex problems. Pay back comes one or two years after hiring a graduate, if you can keep them.’

Teaching issues amounted to only 4% of the responses and were often related to a lack of industry association, although a few were concerned with a lack of interaction and understanding of accents. These teaching issues also underpin the very few (1%) remarks relating to inadequacies in research training. This result is hardly surprising given that the survey was of graduates in the workplace and not those engaged in research.

Generic attributes or ‘soft’ skills were not thought to be missing from university courses to a great extent, although some respondents (4%) commented on a lack of group work. Communication and presentations were mentioned by a small number of respondents (2% each), indicating that universities are meeting those needs adequately.

Other experiences affecting workplace preparation

Item 61 (Appendix 2, Table A2.3) asked: ‘Were there other experiences (e.g. part-time work) that had an impact on your professional preparation?’ There were 605 responses to this question. Twenty-three per cent gave a brief (three words or less) negative answer and 5% gave a brief positive response. The remainder of the responses were dominated by comments related to work experience. However, these were too difficult to reliably categorise because respondents did not always indicate when the work experience occurred, whether it was part-time or full-time and whether it was in an ICT-related job or some other field. Nevertheless, the vast majority of the respondents were positive about their work experience and its relevance to their professional development, e.g.:

> ‘The 12 week placements I completed were of real benefit. If I could do it again I would look for a cadetship. The cadetship is a far better way to learn a profession.’

> ‘An understanding of a real world full-time work environment meant that I was more focused on achieving as much understanding in my uni degree as possible, which in turn, meant that I was more prepared for post-uni employment in ICT.’

> ‘My organisational skills were honed by running a university sporting club, being on the social committee at my college and being involved in the running of my college. My work experience was invaluable because it gave me insight into current technologies and relevancy to many subjects and topics within subjects.’

> ‘Working in the job while studying is the best method for learning.’

> ‘Growing up working on construction sites prepared me more for my job than the degree did!’

> ‘I did a cadetship at the BHP (later Bluescope) steelworks. [I] learned a lot more there than at uni for preparation for a life in industry.’

> ‘I had already being working in the industry for over 20 years which helped with an understanding of what was really needed against what was actually taught. I had a strong understanding of all the Microsoft suites.’

> ‘I learnt so much faster at work than in uni. When I finished by bachelor of science part-time, I was learning in three months at uni what I'd normally learn in two weeks at work.’

> ‘I was working full time for the Department of Treasury and Finance throughout the last year of my university degree. This experience provided me with a great understanding [of] the business environment of a large government agency and also an appreciation of deadlines, timeframes, milestones etc.’

> ‘I worked as a trainer (full-time) while studying for the degree (part-time) and this gave me the insight of the ever evolving ICT world. In addition, as a trainer I needed to have good presentation and communication skills in order to convey my teachings into meaningful and easily understandable information to the students/clients. And at the same time I was able to gain some knowledge on ICT skills that was not taught in the university.’

> ‘I worked full time in the industry I was studying for the whole time of my degree. I felt that this not only gave me the opportunity to immediately put my knowledge into practice but it also has provided me with experience and a better employment position at the end.’

> 'I worked full-time for an ICT company while studying, so in a lot of ways my work helped to prepare me for university as much as university helped to prepare me for work.'

> 'I worked full-time in a related field, so that had massive benefits, possibly more so than my uni course. Though the degree is still the required key.'

> 'Part time work always helps even though not directly. Any work experience helps towards the overall growth.'

> 'Part time work definitely has played a very important factor in my profession. I can say due to the experience gained I have been able to make numerous contacts and also learn more about different workplaces. It is though contacts that I have found new employment opportunities.'

> 'Part time work puts education in perspective.'

> 'Part-time work had a major positive impact on my preparation. The work I do now is similar to but at a higher level than during my degree.'

> 'Part-time work in hospitality during my study term. This provided excellent communication and conflict resolution skills.'

> 'Yes – working at Nortel Networks was invaluable in gaining insight and understanding what is relevant in a practical work environment as compared to a theoretical educational perspective.'

> 'Yes, skills picked up during my part-time and contract work help me in listening, speaking, presenting and networking.'

This sample of responses shows that work experience of just about any kind can be of value in professional development for an ICT career. The optimal preparation appears to be a combination of university study and related professional ICT work.

Most valuable course(s)/topics at university

Item 62 in the open text responses (Appendix 2, Table A2.3) was: 'What were the most valuable course(s)/topics at university?' There were 642 responses to this question. Four per cent of respondents said that all or almost all their course(s)/topics were valuable and 2% said none were valuable; the remainder gave qualified responses.

The wide range of responses to this question were categorised and quantified, and are summarised in Table 2.16. The total responses sum to over 120%, which is acceptable because many responses covered several topics at a time (e.g., databases and programming; project management and industry project). Other courses or topics were each mentioned 1% or less, such as: telecommunications, algorithms, human computer interaction, artificial intelligence, operating systems, soft systems methodology, architecture, SAP, and CISCO certified courses.

Table 2.16: Categories, description and frequency of response to the most valuable course(s)/topics at university

Category	General expressions used by respondents regarding the most valuable course(s)/topics at university	Response %
Business	Business subjects/electives/courses; business analysis; business intelligence; marketing; finance; accounting; e-business; e-commerce; business case development; business communication; business management; business fundamentals; organisational behaviour; change management; business processes; business systems; entrepreneurship; leadership	21
Programming	Programming; web/internet programming; programming [specific programs named]; games programming; advanced/hard-core programming	19
Project management	Project management	12
Databases	Database design; database programming; databases; database subjects/topics/units; database management/administration; database systems; database technology; database theory	12
Project work	Project; project work; final year project; group project; thesis; research project; final project; final group project; final report; industry project	11
Networks	Networks; network computing; networking; network security; network communications; internet; network theory; networking systems; network management; network planning	7
Systems analysis	Systems analysis; systems analysis and design	6
Information systems	Information systems; information management; knowledge management	5
Software engineering	Software engineering	4
Data topics	Data mining; data warehousing; data structures; data communications; data analysis; data modelling	4
Practical skills	Practical emphasis; practical subjects/classes/courses; practical skills; theory and practice; balanced theory and practice; practical stuff; hands-on practice; industry-based practical	3
Mathematics	Maths; mathematics; mathematical modelling; engineering mathematics; advanced maths	3
Multimedia	Multimedia design; multimedia projects; multimedia programming; multimedia related	3
Communication and writing	Communication and presentations; communication skills; learning effective communication; professional communication; writing reports/papers/theses; technical writing; professional writing; writing and speaking	3
Communications (technical)	Communications; communications engineering; communications in IT; mobile communication	2
Electronics	Electronics; electrical principles/subjects; digital electronics/circuits; electrical machines; power	2

	electronics; power system; signal processing; electromagnetics	
Software design	Software design/analysis; software life cycle; software technology; software development; software tools; software architectures; software methodology	2
Statistics	Statistics; statistics courses; stats; business stats; engineering stats	2
Hardware	Hardware infrastructure; computer hardware; hardware design; hardware fundamentals	2
Systems administration and development	Systems administration; administration systems; system development; systems integration; systems implementation; systems architecture	2

It is interesting to note that among the broad range of responses about valuable courses and topics summarised in Table 2.16, almost 90% refer to specific ICT subjects rather than any ‘soft’ or generic topics. Three per cent relate to communication, presentation and writing skills and 11% to project work. Examples of the value of project work included:

> ‘My final semester information systems project was *the* most valuable course I undertook as this was a real-world project and the competitive aspect of the course helped provide incentive to work hard. If an ICT degree consisted of a year of basic concept book-learning and a further four semesters each containing major real-world projects such as this, the course would prepare students better than any other professional development that is available at the moment. The degree would be just about entirely experience-based. There is just no substitute for the kind of value that adds to a young professional!’

> ‘I would also rate my project work in my last semester as a very useful learning experience. We spent a lot of time on it, learned a lot, and it was probably the most realistic real-world course I had.’

Business courses and topics were considered the most valuable by 21% of respondents. Programming of all kinds closely followed with project management and databases at 12% each. The responses to the remaining categories are in single figures each.

It is probable that many of the responses are related to the current work of the graduates, who would be likely to report on the topics with which they associate on a daily basis. It is therefore not surprising that business topics come to the fore, and does support previous comments that business experience is very valuable in the workplace and in finding employment.

Least valuable course(s)/topics at university

Item 63 in the open text responses (Appendix 2, Table A2.3) was: ‘What were the least valuable course(s)/topics at university?’ There were 576 responses to this question. Twenty-four per cent of respondents said that none of their course(s)/topics was least valuable, 2% said that they could not think of any, and 1% said none were valuable; the remainder gave qualified responses.

The wide range of responses to this question were categorised and quantified, and anything mentioned by more than 2% is summarised in Table 2.17. Other courses or topics were also mentioned as being the least valuable, such as Asia–Pacific studies, Australian studies, algorithms, artificial intelligence, networking, operating systems, soft systems methodology, architecture, software engineering, research topics, group projects, information systems, telecommunications, computer history, and English.

Table 2.17: Categories, description and frequency of response to the least valuable course(s)/topics at university

Category	General expressions used by respondents regarding the least valuable course(s)/topics at university	Response %
Business topics	Business subjects/studies/courses; business processes; business management; business communication; business law, statistics, ethics, accounting; e-business; e-commerce	7
Introductory subjects	Introduction subjects/courses; ICT introduction; introduction to computing/computers/Microsoft Office; foundation subjects	6
Programming	Programming (e.g., Java, Cobol, Pascal, Perl, Delphi, VB, C++); programming subjects/courses/modules; basic programming principles; internet programming; assembly programming; maths programming; systems programming	6
Out of date	Outdated computer science courses; out-of-date subjects/modules; old technology subjects; not industry relevant; old hardware and software practices	5
Theoretical	Theoretical courses; abstract theories; lack of practical; heavy theory; long-winded theory; too theory based; unrelated theory and practice	4
Outdated programming	Programming languages not used in industry (e.g., Cobol, Pascal, C, Delphi, VB); archaic programming languages	3
Maths	Mathematics; maths; calculus; discrete maths; maths unit(s)/courses; maths not required by industry; financial mathematics	3
Teaching practices	Unaligned teaching; teaching dated or irrelevant courses; uninterested teachers; uninformed teachers; lack of contact/discussion with teachers; poorly organised courses	2
Project management	Project management (PM); PM not related to workplace; PM too early in course	2
Data topics	Data structures; data analysis; data modelling; data mining; data communications; data warehousing; data security	2
Web	Website design; web marketing; web programming; web development; web interfaces	2
Databases	Database subjects/systems/courses; Access as database; database design	2

One-quarter of respondents stated that every subject was valuable, and those listed as the least valuable are all in single figure percentages. One respondent noted that their appreciation of subjects taught has grown since joining the workforce:

> 'Can't think of any. But I can think of subjects that I thought were less valuable at the time and I payed less attention to. It would have been good to have a reminder of how [these] subjects would help in the workplace back then. Maybe you should let the students read the answers to these questionnaires.'

Several students noted that their responses were in relation to relevancy to their current workplace context, such as:

> 'Computer systems maybe. Not because it was taught in a bad way. On the contrary it was taught to us very professionally. Mentioned this only because of its being less relevant to my current career.'

> 'For my current job the least relevant course would be Advanced Multimedia.'

> 'For my line of work, most of the numerical computing courses are never used.'

> 'From a work point of view some of the core subjects like Discrete Maths are not required but I feel they are required in the course to give the student grounding and understanding in other subjects.'

> 'I don't program much so I don't really use the programming skills I learned, but it is important to understand the programming process in engineering.'

These comments suggest that responses to this question are influenced by what is currently valuable in the workplace or chosen profession rather than indicating what was of little value in their degree. Nevertheless, the comments concerning the teaching of out-of-date technologies or inappropriate introductory courses (essentially too easy or not perceived as relevant) are worth considering.

Improvement of university courses

Item 64 in the open text responses (Appendix 2, Table A2.3) was: 'Do you have any suggestions for improvement to your university course(s)?' There were 533 responses to this question. Responses varied in length from a few words to one surprisingly detailed response of 1,181 words (at the end of a long survey).

The responses to this question were categorised and quantified, and those over 2% are summarised in Table 2.18.

Table 2.18: Categories, description and frequency of response to suggested improvements of university courses

Category	General expressions used by respondents for suggested improvements of university courses	Response %
Industry-related learning	Cadetships; industry presenters/teachers; industry-related courses; industry experience; industry contact/engagement/involvement/liaison; industry oriented; industry placement; external/company projects	34
Up-to-date issues	Outdated methodologies/techniques/courses/subjects; new/recent/up-to-date technologies/courses; current industry practices/technologies; up-to-date lecturers/information; outdated reading materials; up-to-date languages/skill sets	22
Teaching issues	Industry experienced teachers; disparity between teachers and industry; rote learning; better trained teachers; better English for understanding; teacher contact and interaction; respond to evaluations; enthusiastic, knowledgeable teachers; low-quality teaching; boring PowerPoint lectures	19
Practical skills	Practical knowledge; practical and relevant; practical industry focus; balance of theory and practice; better learning with hands-on practice; practical skills; practical application/context; more practical, less theory; practical assignments; practical examples; practical technologies	11
Real-world issues	Case studies; real/relevant examples and courses; real scenarios; real workplace issues; real situations; real-world projects; real life applications	7
Business	Business-related projects; business experience; business skills/knowledge/processes; business writing; business and IT subjects/electives; business focus	5
Wider choices	More subject choices; foreign language; industry-related subject choices; greater range of courses; more variety of subjects; cross-discipline choices	4
Group work	Fair rewards for participation; more group practice/projects/activities/participation; difficulties with mixed cultures; more online group activities/projects; more small groups	3
Theory/ fundamentals	Greater focus on theory/fundamentals; stick to theory; more on theory; more underlying fundamentals; newer technologies and fundamentals; fundamental knowledge/theories; long-term fundamental ideas	3
Projects	Practical projects; longer projects; in-depth projects; personal projects; project-related subjects; project-oriented assessment	2
Communication	Focus on communication skills; effective communication; limited English communication; written and verbal communication	2

More than one-third of respondents directly expressed the need for greater industry association in their learning, e.g.:

> ‘Make all university courses that lead to professions, cadetships. Let those companies who benefit the most from universities pay for the training. I believe

then that some loyalty to employers will be returned. At the moment graduates come out with $50,000 in HECS and have been working 70–80 hours a week to survive. They therefore want to get as much money as possible and don't owe their employers anything. I believe that if you asked those that completed a cadetship how long they stayed with their employer who paid for it, it would be much longer than those that had to pay for it themselves.'

'Have key people from the industry to talk about real experiences not fully rely on theory – design more course material that's more industry related.'

'If the university aligned itself with the ICT industry, it would make the postgraduate students work harder, and it would tend to open up the "closed teams" in industry. This must ultimately be good for the industry and good for the student and good for the country.'

'Industry experience is vital and without it, a degree is of no use.'

'… better teaming with industry professionals – teaching by people with substantial industry experience and understanding.'

'Academics need to look at what is out there in the real world and cater for it – I think an industry type of course should be included in ICT degrees.'

'Add some course[s] for more practical industry focus. So graduate[s] can join in industry easily.'

'I think it would be useful to have more contact with industry through for example having working programmers delivering guest lectures.'

'I would say that a brief outposting to the industry in some way (such as a weekly or even monthly trip to a local ICT business) could benefit students really well, especially younger students who may not have had any experience in working full-time at all.'

'Incorporate industry placements and/or work experience as a compulsory element for graduation.'

'Industry placement is a must.'

'Look to moving a lot more quickly with curriculum and involve industry in the design and delivery to a much higher extent.'

'Maybe more of the courses could include some liaison with industry to give the students access to actual work experience during their studies.'

'Offering courses together with industry partners.'

'Provide practical industry experience please.'

'Teach more in depth on subjects that are valuable to getting a job, teach the students industry standard software, encompass industry placement, introduce the students to the world in which they will be walking in to after their 3–4 years by introducing them to industry professionals.'

The call for greater industry association (indicated by references to industry-associated learning, up-to-date industry-based technologies, real-life examples, practical industry relevance and business knowledge related to industry) amounted to 60–70% of the total responses.

Teaching issues mentioned (19%) were wide ranging and included the desire for industry-relevant teaching by people with up-to-date industry experience. Several respondents observed a lack of experience, especially those who were postgraduates and felt that they were better informed than their teachers (who may themselves have been postgraduate students). Teaching was criticised that encouraged rote learning and memorisation rather than doing and thinking such as with projects. Exam performance was not considered to be indicative of actual abilities relevant to industry. Lecturers with poor English was a common complaint. Lack of interaction with teachers was also noted, especially by students in distance learning programs. PowerPoint presentations that were not used for learning purposes were also criticised.

While 3% of respondents were in favour of more theory and fundamentals, 11% were in favour of less and wanted more practical application. Three per cent of respondents mentioned group work, and they were generally in favour of it provided that it was managed properly with respect to fair rewards, cultural issues and group size. Communication was mentioned by only 2% of the respondents and mainly in the context of understanding the English of students and staff, as well as in improving written and oral communication. Project work (not specifically related to industry) was mentioned by 2% of respondents, who wanted the opportunity to engage in longer or deeper projects for learning and assessment purposes.

Other topics each mentioned 1% or less included helping with the difficulties faced by international students in gaining workplace experience; improving the experience of distance learners with better resources and more interaction opportunities; allowing more focused and narrower degrees; placing more emphasis on research; providing better resources in laboratories and on campus; and providing more opportunities to study maths, project management, programming and web development.

Conclusions from the survey findings

This study found that graduates consider a range of abilities from the personal/interpersonal, cognitive, business, technical and learning domains to be important for performance of their work. These include communication, teamwork, problem-solving, organisation of information, project management, client relationships and technical expertise. However, there was a significant disparity (88%) between what graduates consider to be of high importance for their work and their perceptions of how well universities focused on developing those abilities. This compares with a 75% mismatch between education and work among science and technology experts in a broad European study (Allen and van der Velden, 2007). The free-text comments provided explanations for many of these mismatches in the current study.

While a majority of graduates were satisfied with how their university prepared them for their work, many saw themselves as underprepared in terms of personal/interpersonal skills, business abilities and industry knowledge. Graduates claimed they were generally well prepared in technical skills, but would have preferred more exposure to new and emerging technologies and the technologies used in industry.

The perception that graduates are underprepared in communication and other 'soft' skills is not necessarily because universities did not provide the opportunities for the development of these skills. As a number of graduates claimed, as students they did not appreciate the importance of these skills for future work and hence did not engage at the time as fully as they might have. That ICT students undervalue soft and business skills development despite academic efforts is supported in findings by Petrova and Claxton (2007).

Information from graduates in the workforce indicated that a well-rounded ICT graduate requires relevant technical know-how, workplace experience, problem-solving skills and ability to work in a team for success in professional employment. Sumner and Yager (2008) also concluded that students need a balance of technical and non-technical skills for industry relevance.

In the male-dominated culture of ICT (and the number of women does not appear to be increasing, e.g., Lewis, McKay and Lang, 2006), there are numerous gender differences in the survey responses which may be the result of either learned or biological differences that are expressed in the ICT context. In general in the ICT workplace it seems the technical and managerial roles are dominated by men, with women in support roles. The small numbers of women enrolled in ICT may in part be because ICT curricula are more biased towards technology-centred topics rather then being more inclusive by incorporating social and human concerns (Lewis, McKay and Lang, 2006; Lewis, Lang and McKay, 2007).

It seems that having studied ICT in high school or as a postgraduate degree results in better preparation for the workplace in a variety of abilities.

Different universities have an apparent lead in a range of educational practices. Sharing of these pedagogies would benefit the sector as a whole.

From many perspectives it seems that internships and workplace learning contribute markedly in the preparation of work-ready graduates, and this is strongly appreciated by graduates. The overwhelming response from graduates in the workplace when asked where improvement was needed was in regard to industry-related learning. These industry relationships included industry involvement, workplace learning and business experience, up-to-date teaching and technologies, practical applications, and real-world activities.

The advantages of formal work-integrated learning that is more than just 'work experience' were discussed by Jancauskas et al. (2000), who concluded that such programs 'provide a mechanism by which industry can contribute to curriculum development, keeping programs up to date and relevant to the real world'. This is precisely what the graduates are asking for. Work-integrated learning has been shown to have mutual benefits for universities, students and industry (Orrell, 2004), and specifically in the ICT context (Poppins and Singh, 2005; Pauling and Komisarczuk, 2007). Similar benefits have been proposed by Universities Australia (2008a), which has advanced the idea of a national internships scheme. The discussion paper on the scheme by McIlveen et al. (2008) notes the considerable benefits of work-integrated learning to students' career development and employers' recruitment opportunities, even though the necessary partnerships between industry and universities may be difficult to maintain.

Curriculum implications

The feedback from graduates in the workforce has implications for the ICT curriculum, innovation, and teaching approaches at a local and national scale. The main areas for consideration are:

- work-integrated learning for all ICT students
- involvement of industry professionals in teaching
- use of 'real-world' examples, case studies and scenarios
- balancing of up-to-date technologies and practices with fundamental theoretical approaches
- gender-inclusive pedagogy
- identification and sharing of good educational practices
- inclusion of business practices
- development of personal/interpersonal skills, including communication of all kinds
- authentic problem-solving activities
- group work related to industry practices of teamwork
- project work related to industry and project management
- teaching practices that involve greater interaction between teachers and students
- clear demonstration of subject relevance to employment.

Chapter 3: Perspective from ICT employers

Introduction

The readiness of graduates for work can be quantified in terms of relevant knowledge, skills and attributes. The qualities of graduates required by employers, and any perceived deficiencies, can be determined by several means:

- a study of published literature that includes employer considerations
- an analysis of relevant job advertisements
- professional accreditation bodies associated with industry
- surveys of employers.

This chapter reports on published work in these areas and gives the results of a pilot survey of employers that was carried by the Australian Information Industry Association (AIIA) for this project. Regarding ICT-specific knowledge and skills, it is broadly recognised that employers need to be consulted about the requirements of ICT graduates (e.g., Hagan, 2004; CEN, 2006; Gregor et al. 2008; Information Technology, 2008) and related engineering graduates (Ilic, 2007; King, 2008).

The knowledge, skills and attributes of graduates are essentially divided into two broad areas: generic attributes ('soft' skills) and technical skills. The specific technical skills required of graduates in each of the disciplines comprising the broad ICT spectrum (electrical engineering, computer engineering, telecommunications engineering, software engineering, computer science, information technology, and information systems) are beyond the scope of this project.

Literature review

General attributes applicable to most graduates

The general graduate attributes are often referred to as 'soft' skills, and they are not necessarily specific to any particular discipline. A survey of employers in Australia regarding satisfaction with graduate skills was carried out by AC Nielsen Research Services (2000). Two methods were used: qualitative focus groups with open-ended discussion and a quantitative mail survey where the prompts were supplied. The two approaches gave somewhat different results. Generalisations were made regarding all university graduates, as well as specific findings relating to computer science and engineering graduates.

From the qualitative (group discussions) research (AC Nielsen Research Services, 2000), the general graduate skills (excluding those expected to have been learned at high school and infrequently sought) were found to be:

- academic achievement in a suitable discipline
- time management skills
- written business communication skills
- oral communication skills
- interpersonal skills
- teamworking skills
- problem-solving skills
- comprehension of business processes.

Any dissatisfaction with graduate skills lay in the area of written communication, because it was thought by employers that most students are not taught business writing.

The quantitative survey found that oral business communication skills were the most important to employers. The overall main deficiencies perceived by employers were a lack of communication and interpersonal skills and a lack of understanding of business practice. This perceived lack of business knowledge and importance of communication skills were also identified by many ICT graduate respondents in a recent survey (Koppi et al., 2009; and Chapter 2 of this report).

Overall, the areas in which new graduates appeared to be most deficient were:

- problem-solving skills
- oral business communication skills
- interpersonal skills.

The recent Graduate Outlook Survey (Graduate Careers Australia, 2008) had findings similar to those of the 2000 Nielsen report. For employers in general, the most important key selection criteria in recruiting graduates were again interpersonal and communication skills. Employers also reported difficulties in sourcing graduates from specific disciplines in 2008, with engineering and related disciplines being most in demand. Employers reported difficulties in retaining their graduate employees; most employers expected that graduates would not stay more than three years. This is at odds with the survey of ICT graduates conducted for this study (Chapter 2, Table 2.6), where most graduates in ICT jobs did not expect to change jobs frequently, nor did they think employers expected them to change jobs frequently.

In their recent review of Australian higher education, Bradley et al. (2008) frequently noted that the university sector needed to consult or liaise with employers, industry and other relevant information sources and stakeholders to provide relevant university courses. Bradley et al. also noted that, in submissions from business and industry, 'Technical skills and generic employability skills (such as communication and language skills) were considered to be of equal importance' (2008, p. 210).

General attributes more specific to ICT graduates

In her report on the ICT industry in the United Kingdom, Webster (2007, p.1) noted employers' increasing emphasis on 'soft' skills:

> There is also a growing demand for 'soft' skills in ICT work; these are increasingly emphasised in recruitment and selection processes. 'Soft skills' generally refer to: business skills, communications skills, team-working skills, competencies, personal attributes, individual qualities, transferable skills, social skills, interpersonal skills – all important for client-facing work and for managing outsourcing relationships, on which the ICT sector is strongly dependent.

The demand by ICT employers for 'soft' skills has been reported more widely in numerous studies (e.g., Scholarios, Van der Schoot and Van der Heijden, 2004; Sami, Mari and Tarja, 2004; Roslöf, 2006; Al-Mahmood and Gruba, 2007; Doucek and Novotný, 2007).

With respect to the general skills of computer science and engineering graduates, the AC Nielsen Research Services (2000, p.26) reported the following performance ratings given by employers:

> The computer science graduates were given above average performance ratings for many skills, but also below average ratings for many others. The skills for which they received quite high ratings were: time management skills, comprehension of business practice and academic learning, while those for which they received relatively low ratings are: their ability to benefit from on the job training, both written and oral business communication skills, initiative, leadership qualities, personal presentation, numeracy and problem solving skills.
>
> …
>
> Engineering graduates were perceived to be particularly poor at critical and independent thinking, comprehension of business practice and motivation.

ICT employers want job candidates with appropriate work experience, commercial understanding and strong communication skills (Forth and Mason, 2003). Technical skills are as important as social and personal qualities in the professional context (Petersen et al., 2004). Nagarajan and Edwards (2008) report that non-technical skills and personal attributes ('soft' skills) may be at least as important as purely technical skills in IT graduates. These authors also noted that employers may not always clearly express the graduate capabilities they require.

Direct approaches to identifying employer requirements

Direct approaches to identifying ICT employer requirements include interviews and surveys. Scholarios, Van der Schoot and Van der Heijden (2004) interviewed representative ICT employers from a range of countries and found that managers consistently identified the 'soft' skills, such as communication, flexibility, team working and consultancy capabilities in dealing with clients, as being as important as technical software or systems development skills.

Hagan (2004) reported on a survey of employers of ICT graduates. Respondents identified a number of areas for university improvement in the preparation of graduates:

- work experience
- industry consultation
- industry awareness
- written and oral communication
- teamwork
- problem-solving
- business skills/knowledge
- technical skills.

The majority of responses from employers concerned improvements in work experience and the need for more industry involvement in the university ICT curriculum. These responses correspond with the greatest improvements sought by recent ICT graduates (Chapter 2 of this report). Vu, Tan, and Maneerat (2004) and Pauling and Komisarczuk (2007) also note that the ICT industry is demanding that students gain more work-oriented skills. Improved work experience was also advocated for enhancing the work readiness of related engineering graduates (McDermott, 2007).

While the majority of employers were satisfied with their graduate ICT employees, the main areas of dissatisfaction were project management and understanding of business processes (Hagan, 2004). These areas of low satisfaction correspond with the deficiencies across a range of disciplines identified by AC Nielsen Research Services (2000), namely: communication, understanding of business processes, and problem-solving skills. The importance of problem-solving skills for computer scientists was also stressed by Tan and Venables (2008) and identified as a key knowledge area for ICT graduates (Gregor et al., 2008) and for related engineering graduates (Dym et al., 2005; McLennan and Keating, 2005; King, 2008).

Indirect approaches to identifying employer requirements

Indirect approaches to identifying ICT employer requirements include analyses of job advertisements, and the work of discipline-specific professional groups concerned with developing industry-relevant curricula.

To determine the knowledge and skills sought of recent information systems graduates by employers, Kennan et al. (2008) examined the content of 400 online job advertisements in Australia. These authors identified 17 content analysis categories as graduate requirements; the three most frequently occurring were IS development, personal characteristics and communication skills. Requirements for this set of skills among ICT employers were also found by Seymour et al. (2006) and Petrova and Claxton (2007). Unexpectedly and inexplicably, the technical skills employers wanted in information systems graduates were more like those expected of a software engineer or computer science graduate (Kennan et al., 2008).

Also of note is that nearly half (49%) of the advertisements for recent graduates asked for a person with experience, and a further 9% asked for 'some experience'. Only 5% of the advertisements stated that no experience was required. While Kennan et al. (2008) noted this with concern, it does support the comments of recent ICT graduates (Chapter 2 of this report) that employers seek people with experience whether or not they have only recently graduated, and that work experience is an essential part of employment preparation. Experience in ICT is generally weighed against formal qualifications (CEN, 2006). Kennan et al. (2008) also note that the key 'core body of knowledge' (CBOK) areas (in the professional knowledge area) specified by the ACS (Gregor et al., 2008), including ethics, professionalism and society issues, were mentioned in only two of the 400 advertisements. This may indicate a gap between the CBOK and actual practice or that these issues are pursued at interview stage.

Petrova and Claxton (2007) investigated the alignment of the IS curriculum with industry requirements. They found that most employers consider that the communication skills of their graduate employees could be improved, whereas most undergraduate students felt confident that they had these skills. These authors also reported that both employers and students consider students to be lacking in real-life experiences and therefore lacking in work readiness. This lack of real-life experiences was strongly supported by recent graduates (Chapter 2 of this report). Petrova and Claxton (2007) also reported that employers pointed out a lack of skills and capabilities in networking concepts and e-business development, and that business soft skills are best learned in a workplace environment. These findings have implications for IS and IT curricula and underscore the importance of employer involvement in curriculum design, and the inclusion of real-world and workplace learning opportunities.

Professional accreditation bodies associated with industry

While not a direct view from employers, the CBOK given by the ACS (Gregor et al., 2008) defines the knowledge shared by ICT professionals. It is therefore broadly representative of general employer requirements, although it does not include job-specific roles. Curricula relating to job-specific roles can be found elsewhere, such as IS Curriculum Wiki (2008) for international IS developments; Computer Science Curriculum (CSC, 2008) for the ongoing international revision of the computer science curriculum; and Information Technology (2008) for IT undergraduate curriculum guidelines. Details of related engineering-specific skills can be found through Engineers Australia (2008). Specific skills at various levels of ICT professionals are also given by the Skills Framework for the Information Age (SFIA, 2008).

Regarding the IS Curriculum Wiki (2008), there is no obvious recent employer research input apart from references to the 'community' and 'practitioners'. The CSC (2008) review adopted a broad consultation process, which recognised that the needs of industry had to be included in the curriculum development process. A quote from one industrial commentator captured many of the concerns:

> The thing that we can't afford to do … is teach candidates how to think critically, to be effective problem solvers, and to have basic mastery of programming languages, data structures, algorithms, concurrency, networking, computer architecture, and discrete math / probability / statistics. I can't begin to emphasise the importance of algorithms and data structures to the work we do here… With multi-terabyte disks, bigger broadband pipes, etc. on the way, the big data problems that demand these skills … are quickly going to be in need in a huge number of programming contexts. (CSC, 2008, p. 11.)

Other desirable student experiences identified in the CSC industry consultation process were industry internships, contribution to open source software, and undergraduate systems software projects.

The development of the IT curriculum guidelines (Information Technology, 2008) included industry considerations and strategies for incorporating professional practice into the curriculum. Common skills noted as being required for professional practice include communication, problem-solving and technical skills. The opportunity for students to work in industry through practicum, internship and co-op programs was seen as contributing to the development of professional practice, as were senior capstone projects that included teamwork and dealing with real-world issues and clients. Other courses such as ethics, psychology and business management were also recognised as being beneficial. Modelling practices of the business world in academia were seen as contributing to students' job-readiness.

The ACS CBOK working paper (Gregor et al., 2008) presents employers and students among the stakeholders of the ICT profession and their vision advocates industry participation 'through advisory committees, guest lectures and involvement with student projects and work-integrated learning' (p. 6). The authors recommend that curricula be industry relevant, flexible and continually updated in response to the jobs that graduates will undertake. The authors also appreciate that the working paper requires more industry input. Currently the CBOK that is applicable to all ICT graduates includes ICT and professional knowledge areas as shown in Table 3.1.

Table 3.1: The ICT and professional knowledge areas of the core body of knowledge given by Gregor et al., 2008

Core body of knowledge (ICT knowledge area)	Core body of knowledge (professional knowledge area)
• Problem solving using modelling and abstraction • Hardware and software fundamentals • Data and information management • Networking • Programming fundamentals • Human–computer interaction • System development and acquisition • ICT project management	• Ethics • Professionalism • Governance and organisational issues • Teamwork concepts and issues • Communication • Society issues

The professional knowledge area on the right of Table 3.1 shows the personal skills and behaviours that would be relevant to employers of ICT graduates. It is noteworthy that Kennan et al. (2008) reported that very few employers actually ask for 'ethics, professionalism or society issues' in their job advertisements. Business knowledge is seen as 'complementary knowledge' outside the core body of knowledge, yet many recent graduates indicated its importance (Koppi et al., 2009; Chapter 2 of this report), as have many other authors (e.g., AC Nielsen Research Services, 2000; Hagan, 2004; Sami, Mari and Tarja, 2004; Petrova and Claxton, 2007; Webster, 2007).

Survey of AIIA member employers

Survey method

Michel Hedley (AIIA NSW Executive Officer & AIIA National Workforce Policy Manager), supported by Ian Birks (AIIA CEO), prepared an online survey of CEOs who are members of AIIA regarding recent ICT graduate recruits. The project team provided comments and feedback to refine the survey, which was housed and administered by AIIA.

The response rate from employers was not as great as was hoped (despite several encouraging attempts) and mirrors the disappointment expressed by Hagan (2004), who also commented on the poor response rate to a postal survey of employers. Perhaps this is because senior employers are too busy to partake in surveys. The data provided by AIIA were analysed and compared with findings in the literature.

A selection of survey results is given in Appendix 3. Responses were received from every state and territory; most of the companies had headquarters in Australia; and a range of businesses were represented.

Employer survey findings

The recent graduate recruits were from a variety of ICT disciplines, with information technology, computer science, and software engineering being the most common. These graduates were employed in a wide range of positions; the three most common were analyst programmer, programmer, and developer. These graduates met about half of the knowledge and skills needs of employers, but only met some of their needs in understanding business processes, project management knowledge, and written communication qualities. More than half of the employers indicated that the graduates did not meet their needs for commercial awareness. Overall, just over half of the employers were satisfied with the knowledge and skills of their recent graduates.

A lack of communication skills has often been reported in the literature regarding graduates from many disciplines, including ICT (AC Nielsen Research Services, 2000; Hagan, 2004; Scholarios, Van der Schoot and Van der Heijden, 2004; Graduate Careers Australia, 2008) and in business submissions to the Australian higher education review (Bradley et al., 2008). It has also been widely reported that ICT graduates lack business skills or commercial awareness (AC Nielsen Research Services, 2000; Hagan, 2004; Sami, Mari and Tarja, 2004; Petrova and Claxton, 2007; Webster, 2007).

Graduates met the needs of employers for more than half of the identified personal qualities. The qualities lacking to some extent were planning capability, problem-solving skills, initiative, self-management, and having a global perspective. The lack of problem-solving skills has been noted elsewhere for ICT graduates (AC Nielsen Research Services, 2000; Hagan, 2004; Tan and Venables, 2008) and problem-solving is considered important in various ICT curricula (IS Curriculum Wiki, 2008; Information Technology, 2008) as well as for engineering (King, 2008). Problem-solving has been identified as a key knowledge area for ICT graduates (Gregor et al., 2008). Nearly two-thirds of the employers said that graduates lacked planning abilities, which is perhaps linked with the lack of commercial awareness of recent graduates.

Graduates met the needs of employees for less than half of the interpersonal skills identified in the survey. Of note is that nearly two-thirds of employers considered that ICT graduates met their needs for teamwork. Team-working skills have often been reported as being important in the ICT workplace (Hagan, 2004; Scholarios, Van der Schoot and Van der Heijden, 2004; Webster, 2007), and from this survey of employers it appears that universities are generally producing graduates with team skills. The interpersonal skills that lacking were undertaking planning; serving clients and customers; appreciating and exercising social responsibility; teaching others; negotiating issues and outcomes; and exercising leadership. The requirement by ICT employers for general interpersonal ‘soft’ skills has been reported widely (Scholarios, Van der Schoot and Van der Heijden, 2004; Sami, Mari and Tarja, 2004; Roslöf, 2006; Al-Mahmood and Gruba, 2007; Doucek and Novotný, 2007; Nagarajan and Edwards, 2008). It is noteworthy that less than half of the employers were satisfied with the personal qualities and interpersonal skills of their recent graduate recruits.

There was strong agreement among employers about the value of prior industry experience of recent graduates. The benefits of students undertaking industry internships or professional practice has also been noted by curriculum developers (CSC, 2008; Information Technology, 2008). Work-integrated learning is also a component of the stated vision of the ACS core body of knowledge (Gregor et al., 2008), and Universities Australia (2008) has advocated a national internship scheme to improve graduate employability.

Employers also provided information on how long it takes to get recent ICT graduate recruits up to speed in industry and the cost of doing so. These data indicate that it commonly takes three to 12 months and sometimes longer, and usually costs in excess of $10,000 for each graduate. Employers were asked to suggest strategies for universities to improve the employability of recent graduates. The results are given below, in order of importance (equal numbers have the same rank order).

1. Universities should consult industry more in designing curricula and courses.
2. Students should do work placements as part of their study.
3. Courses need to have more industry experience.
4. Teaching staff should have industry experience.
5. Courses need to have more real-world training.
5. IT curricula should teach more about how business and companies work.
5. IT curricula should focus on fundamental knowledge, not current applications.
6. IT curricula should be focused on current technologies and not on theory.
6. Courses need to have more industry-based project work.
7. Teaching staff need to focus on applied technology rather than theory.
7. Students need to know more about how companies work.
8. Students should learn more through simulations.
8. Students should do more group work.

The first four of these strategies are concerned with greater university and industry liaison. This sentiment has often been expressed elsewhere (Hagan, 2004; CEN, 2006; Gregor et al. 2008; Information Technology, 2008). The findings here are consistent with Hagen's (2004) report on a survey of ICT employers, which gave improvements in work experience and more industry involvement in the university ICT curriculum as the two most important concerns of employers.

Employers were also asked to indicate the graduate qualities most in need of improvement. The results are given below, in order of importance (equal numbers have the same rank).

1. Communication skills need to be improved.
2. Problem-solving capabilities need enhancing.
3. Self-management needs more development.
4. Students need to develop more initiative.
5. Students need better planning abilities.
5. Independent learning needs improvement.
6. Teamwork abilities could do with improvement.

The first two capabilities (communication and problem-solving) are the ones often reported in the literature as lacking in ICT graduates. Improvement in teamwork abilities ranks a distant last and confirms the interpretation made above that universities are apparently developing teamwork abilities well.

Conclusions from the literature and employer survey

Several broad conclusions can be drawn from the literature regarding ICT employer requirements, the capabilities of ICT graduates, and ICT curriculum development:

- Generic attributes ('soft' skills) are as important as competence in technical skills.
- Communication skills are very important.
- Workplace experience is necessary, even for recent graduates.
- Industry needs to be involved in curriculum design and delivery.
- Business knowledge is a valuable asset.
- Problem-solving skills are underdeveloped.
- Team-working and interpersonal skills are important and sometimes lacking.

Specific conclusions can be drawn from the survey of employers by AIIA regarding their recent ICT recruits.

- Most employers considered that graduates met their needs in relevant ICT knowledge, foundation in theoretical principles, literacy and numeracy, computer languages and software applications.
- Commercial awareness did not meet the needs of more than half the employers.
- Some employer needs were met in project management knowledge, written communication skills and understanding of business processes.
- There seems to be a more-or-less equal balance between the desire for fundamental knowledge and familiarity with current technologies.
- The graduate qualities most in need of improvement are communication skills and problem-solving capabilities.
- Other qualities in need of improvement are self-management, initiative, planning abilities and independent learning.
- The need for improvement in teamwork was ranked very low.
- Less than half of employers were satisfied with the personal qualities and interpersonal skills of their graduate recruits.
- Universities and the ICT industry need to cooperate more in designing curricula and courses that include industry experience.
- Students need more work placements to gain industry experience.
- Teaching staff should also have industry experience.
- Curricula need to include business awareness.
- The time and cost of getting recent graduates up to speed in industry can be considerable.

General conclusions concerning employers and the ICT curriculum

Although few employers participated in the AIIA online survey, their responses reinforce and are consistent with published findings. Greater cooperation between industry and universities in curriculum design is often advocated, and implies that this expressed desire and actual practice still require realisation. Implementing the employer desire for students to have industry experience with work placement should contribute to alleviating perceived deficiencies such as communication, problem-solving and planning abilities, and the development of business skills, provided that the students are engaged in authentic business projects which have recognised academic merit. The time and cost of getting recent graduates up to speed in industry may be considerable and just how far universities can be expected to prepare students for employment requires negotiation and clarification between academia and industry.

Appendix 1: Academic consultations

The consultation process included interviews and surveys of a broad range of academic stakeholders. Those consulted included deans and heads of school, the Australian Council of Professors and Heads of Information Systems (ACPHIS), and the heads and professors of the Computing, Research and Education Association (CORE), other members of CORE who responded to an email request for information, and attendees at various conferences covering the ICT spectrum. Forums were held at a range of conferences, such as the International Conference on Engineering Education and Research, the Australasian Computing Education Conference, and the Australian Software Engineering Conference. Over 100 written submissions were received, and over 20 interviews were conducted.

The initial consultation was with deans, heads of school, and associated academic staff from:

- La Trobe University
- Monash University
- Queensland University of Technology
- Swinburne University
- University of Adelaide
- University of Queensland
- University of South Australia
- University of Technology Sydney
- University of Wollongong

The results have been compiled and distilled into Table A1.1. Categories were created to structure the discussion.

During the early consultation process with the deans and associated staff (Table A1.1), numerous statements were made. A table containing 24 common statements was prepared and given to other groups to canvass their agreement with the deans' statements. The following six groups participated and the results are given in Tables A1.2 to A1.7:

- Australian Council of Professors and Heads of Information Systems (ACPHIS)
- Heads and professors of CORE
- Other members of CORE contacted by email
- Attendees of the Australasian Computing Education Conference (ACE)
- Attendees of the Australian Software Engineering Conference (ASWEC)
- Attendees of the International Conference on Engineering Education and Research (iCEER)

Numbers given in Tables A1.2–A1.7 do not always sum to the number of respondents (N) because not all participants responded to every statement. The total number of respondents from these diverse groups was 112.

The same six groups were also asked to freely express in writing their main concerns about ICT education and outcomes they would like to see from the project. These responses were typed and the comments categorised and grouped as a level 1 process. These groupings were then refined and trimmed to remove repetition and abstract the main points as a level 2 process. As a level 3 abstraction, the points were arranged under 3 headings: 'Problem'; 'Who is involved'; and 'Actions recommended or required'. These refined results are given in Tables A1.8–A1.11.

Table A1.12 is the processed transcript from attendees of the ASWEC panel session entitled ‘Issues in ICT Education’. The panel recording was transcribed and analysed for the main points (level 1), which were then categorised and grouped (level 2) prior to being organised in the same level 3 format as in Tables A1.8–A1.11.

During the consultation activities, individuals and groups were asked to nominate relevant stakeholders in ICT. Forty stakeholders were mentioned in the early part of the consultation process. Further consultation, particularly with respect to stakeholders contributing to the university curriculum, pared this list to 25. By using a voting system to identify the most important five from this shorter list with later groups (iCEER, ACE, professors and heads of CORE, and ASWEC), a ranking of these 25 was achieved. This is presented in Table A1.13. It should be noted that ACPHIS was an early group consulted and all participants at the ACPHIS meeting (N=23) included ACPHIS as a stakeholder, yet ACPHIS was not part of the later voting system (whereas professors and heads of CORE were). While this may appear to present a distorted result in an evolutionary process, the importance of ACPHIS is recognised and included among the key stakeholders.

A further indication of key stakeholders was given by those specifically mentioned in the free-text responses and the panel session (Tables A1.8–A1.12). This produced a much shorter list:

- high schools
- universities
- industry
- government
- Australian Computer Society (ACS)
- Engineers Australia
- Australian Council of Deans of ICT (ACDICT, formerly known as the ICT Council)

This list also corresponds broadly with the main stakeholders identified through the voting process (Table A1.13).

Table A1.1: Compilation and categorisation of issues and challenges identified by deans, heads of school, and associated academic staff from various universities

Issues and challenges	Responses compiled from deans’ consultations
Project emphasis	***Peak body*** • Creation of a useful, representative, unifying and overarching body with which the government can liaise ***Identify and share best practices*** • Identifying good practice is a basic aim – knowing what others are doing and funding would be valuable • Should be concerned with teaching practice and curriculum improvement locally and across the tertiary sector • Identification of good practices would help with further funding • Sharing best practices is a knowledge management issue ***Holistic and national emphasis*** • Should be holistic and include all stakeholders, including high schools, universities and industry • Identify the progression from high school to tertiary to industry • Need to focus on Years 7 and 8 because that is where critical decisions are made. Years 11 and 12 are too late • Focus on universities first and identify curriculum structures, then involve students and employers • Build on recommendations of original Monash University study • Support projects of national importance • Identify issues of current and past students in industry

	• Seek international students' perspectives because they are a significant group • Existing ALTC and internally funded ICT projects across the sector would be of interest • Look for ways of 'synergising' our efforts as a consortium rather than each working on the same things independently • Develop a common vision for ICT education • What are future directions for the profession and the discipline? ***Student numbers*** • Recruitment of students is top priority ***Stakeholders*** • Stakeholders include industry and professional bodies such as AIIA, ACS, CIO Executive Council, and Internet Industry Association, Engineers Australia, Australian Telecommunications Users Group • CORE and ACPHIS are important stakeholders • Industry needs to be involved to provide students with real-world experiences and making studies relevant • Explore possible relationship with ifip (International Federation for Information Processing) [only mentioned once, by Monash] • In universities, stakeholders are students, staff and management with different contextual issues which should be identified from a national perspective • Get industry to help universities improve weaker students to enhance their employability ***High schools*** • Improve ICT teaching in high school and the perceptions of ICT in high schools • Make ICT more attractive to better students. Poorer students do ICT • Current university students can give high school experience • More emphasis on ICT as a career in high schools. CORE needs to connect with the teacher educators ***Perceptions*** • Improve poor perceptions of ICT in schools, community and parents • Universities need to be co-owners of challenges facing high schools and industry with respect to improving the perception of ICT in the community • High school students need to be informed of the attractions of an ICT career e.g., interesting work and can work anywhere because IT is ubiquitous
Major achievements	***University of Adelaide*** • Part of engineering group – all deans and Group of Eight universities • Successful marketing of engineering degrees by making them topical, current and relevant; doing it in ICT with computer graphics • Degree programs include processes (e.g., major projects involving teamwork) that are valued by industry • Main purpose is to train people who are adaptable for changes in the industry and workplace – at least 30% of current school children will have jobs that do not exist at the moment ***University of South Australia*** • Newly formed Heads of ICT among Australian Technology Network (ATN) of universities: Curtin University of Technology, University of South Australia, RMIT University, University of Technology Sydney, and Queensland University of Technology. • Centralisation of disciplines (decreed by the Vice-Chancellor): central groups service faculty needs (central vs dispersed). This avoids ICT fragmentation and dilution. • ICT is coming of age as a profession ***University of Technology Sydney*** • ALTC grant success and strong industry ties with ninth-month placement of students in third year

	Monash University • Local and international students working in teams on authentic industry projects • Recent major faculty curriculum restructure to give common core units in first two years. A motivation was efficiency gains through use of common resources ***Queensland University of Technology*** • Work with high schools and girls in particular • Strong teaching and research into teaching • Promotion possible on teaching performance at all levels (Lecturer to Professor). Can submit 60% of case as teaching • Strong curriculum and student support • Scholarship of teaching is valued and recognised as research • Published book: *Transforming IT education: promoting a culture of excellence*, Informing Science Press (2006). ***Swinburne University*** • Giving students real-world and workplace experience • Robust association with industry that has being going for more than 20 years • Strongly focused on producing industry-ready graduates • Swinburne early adopter attitude and approach – risk but helps with preparing students ***University of Wollongong*** • Revised, stronger Bachelor of Information Systems and Bachelor of Information Technology degrees • Strong industry engagement, e.g., Accenture on campus. • ICT together in the Faculty of Informatics – strategy to meet the challenge of ICT fragmentation • Staff (including professors) visit high schools and talk with students • Brings industry practitioners into the classroom for relevant real-world experiences • Contextualises generic skills, e.g., communication and writing for documentation of customer requirements ***University of Queensland*** • Fundamental teaching produces versatile and adaptable graduates; industry placements have academic standing ***La Trobe University*** • Strong industry contribution to the curriculum and placement of students • Has Technology Park and industries on campus (Bundoora) • Links with India
Challenges	***The profession*** • Define the ICT profession and ICT professional in relation to ICT diversity, qualifications and industry • ICT is not a well-defined respectable career, unlike engineering • Development of Chartered IT Professional – like a Chartered Practicing Accountant, who effectively market the profession • Because of state of flux in IT, not clear what constitutes an IT professional • Professionals not interested in further credentialed study ***Stakeholders*** • Role of NICTA and AIIA in this project? • Making CORE useful because it lacks an agenda as a professional body • Making industry more involved in education at all levels • Include Business Council Australia, ACS, Engineers Australia ***Gaps*** • Gaps between schools, university and industry ***Poor perceptions*** • Erroneous perception among students that there are few jobs in ICT, e.g., strong current demand from industry for software engineers • Clarifying ICT as a career for high school students and allowing them to see

exciting prospects – broad range of jobs available

- Improving IT perception in high schools, including among careers advisors
- Raising student awareness of the profession and negative student perceptions of ICT
- Combating perception of ICT as something not worth studying because it's just something we all use and no need to study it
- Correcting perception that studying ICT is only for nerds
- Correcting wrong perception of IT by other academics (especially engineers) – they think it's about programming
- Communicating to parents and students that the skills shortage in ICT is both an opportunity (more jobs) and a threat (jobs will be outsourced if demand is unmet locally)
- Gender balance in ICT is worse than in engineering - more women would lead to more improvements because of improved perceptions

University courses and marketing

- Uneven demand for courses
- Computer degree dressing and marketing
- Mass of ICT degrees are mostly similar with small variation for marketing
- Simplification of degrees (core plus majors) for benefit of employers
- Meeting the demand for popular degrees (e.g., gaming) while preserving the generic degree so that students have broad capabilities; preferred solution is to have generic degree plus major in special fields
- Attrition rates and low class attendance
- Understanding student motivation
- Slower timescale for curriculum change than industry changes
- Difficult to obtain industry support for necessary change
- Industry should contribute more to curriculum development
- Blending of local and international students
- Limitations of online learning management system
- Teaching of ICT in faculties by the faculties other than central ICT unit – threat to central unit and standards
- Technology and science in general are not popular among students – major marketing issue
- Competition between local institutions not collaboration, especially in depressed market
- Expanding scope of workplace learning and learning by experience
- Continuous change in ICT and keeping courses abreast of developments – especially difficult with less people
- Make ICT more attractive to better students. ICT has poorer students

Student numbers

- Decline in domestic student enrolments and increase in international students. The high dependency on overseas students is a major risk
- Continuing drop in enrolments – jobs there but students not
- Communicating career prospects better to potential ICT students
- Recruiting high quality undergraduate students, particularly Australian ones
- Addressing industry outcomes and requirements for graduates is not attracting students into programs
- Boom and bust cycle
- Decline in student numbers and staff layoffs

Graduate preparedness

- Students being prepared for industry retraining and changing jobs frequently

University teaching

- Balance of technical and generic graduate attributes, particularly good communication skills
- Adoption of enquiry-based learning (EBL)
- Marketing of learning and teaching achievements and collecting evidence of local good practice
- Improving poor Course Experience Questionnaire (CEQ) performance in IT

	even when there are sound teaching practices • Language challenges with high proportion of international students in IT • Need to redesign all subjects with respect to content and skills, e.g., programming and interpersonal management skills • Development of graduate attributes in the sector, e.g., ability to write business cases • Need more industry placements especially to help poorer students • Balancing fundamental/foundation (core) teaching with rapid industry changes – needs effort and understanding between universities and industry • Staff flexibility with respect to industry changes • ICT teaching by other disciplines need contact with ICT professionals to maintain standards • Lack of quality assurance in teaching delivery of ICT – should involve a peer review process • Maintaining the balance of teaching and research among academics • Balance of ICT being taught in the faculties by local academics and maintaining central expertise • Long time lag with industry ***Industry*** • More vocal industry and industry involvement in high schools • Industry funding of projects • Willingness of industry to collaborate with universities on helping weaker students gain industry-ready skills • Placements are a challenge because of lack of availability in industry (little or no actual practice) • Establishing a scheme where students shadow an industry expert for about a week • Industry talking to students more – will improve perception about ICT • Industry needs to change the perception of itself to attract more students into studying ICT • Universities servicing industry • Casualisation leads to less core expertise development in industry • Graduates want and expect short-term jobs • Industry giving clear direction in an uncertain future • More understanding between universities and industry • Industry definition of required skills is weak ***High schools*** • Links with high school teachers are minimal • Effective university and high school liaison and being able to influence the school curriculum • Knowing the nature of ICT teaching in high schools and attitudes among teachers • Advising careers advisors and knowing what they are saying about ICT and the ICT profession • Development of career paths and advisors at high-school level to create interest in ICT in schools • ICT teacher training at universities • Involving deans of education in improvement of high school teacher ICT skills • Quality of high school ICT teaching and the negative impact on students • The number of ICT students in high schools is related to the number of enrolments • Students have less and less capabilities from high school • General decline in uptake of the sciences, ICT and maths in high schools (science and maths are enabling disciplines for ICT) • Making use of a foundation year to address student shortcomings in the sciences, ICT and maths • Connect more with industry

	Discipline future • Dispersion of the discipline as others take over IT teaching • Fragmented ICT in universities because ICT is an enabler in many disciplines • Central university ICT group versus ICT distributed among the faculties • Amalgamations with other faculties such as engineering • IT leaders in academia – there are few obvious replacements for senior managers – common problem around the country • Problem of recruiting IS academics (but not ones for computer science) particularly when student numbers growing in IS • Business groups should avail themselves of IS • Forming partnerships with other disciplines • Downsizing of academic units because of student downturn • Downsizing leading to higher workloads and less research – possibility of going backwards • Computer science is part of so many disciplines it is in danger of being lost • Reinvigoration of ICT in Australia is required ***ICT Council*** • Need effective, coherent 'council of deans' • Needs to be more than a talkfest • Highly desirable to include reps from CORE, ACPHIS and electrical engineering • CORE and ACPHIS are too sectarian in interests • May be difficult because of fragmented ICT disciplines and professional bodies • Consult with government • Liaise with deans of education ***ACS*** • Not representative of whole ICT spectrum – computer science oriented • Does not have the influence or control that engineering bodies do – ACS should be more effective • Needs to work more in partnership with engineering bodies to gain respect • Demands of the sector are too big for ACS ***Fractured sector*** • Lack of sharing of knowledge and experiences across the sector • Several sub-organisations (including CORE and ACPHIS) are not always in sync • Consensus on what ICT includes – electrical engineering often not seen as part of ICT, whereas in reality electrical and telecommunications engineering are integral to ICT ***Skills shortage*** • Skills shortage due to increase in industry demands for skilled graduates • Industry Leaders Group (ILG) addressing skills shortages ***Research Quality Framework (RQF) impacts*** • Negative effect of RQF in polarising research and teaching • The RQF may lead to industry selectively engaging with partners ***This ICT project*** • Evaluation of this ICT project • The scope of the project and its long-term impact • Consensus for this project ***Benchmarking*** • How does Australian ICT compare with the rest of the world?
Industry connections and influence on the curriculum	• Broad training so that students have sound base and are adaptable • Industry interested in content but not teaching processes • Industry placements have academic standing as part of a managed process • Industry could support development of new curricula more than they do • Variety of industry-based projects where undergraduate students service industry on authentic problems

	• Demand for graduate attributes – developed through third year group projects; also senior students mentor junior ones • Interest in computer graphics is industry driven, e.g., movies • Curriculum comprises a fundamental core as well as applied and modern perspectives • Industry should fund projects • Currently minimal influence but needs industry engagement • Existence of industry advisory boards is at odds with 'minimal industry involvement' • ACS accredits courses but makes minimal contribution to the curriculum • Staff working with industry, which influences their teaching and the curriculum • Industry-based learning (various types) is valuable • One year industry-based learning, which does not replace academic study and has academic credit – recognition on academic transcript and on testamur • Projects for industry clients (authentic projects) for undergraduate students for which they receive academic credit • Industry partnerships include research • Constant industry feedback on curriculum • Industry clearly stating requirements in the face of rapid changes • Do not teach latest gimmicks, but rather concentrate on fundamentals
Curriculum and staff flexibility	• Staff are considered to be quite flexible – curriculum actually looked at every year • Not all staff are flexible; possibly 20–60% less flexible • Staff flexibility is enhanced by industry associations such as industry-based learning • Young staff recruitment helps with general flexibility • Often a program has a niche name but it probably only includes two to three courses out of the typical 24 (three years), with the remaining being exactly the same as the other degrees • Most staff respond to frequent and rapid ICT curriculum changes • The university system is the barrier to rapid change and flexibility • Staff are concerned with teaching principles and foundation skills in context. Industry relationships by academic staff assists them in keeping up to date with developments • Teaching of graduate attributes is in response to industry requirements • New staff all complete 'Introduction to Tertiary Teaching' program and are therefore flexible in their teaching • Teaching is concerned with fundamentals. Guest lecturers from industry to help keep up to date. Use real-world programs as examples of principles. Graduates are able to pick up trends themselves
Teaching and research connection	• Really is a three-way link of teaching, research and industry, which is often at the forefront of research • Research strengths include Australian Centre for Visual Technologies with industry connections; Virtual Reality; code and design • Research changes teaching and is brought into lectures • Summer scholarships involve students in research projects • Would like more enquiry-based learning, which occurs in small areas • Problem-based learning (PBL) tried in small areas. • Teaching–Research nexus started but long way to go • Local groups concerned with research into teaching • Topical issue, especially for non-research-intensive universities • Staff do research into teaching, and use their discipline research in their teaching • Students engage in research as part of coursework at undergraduate level, particularly through projects and summer research opportunities • RQF (or equivalent) can improve research and flow on to teaching

	• Fundamental teaching and research important
Vision for the next few years and long term (if possible)	• ICT degrees will be more popular as demand for jobs is realised • Enhancing the quality of ICT professionals by establishing a well-respected profession • Future for mathematics and computer science is in applied areas like engineering and technology • Teaching more IT in the disciplines, e.g., law IT users, medical IT users, also IT ethics • Developments and thinking will be more at the system level, and more service oriented • Improving IT perception amongst students • Diversification (e.g., including graphics); high student intake; responsive to students and industry; better links with high schools • Better links with technology and engineering • Industry contributes to changing ICT perceptions of itself to attract more students • Lessons learned from this downturn – not to be complacent when the numbers increase again • No obvious vision from industry • Industry, education sector and government need to define a vision for developing a vibrant IT industry in Australia based on the proposition that IT enables, facilitates and drives business value and creates new economies for the country's prosperity • Increase postgraduate research students • Continue with improvements in teaching • Closer cooperation between university, industry and government to improve applications and enrolments in ICT • Vision is concerned with producing developers rather than users; learning how to learn - think not click; clockmakers not timetellers. • Internships in industry for all undergraduate students • Expand industry partnerships with Cooperative Research Centres to improve research and education • More use-inspired research – help with measurement of impact – in industry and in society • Engagement in 'Smart Services CRC' along with Wollongong and Queensland University of Technology • Divergence of teaching and research staff – needs specialists in both areas to get best overall performance; the all-rounders are also coveted • Embrace trends and form partnerships with other disciplines that use IT such as medicine • Joint degrees (really overlapping) as well as double degrees (which are strong now) • Possible Melbourne model of general undergraduate and specialised postgraduate • More emphasis on innovation, creativity and critical thinking • Graduates will have multi-disciplinary skills in terms of knowledge and industry needs • Enrich the student experience by practical experiential work in safe environments that allow experimentation • Student learning is engaging, experiential and related to their experience (prior knowledge) yet structured and goal oriented • Industry contributes to teaching and enriching the student experience
Benchmarking – university comparisons	• Necessary to compare content and best practice • Compare particularly with other Group of Eight universities, and also with RMIT, Swinburne, Deakin, Wollongong, Universitas 21 • Should make national comparisons

	• The UK compulsory model of external examiners is desirable – it is a valuable experience particularly for cross-fertilisation • Also need teaching quality assessment process like in UK which identifies best practice • Benchmark with ATN • Benchmarking between partners on this project with respect to internal and external teaching grant funding • Need to do more locally and internationally to improve standards and performance
Curriculum: industry-ready graduates	• Most graduates need training when in industry – they are employable but not necessarily 'industry-ready' • Emphasis on portfolio development • Graduates are fit for industry because employability is high – rest in full-time study • Graduates adapt well and quickly to industry because of fundamental training that focuses on principles • Students can choose where they sit on academic–industry continuum • Graduates being ready for industry is not a problem – bit of a myth • Transferable skills (graduate attributes) are part of curricula • Balance between education and training • Students with nine months' industry placement have an advantage • Students work in teams on authentic industry projects as undergraduates • Close industry involvement in curriculum development particularly through faculty advisory committee • Teaching foundations and developing generic attributes means that students are able to adapt and learn quickly • Real-world experience and placements are important • Good students have no problem gaining employment anyway • Generic degrees means students are adaptable for a variety of careers • Industry liaison person recently appointed at University of Queensland for engineering and ICT • Undergraduate students outsourced to industry
High school – university – employment links	• There are significant gaps • Often weak and indistinct links • No sense of continuity, of the parts working together strongly to push the agenda forward • Great potential to educate young children of the true opportunities in IT as a career • Needs dedicated outreach officer in the university • Industry helps with marketing and giving talks to students • Employers (industry) bring real-world value as guest lecturers
Cross-discipline links	• IS is independent in commerce – BBIT (Bachelor Business IT) – actually not very popular • Links between computer science and engineering • Other disciplines taking on their own IT, e.g., computers and geosciences, computational physics, civil engineering, but not highly embedded elsewhere • Double/joint degrees occur between disciplines • In some places, IT teaching centrally provided for a number of faculties • Service teaching in IT is difficult because of meeting needs of different, perhaps (too) small disciplines • Business groups should avail themselves of IS • Problem of IT perception by other academics – they think it's about programming • Need to develop and explore further, e.g., Second Life is of interest in arts and digital media • Examples include links with bioscience, economics, Air traffic control, Australian Research Council Centre for Complex Systems, and business

Examples of good practice	• ALTC-funded ICT projects and internally funded teaching projects would be an indicator of good practice • Local showcases of good practice • Local staff support website with examples of good practice • Use of the University Learning Management System (WebCT) can be a barrier to good practice • Incorporation of generic attributes and small group projects • Student engagement through real-world problems and problems relating to industry • Game development is engaging for the students
Council of Deans and Heads of School	• CORE is useful but not for bringing the sector together • CORE should be the council and connect with deans of education • IS is not part of IT; IS belongs in business/commerce • CORE should be made more effective – don't need another ineffective group • This council should liaise with deans of education to improve ICT in high schools • Very necessary body • Necessary in a dynamic, changing sector • Unified body is desirable but the sector is fragmented which makes it a challenge • Write to vice chancellors asking for single university representative
High school teacher links	• Needs improvement – don't do enough of it • Good links with high school careers advisors (big emphasis recently) – the people who influence the students • Mostly liaison with careers teachers by university marketing people • Direct links between high school ICT teachers and universities are poor to non-existent • Need to provide professional development opportunities for teachers • Active outreach programs exist, e.g., Robotics; Girls in ICT; in-house workshops for high school students

Table A1.2: Results from the Australian Council of Professors and Heads of Information Systems (N = 23), ranked on level of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. The perception of the ICT profession amongst students (high school and university) should be improved				1	22
2. What ICT is as a profession needs to be clearer to the public				1	22
3. High school careers advisors need to be better informed about the ICT profession				6	17
4. The sector needs to identify and share good educational practices				9	14
5. Links between high schools, universities, and industry should be strengthened		1	1	4	17
6. Former graduates in the workforce can provide valuable perspectives on their curriculum			2	8	13
7. This project should be concerned with improving learning and teaching			3	9	11
8. ICT students need workplace experience			2	11	9
9. Graduate students in ICT employment should be consulted about improving their degree experience			3	11	9
10. Industry should engage more in ICT education at all levels		1	2	6	13
11. ICT students need to work on authentic industry projects			4	8	11
12. There should be a representative peak body to address issues and concerns in all areas of the ICT sector			5	9	9
13. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research		1	4	13	5
14. Industry should liaise more with high schools	1	1	4	7	10
15. Central ICT [teaching] units in universities should service all the ICT needs in other disciplines	2	2	2	11	6
16. ICT education issues can be addressed by research-driven learning and teaching		2	4	13	4
17. Student opinions can lead to curriculum improvements	1	3	2	14	3
18. Australian universities should benchmark with overseas educational practices		2	5	11	4
19. Industry plays an important role in teaching and research		6	3	7	7
20. The disciplines teaching their own ICT will impact negatively on central ICT [teaching] units	2	2	4	9	5
21. The proliferation of ICT degrees should be curtailed	1	1	11	6	4
22. This project should focus more on universities than anything else	1	8	6	6	1
23. There should be more focus on fundamental research rather than learning and teaching	2	8	7	5	1
24. The Deans of Education have a responsibility for ICT teaching in high schools	3	1	12	2	

Table A1.3: Results from the heads and professors of the Computing, Research and Education Association (CORE) (N = 34), ranked on degree of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. What ICT is as a profession needs to be clearer to the public			2	3	26
2. The perception of the ICT profession amongst students (high school and university) should be improved			1	5	25
3. High school careers advisors need to be better informed about the ICT profession			1	7	23
4. Links between high schools, universities, and industry should be strengthened			1	13	18
5. Former graduates in the workforce can provide valuable perspectives on their curriculum			1	17	14
6. There should be a representative peak body to address issues and concerns in all areas of the ICT sector		1	3	14	14
7. Industry should engage more in ICT education at all levels		2	6	12	12
8. Industry should liaise more with high schools		2	6	11	12
9. Graduate students in ICT employment should be consulted about improving their degree experience			5	16	11
10. The sector needs to identify and share good educational practices		1	2	18	10
11. Australian universities should benchmark with overseas educational practices			7	15	10
12. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research		1	5	16	9
13. Central ICT teaching units in universities should service all the ICT teaching needs in other disciplines	2	5	4	11	10
14. Industry plays an important role in teaching and research		2	9	10	10
15. This project should be concerned with improving learning and teaching		2	7	16	6
16. ICT students need workplace experience		4	6	16	5
17. Student opinions can lead to curriculum improvements	1	2	7	19	3
18. ICT students need to work on authentic industry projects		2	11	12	6
19. The disciplines teaching their own ICT will impact negatively on central ICT teaching units		2	11	12	6
20. ICT education issues can be addressed by research-driven learning and teaching	1	6	10	10	5
21. The proliferation of ICT degrees should be curtailed	5	4	10	6	6
22. This project should focus more on universities than anything else	2	2	14	7	5
23. The Deans of Education have a responsibility for ICT teaching in high schools	5	5	9	9	3
24. There should be more focus on fundamental research rather than learning and teaching	4	13	9	3	3

Table A1.4: Results from other than professors and heads of the Computing, Research and Education Association (CORE) contacted by email (N = 15), ranked on degree of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. Links between high schools, universities, and industry should be strengthened			1	4	10
2. High school careers advisors need to be better informed about the ICT profession			1	4	10
3. The sector needs to identify and share good educational practices				6	9
4. The perception of the ICT profession amongst students (high school and university) should be improved			1	5	9
5. What ICT is as a profession needs to be clearer to the public			1	6	8
6. Graduate students in ICT employment should be consulted about improving their degree experience			1	7	7
7. ICT students need workplace experience			1	7	7
8. Former graduates in the workforce can provide valuable perspectives on their curriculum			2	7	6
9. ICT students need to work on authentic industry projects			2	7	6
10. Industry should engage more in ICT education at all levels		1	2	6	6
11. This project should be concerned with improving learning and teaching			5	4	6
12. Australian universities should benchmark with overseas educational practices	1	1	3	5	5
13. Central ICT teaching units in universities should service all the ICT teaching needs in other disciplines	1	1	4	4	5
14. Student opinions can lead to curriculum improvements			4	9	2
15. Industry should liaise more with high schools		2	3	7	3
16. There should be a representative peak body to address issues and concerns in all areas of the ICT sector	2	1	4	5	3
17. Industry plays an important role in teaching and research	3	3	1	5	3
18. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research		2	4	7	2
19. The disciplines teaching their own ICT will impact negatively on central ICT teaching units	1	4	3	4	3
20. ICT education issues can be addressed by research-driven learning and teaching	1	4	4	4	2
21. The Deans of Education have a responsibility for ICT teaching in high schools	2	2	5	5	1
22. This project should focus more on universities than anything else	1	5	4	3	2
23. The proliferation of ICT degrees should be curtailed	3	4	3	4	1
24. There should be more focus on fundamental research rather than learning and teaching	1	9	2	2	1

Table A1.5: Results from attendees of the Australasian Computing Education Conference (ACE) (N = 13), ranked on degree of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. The sector needs to identify and share good educational practices					13
2. The perception of the ICT profession amongst students (high school and university) should be improved				4	9
3. What ICT is as a profession needs to be clearer to the public		1		3	9
4. This project should be concerned with improving learning and teaching			2	2	9
5. ICT education issues can be addressed by research-driven learning and teaching				5	8
6. High school careers advisors need to be better informed about the ICT profession			1	4	8
7. Links between high schools, universities, and industry should be strengthened				6	7
8. Graduate students in ICT employment should be consulted about improving their degree experience		1		6	6
9. Former graduates in the workforce can provide valuable perspectives on their curriculum			1	8	4
10. ICT students need workplace experience	1		2	9	1
11. Australian universities should benchmark with overseas educational practices	1	1	3	3	5
12. ICT students need to work on authentic industry projects			5	5	3
13. Industry plays an important role in teaching and research		2	3	5	3
14. There should be a representative peak body to address issues and concerns in all areas of the ICT sector	2		3	5	3
15. Industry should engage more in ICT education at all levels			4	4	4
16. Student opinions can lead to curriculum improvements		2	2	7	2
17. Industry should liaise more with high schools		1	4	6	2
18. The disciplines teaching their own ICT will impact negatively on central ICT teaching units	1	2	3	5	2
19. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research		2	6	2	3
20. The Deans of Education have a responsibility for ICT teaching in high schools	2	4	1	2	2
21. Central ICT teaching units in universities should service all the ICT teaching needs in other disciplines	1	4	4	2	1
22. This project should focus more on universities than anything else	3	3	4	2	1
23. There should be more focus on fundamental research rather than learning and teaching	2	5	3	1	1
24. The proliferation of ICT degrees should be curtailed	1	4	4	2	

Table A1.6: Results from attendees of the Australian Software Engineering Conference (ASWEC) (N = 19), ranked on degree of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. Industry should engage more in ICT education at all levels			2	3	14
2. The perception of the ICT profession amongst students (high school and university) should be improved				6	12
3. What ICT is as a profession needs to be clearer to the public	1		1	5	12
4. Links between high schools, universities, and industry should be strengthened			1	7	11
5. ICT students need workplace experience		2	2	3	12
6. Former graduates in the workforce can provide valuable perspectives on their curriculum		1		7	11
7. ICT students need to work on authentic industry projects		1	4	3	11
8. Industry plays an important role in teaching and research		2	1	7	9
9. The sector needs to identify and share good educational practices			2	9	8
10. Graduate students in ICT employment should be consulted about improving their degree experience			1	11	7
11. High school careers advisors need to be better informed about the ICT profession			1	12	6
12. This project should be concerned with improving learning and teaching	1		2	10	6
13. Industry should liaise more with high schools		3	3	6	7
14. Australian universities should benchmark with overseas educational practices		1	4	8	6
15. There should be a representative peak body to address issues and concerns in all areas of the ICT sector	1	1	4	7	6
16. Student opinions can lead to curriculum improvements	1		1	14	3
17. Central ICT teaching units in universities should service all the ICT teaching needs in other disciplines	1	2	6	7	3
18. The proliferation of ICT degrees should be curtailed	3	4	2	8	2
19. The disciplines teaching their own ICT will impact negatively on central ICT teaching units		4	7	4	4
20. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research	2	2	5	9	1
21. This project should focus more on universities than anything else	4	4	3	8	
22. The Deans of Education have a responsibility for ICT teaching in high schools	3	7	3	5	1
23. ICT education issues can be addressed by research-driven learning and teaching		5	7	7	
24. There should be more focus on fundamental research rather than learning and teaching	6	7	2	4	

Table A1.7: Results from attendees of the International Conference on Engineering Education and Research (iCEER) (N = 8), ranked on degree of agreement with statements made during the deans' consultation process

For each of the following statements indicate your degree of agreement with a cross (x) in one of the 5 boxes on the right	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1. Links between high schools, universities, and industry should be strengthened				1	7
2. Former graduates in the workforce can provide valuable perspectives on their curriculum				1	7
3. High school careers advisors need to be better informed about the ICT profession				3	5
4. Industry should engage more in ICT education at all levels				5	3
5. The sector needs to identify and share good educational practices				1	6
6. The perception of the ICT profession amongst students (high school and university) should be improved			1	2	5
7. Australian universities should benchmark with overseas educational practices				2	5
8. ICT education issues can be addressed by research-driven learning and teaching			1	2	5
9. ICT students need to work on authentic industry projects			1	3	4
10. Adapting the ICT curriculum to technology changes can occur more effectively through closer ties between teaching and research			1	4	3
11. Student opinions can lead to curriculum improvements			1	4	3
12. ICT students need workplace experience			2	1	5
13. What ICT is as a profession needs to be clearer to the public	1	1		1	5
14. This project should be concerned with improving learning and teaching		1		3	3
15. Industry plays an important role in teaching and research		1	1	4	2
16. Graduate students in ICT employment should be consulted about improving their degree experience			3	2	3
17. The Deans of Education have a responsibility for ICT teaching in high schools			3	2	3
18. Industry should liaise more with high schools	1		1	4	1
19. There should be a representative peak body to address issues and concerns in all areas of the ICT sector	2		1	1	3
20. The proliferation of ICT degrees should be curtailed		1	2	1	3
21. Central ICT teaching units in universities should service all the ICT teaching needs in other disciplines	1	2	1	2	2
22. The disciplines teaching their own ICT will impact negatively on central ICT teaching units	1		4	2	1
23. This project should focus more on universities than anything else		2	4	1	1
24. There should be more focus on fundamental research rather than learning and teaching	2		4	2	

Table A1.8: Processed free-text results from the Australian Council of Professors and Heads of Information Systems (N = 23) about their main concerns and preferred project outcomes

Problem	Who is involved	Actions
Poor perception and understanding of IS and ICT	High schools	• Improve understanding and perception of IS and ICT among students, women, parents, career advisors, teachers, and the broader community • Poor perception of discipline related to poor enrolments • Increase awareness of the profession and career prospects • Improve ICT education and curriculum • Understand students better, including women
Educational quality in schools and universities	High schools	• Secondary teachers need to be better informed • Business education needs improvement
	Universities	• Business education needs improvement • Teaching staff not up to date with the digital world • Teaching and supervision need improvement • Need succession plans for aging academic staff • Focus on fundamental ICT knowledge rather than student preferences • Improve ICT teaching in relation to women • Improve the curriculum and attractiveness of courses • Provide a comprehensive model of the education process, context and outcomes from a knowledge perspective with an emphasis on quality • Understand students better
	Government	• Improve support for universities • Develop policy to improve ICT education
Declining student enrolments in ICT higher education	High schools	• Focus on high schools for university intake purposes
	TAFE	• Focus on TAFE for university intake purposes
	Universities	• Ensure the ICT project focuses on enrolments not new teaching methods or there will be no ICT education left
Professional development of teaching staff	Professional bodies	• Help keep members up to date – ongoing professional recognition and reskilling is required • Provide financial and policy support
	Government	• Provide financial and policy support
	Universities	• IS and IT teachers need ongoing professional development • Lack of support for staff in learning about learning and teaching • Lack of recognition in promotion for learning and teaching
Fragmented discipline	Universities	• Key outcome would be effective grouping of ICT educators • Needs unified approach to ICT and with other disciplines using IT

Relationship between industry and university	Industry	• Industry more interested in skills and competencies than knowledge and education • Improve relationship with universities • Sponsor more student places • Identify why industry is remote from and sceptical about university education
	Universities	• Improve relationship with industry to identify real needs • Engage all ICT academics with industry to develop more industry integrated curriculum • Understand the skills and knowledge for particular professions • Understand best work experience practices

Table A1.9: Processed free-text results from the heads and professors of the Computing, Research and Education Association (CORE) (N = 34) about their main concerns and preferred project outcomes

Problem	Who is involved	Actions
Poor perception and awareness of ICT discipline and careers in the broad community	Universities	• Define scope of ICT and range of career opportunities • Study 10-17 year-olds to find reasons for perceptions of ICT • Help schools with ICT teaching • Develop a common terminology for the ICT sector • Showcase innovations and entrepreneurship in ICT • Clarify the profession of ICT to the community, students, careers advisors, parents and teachers • Provide one comprehensive source of information on degrees and career prospects • Understand relationship of perception with declining enrolments • Increase awareness that ICT plays central and global role in many work areas and it has a human component
	Government	• Show more interest in poor perceptions of ICT, low enrolments and skills shortage • Change the culture to encourage more ICT study
	Australian Computer Society	• Effectively promote ICT as a profession • Maximise liaison with other relevant professional bodies
High school ICT teaching	High schools	• Ensure that appropriately qualified staff teach relevant ICT with adequate resources • Make ICT fun and desirable to study • Liaise with universities regarding curriculum • Emphasise how ICT affects society at many levels
Declining student enrolments in ICT higher education	Government	• Address low enrolments
	Universities	• Develop understanding of primary and high school students and relevance of poor perceptions of ICT • Clarify nature of ICT teaching in schools

Fragmented ICT community	Australian Computer Society	• Improve effectiveness and integration with the community • Liaise with Engineers Australia
	Engineers Australia	• Do not leave running of ICT to ACS
	ICT Council	• Represent the university ICT community • Provide cohesive effort in raising the image of ICT • Act as strong lobby group for ICT tertiary education, government and industry • Improve links with industry
	Universities	• Improve links between professional groups and foster the community • Enable sharing of educational materials
University curriculum	Universities	• Improve industry involvement with education • Share teaching materials • Benchmark degrees • Improve quality control and address declining quality as enrolments decline, and increase local student intake • Understand and engage students • Provide appropriate content, fundamental skills, structures and interdisciplinary areas with flexible career options • Integrate with high schools, industry, and society • Address low-quality courses to attract overseas students • Develop industry-ready graduates with business understanding
	Industry	• Improve involvement, including financial, with education • Contribute to the ICT curriculum • Take academic staff into the workplace to keep them up to date
	Australian Computer Society	• Contribute to raising degree standards • Liaise with Engineers Australia for whole ICT spectrum
Industry involvement with education	Industry	• Improve links with universities • Develop understanding with universities on knowledge, skills and technical abilities • Promote ICT as a viable career and market the profession

Table A1.10: Processed free-text results from other than professors and heads of the Computing, Research and Education Association (CORE) contacted by email (N = 15) about their main concerns and preferred project outcomes

Problem	Who is involved	Actions
Shortage of sensible career paths for today's graduates	Industry	• Lessen the number of jobs sent offshore • Provide greater local opportunities for advancement • Respond to requirement for more job diversity, as many are product-specialised, e.g., Oracle or SQL • Increase number of research and development jobs • Increase number of women
Quality of management in industry ICT	Industry	• Improve the poorly conceived and run industry projects on which students have to work in placements or as industry-linked projects
Relevance and quality of ICT degrees	Universities	• Include the complexity, knowledge and skills needed for most ICT jobs • Increase degree length from 3–4 years to 5 years to cope with industry requirements
Quality of high school ICT teaching	High schools	• Change the discouraging, boring and outdated teaching which is centred on rote learning, trivial algorithm following, and rigid document-centric process. • Improve the quality of high school ICT teaching and consequent poor perception of ICT by high school students • Focus teaching on innovation and cutting-edge international practices • Increase motivation of students to pursue ICT at tertiary level • Be mindful of the teaching that universities require to prepare students for ICT
Quality of university ICT teaching	Universities	• Provide support for academics for keeping up to date with industry • Provide more reward for academics who teach well • Lessen workload which adversely affects teaching quality • Increase innovation in teaching approaches
Quality of university curricula	Universities	• Bring curricula more up to date with industry advances • Ensure industry requirements are being met • Ensure relevant new areas are being taught, e.g., business applications, multimedia, social media, creativity • Align skills and capabilities with industry requirements and educational objectives
	ICT Council	• Make appropriate decisions on ICT education and influence what is taught at different levels

Viability of ICT schools in universities	Unspecific	• Address the systemic society issue • Address the globalisation threat, especially brand US universities taking Australian students • Recognise that fewer students means lower standards or fewer academics or both
	Universities	• Attract more students by improving negative perceptions that study options are restricted
ICT Council expectations	ICT Council	• Very difficult for peak body to control a sector that is too diversified and filled with competing technologies, ideologies and opinions • Gather statistical information on employer needs and graduate requirements • Gather information on the utilisation and deployment of differing technologies and methodologies • Improve teaching with information on employer needs and relevant technologies • Gather information on what universities want taught in high school to better prepare students for ICT higher education • Change the perception of ICT in the wider population • Represent the sector and make appropriate decisions on ICT education and influence what is taught at different levels
Perception of ICT	Unspecific	• ICT lacks cohesion and recognition • Lack of cohesion and recognition and being professionals • The profession is vague and needs proper accreditation like the engineers • Perception of ICT career as boring, anti-social, sitting in front of a computer all day and male dominated
	High schools	• Parents and careers advisors do not know what IT and IT degree involve • Correct the perception that ICT degrees are limited in choice and required abilities • Improve high school teaching to improve the perception of ICT by students • Clarify career perceptions
	Universities	• Make clear the scope of an ICT degree and broad range of abilities needed (not just narrow maths) • Improve career perceptions • Improve the clarity on what an IT graduate is
Industry–university alignment	Industry	• Industry needs to support universities more and play a bigger part in teaching and research • Need to financially support industry placements and research • Overcome inertia in working with universities • Provide requirements of university graduates • Be more involved in the curriculum to ensure universities are producing tomorrow's business owners and leaders

		• Bring academic researchers up to speed with commercial advances in ICT
	Universities	• Include industry in curriculum developments • Be more involved in industry advances

Table A1.11: Processed free-text results from all conference forums (iCEER, ACE, ASWEC) (N = 40) about their main concerns and preferred project outcomes

Problem	Who is involved	Actions
Low enrolments and lack of trained ICT people despite industry demand	Universities	• Develop strategies to address the low numbers of local and international students in ICT in higher education • Determine how to train enough skilled grads to meet growing needs • Ensure sufficient funding to sustain courses through declining enrolments • Address low female and minority [very rarely mentioned] enrolments and high female attrition • Support outreach where university students recruit in their own communities
	Government	• Develop strategies to address the low numbers of local and international students in ICT in higher education • Provide additional funding for ICT graduate training, as for nursing and education
Perception of ICT study, jobs and profession is poor	Unspecific	• ICT profession needs to be made clearer to the public • Need a common language for describing the profession and components • Students often have misconceptions of ICT job and study • Negative image among women
	Universities	• Support ACS in defining the profession which changes rapidly
	Australian Computer Society	• Define the profession even though difficult because of rapid change
	Industry	• Greater contribution to marketing and promotion required • Provide remuneration information • Image of ICT industry needs major overhaul
Survival of ICT in universities	Universities	• Revise model of change and demand • Derive strategies for surviving the downturn – less students leads to less money and lower capabilities – downward spiral • Plan for future without another boom • Survival threatened with acceptance of lower-quality students • University sector needs increased funding
Quality of ICT teaching in high schools	High schools	• Address shortage of suitably qualified teachers • Improve teaching especially at early levels • Provide sufficient depth particularly with maths • Identify and support areas of excellence • Better computing curriculum and delivery required • Raise quality of students entering university
	Universities	• Better links and mentoring for high schools
	Industry	• Better links and mentoring for high schools
Qualities of school leavers	High schools	• Change culture of distaste for rigorous methods (in society too) • Improve inaccurate and negative IT perceptions

		• Change student belief system that they know all about IT already • Provide real computer science experience • Improve maths ability by students entering computer science
	Universities	• Improve student transition experience coming into university
Qualities of graduates	Universities	• Need for good social skills and critical thinking capabilities • Communication and social competence are fundamental skills of ICT people • Ensure graduates have the appropriate mix of attributes, skills and knowledge and not 'super-geek' perception • Industry-ready with practical experience • Capability seems to depend on where trained
Quality of university teaching	Universities	• Provide necessary professional development in teaching • Teaching and learning of ICT needs improvement to produce superior ICT professionals • Lecturers need industry experience to demonstrate relevance • Enable lecturers to keep up to date • Quality teaching should come before publications • Manage efficient online teaching • Provide incentives for academics to engage with industry • Reverse the emphasis on research at the expense of teaching – contributes to decline in student numbers • Improve poor perception of computing education in universities • Identify and measure quality teaching and learning in classrooms and provide more support • Enable sharing of good educational practices and effective educational methods • Value ICT education research and provide support for research in computing education
	Industry	• Provide industry experience for lecturers
Quality of ICT professionals in industry	Industry	• Provide more career development opportunities and ensure skills are up to date • Lessen excessive work demands • Improve women-friendliness of work environment • Improve commitment to internships and graduate recruits and mentorship • Build internal capability rather than using knee-jerk reactions to lure in from offshore or outsource to offshore • Find long-term solution other than outsourcing • Improve staff shortage and retention of staff • Provide development and mentoring of staff in the workforce
Quality of ICT curricula	Universities	• Improve adaptability to rapidly changing technology and knowledge

		• For uniformity, compare curricula across the sector • Improve standards, content and breadth • Reverse lowering of standards to satisfy fee-paying students • Improve industry liaison regarding requirements of current and relevant skills and keeping academia in touch • A broad range of industry groups need to contribute to the curriculum • Address tension between university curricula and industry requirements • Provide engineers with relevant and not overly theoretical courses • Lessen number of courses with overlapping content • Provide clearer definition of what ICT courses are • ICT departments should teach their expertise and develop closer interconnection • Research better ways to teach • Action research onsite with industry to analyse projects and outcomes • Teaching should emphasise ‘studio’ learning, practical learning, problem-based learning and accommodate generic skills • Ensure appropriate methods of assessment • Align curricula to the Skills Framework for the Information Age • Make courses more transparent and outcomes based • Provide more double majors to include business perspective • Survey students who have withdrawn from ICT courses • Address problems with plagiarism [rarely mentioned], group work, written exams, lack of student motivation, online learning, attendance, passing programming courses
	Industry	• Provide more input to relevant curricula • Engage with academics to analyse projects and outcomes
Fragmented sector	General	• Stronger liaison is required between the major stakeholder groups, and stronger unity of purpose • Lack of public sector support
	Universities	• Keep deans in touch with rapidly changing disciplines • Improve communication between universities and industry and wider community • Engage regional universities • Build better connections between Vocational Education and Higher Education and industry • Improve communication between industry and universities • Improve communication between ICT departments • Engage in more joint research with industry

		• Learn from overseas ICT, including Europe and United States • Provide support for multi-institutional research in computing education
	Industry	• Improve communication with universities and TAFE • Improve contribution to ICT education to make it more relevant • Engage in more research with universities
	TAFE	• Improve relations with universities and industry
	Government	• Provide better leadership, policies and investment • Develop strategies to deal with decline in enrolments and increase in industry demand
	ICT Council	• Ensure new ICT Council does not add to fragmentation – consolidation and broad achievable objectives required • ICT Council must be inclusive of industry and listen to industry over academics
	Australian Computer Society	• Procure more support in defining the profession and developing the CBOK

Table A1.12: Processed results from the transcript of the recorded ASWEC panel session (N = 30) on 'Issues in ICT education'

Problem	Who is involved	Actions
Declining student enrolments in ICT higher education	High schools	• Improve relevance of ICT courses • Ensure career advisors and students are informed of ICT employment opportunities
	Federal government	• Declare ICT in crisis and offer financial support
	Industry	• Together with the ICT Council, lobby the federal government • Together with the ICT Council, market ICT at school level • Deliver a national advertising campaign for the community at large
	ICT Council	• Develop strong working relationship with industry • Work with industry on above actions • Develop a unified higher education sector • Ensure universities have transparent, flexible and relevant courses • Investigate why overseas education systems (e.g., Irish and Indian) are apparently better • Investigate relationship with TAFE and other providers • Work with the ACS to develop a marketable profession
	Australian Computer Society	• In association with industry and the ICT Council, contribute to the development and marketing of the ICT profession • Encourage young professional members to promote ICT to students
Academic staff not up to date with industry requirements	ICT Council	• Ensure academic staff are up to date with industry requirements • Ensure academics have industry placement opportunities
	Industry	• Provide academic placements as well as students
ICT profession not clearly established	Australian Computer Society	• Establish a profession that is trustworthy and reliable to the community at large and then market that profession
	ICT Council	• Together with the ACS and industry, support the marketing of the ICT profession
	Industry	• Together with the ACS and ICT Council, support the marketing of the ICT profession • Contribute to graduates achieving professional status
Industry graduate requirements	Industry	• Clarify balance of skills, knowledge and generic requirements of graduates under a variety of jobs
	ICT Council	• Ensure curricula are relevant to industry requirements
	Australian Computer Society	• Development of common nomenclature (e.g., Skills Framework for the Information Age)

Table A1.13: Stakeholders (25) ranked in a voting system by iCEER (n = 8), ACE (N = 13), professors and heads of CORE (n = 34), and ASWEC (n = 19). (Due to the timing of derivation of this system, ACPHIS was not included in the voting.)

Universities	62
Industry	56
High schools, including students and parents	41
Government	37
ACS (Australian Computer Society)*	27
ICT Teachers Group	17
Careers teachers	13
CORE (Computing Research and Education Association)*	12
Engineers Australia*	11
TAFE (Technical and Further Education)	10
AIIA (Australian Information Industry Association)*	9
Education departments (government)	9
Mature-age students	8
NICTA (National ICT Australia)*	4
ACPHIS (Australian Council of Professors and Heads of Information Systems)*	3
Industry Leadership Group	3
International students	3
Private providers	3
CIO Executive Group	2
AAIS (Australasian Association for Information Systems)*	1
Education deans	1
'Migration policies'	1
Overseas agent bodies	1
AIS (Association for Information Systems)*	1
Victorian ICT for Women Network	1
Other suggestions made by various respondents	
Australian Council of Engineering Deans*	
Institute of Electrical and Electronics Engineers*	
Association for Computing Machinery*	
Australian Telecommunications Users Group*	
Various industry ICT managers	
Platform and software companies	
Primary schools	
State and territory education departments	
Information Systems Audit and Control Association*	
Mass media	
Various Cooperative Research Centres	
Special Interest Group in Computer Science Education	
Women in ICT	
Contracting agencies	

* Professional body

Appendix 2: Graduates in the workforce

This appendix presents the results from the survey of graduates in the workforce.

Table A2.1 shows the alma mater of the respondents. Twenty-one universities are represented, and the total number of respondents was 719. The number of respondents who started the survey was 1,155 from 24 universities. Each respondent was checked for relevance and removed from the data if judged to be unsuitable. Criteria used were completion of an ICT degree and having worked in the ICT industry since graduation or in a job that utilises ICT training. Responses from graduates in other disciplines or who had no workplace experience were removed.

The majority of responses from the 21 universities are from 10 universities. However, the distribution is broad and arguably representative of the Australian university sector. An earlier paper by the project team (Koppi et al., 2009) that was presented at the Australasian Computing Education Conference used data prior to closure of the survey and included 548 responses from five universities. The current data set is larger and more broadly representative. It also includes the responses from more open text questions that sought more information regarding university courses and areas for improvement (as shown in Table A2.3).

The quantitative part of the survey was structured as three columns on a webpage. Statements of abilities relevant to a particular category were down the centre, with the rating scale of importance of that ability in current professional work on the left, and the extent to which the university course focused on developing that ability on the right. The full list of quantitative statements of ability is shown in Table A2.2, and the open-ended qualitative questions are shown in Table A2.3. Five-point Likert scale responses were used for the comparison of responses on the left and right of the table. Comparing the left and right sides illustrates how well the curriculum is integrated with the requirements of professional practice. The results tables presented below differ from the online version, which included radio buttons and a reversed high–low order. There was also a series of statements regarding preparation for work and expectations of work duration.

To identify good practices in preparing students for the workplace, a comparison between universities was made. This comparison included only those universities for which the number of respondents was greater than 20. This made for a short list of eight universities as shown in Table A2.4. The Kruskal-Wallis Test was applied to rank the eight universities for significantly different ability items (listed in Table A2.2), and 45 significant differences were found as shown in Table A2.5.

Table A2.1: The alma mater of graduate respondents

University and abbreviations used	Frequency	Percent	Cumulative percent
Australian National University (ANU)	2	0.3	0.3
University of Canberra (CAN)	1	0.1	0.4
Charles Darwin University (CDU)	1	0.1	0.6
Central Queensland University (CQU)	141	19.6	20.2
Curtin University of Technology (CUR)	98	13.6	33.8
Edith Cowan University (ECU)	3	0.4	34.2
James Cook University (JCU)	1	0.1	34.4
University of Melbourne (MEL)	5	0.7	35.0
Monash University (MON)	150	20.9	55.9
Murdoch University (MUR)	33	4.5	60.5
other	1	0.1	60.6
University of Queensland (UQ)	5	0.7	61.3
Queensland University of Technology (QUT)	35	4.9	66.2
RMIT University (RMIT)	1	0.1	66.3
Swinburne University of Technology (SWI)	10	1.4	67.7
University of Sydney (SYD)	16	2.2	70.0
University of New South Wales (UNSW)	1	0.1	70.1
University of Wollongong (UOW)	128	17.8	87.9
University of Southern Queensland (USQ)	48	6.7	94.6
University of Technology Sydney (UTS)	37	5.1	99.7
University of Western Sydney (UWS)	2	0.3	100.0
Total	719	100.0	

Table A2.2 lists the ability statements used in the quantitative survey of graduates in the workforce.

Table A2.2: Numbered items of ability statements used in the quantitative survey of graduates in the workforce

Personal/interpersonal abilities
1 Ability to speak to groups of people effectively
2 Ability to communicate effectively in writing
3 Ability to communicate effectively in visual or graphical formats
4 Ability to communicate effectively and appropriately using electronic media
5 Ability to work productively with people from a wide range of cultural backgrounds
6 Ability to communicate in languages other than English
7 Ability to contribute positively to team-based projects
8 A willingness to consider different points of view before coming to a decision
9 A willingness to face and learn from my errors and listen openly to feedback
10 Ability to remain calm under pressure or when things go wrong
11 Ability to consider the impact of my actions on the environment
12 Ability to consider the impact of my actions on people in the broader community
Thinking/cognitive abilities
13 Ability to keep up to date with relevant developments
14 Ability to bring a creative approach to problem solving
15 Ability to access and organise information effectively
16 Ability to synthesise information into appropriate formats
17 Ability to work equally well in paper-based and electronic-based formats
18 Ability to diagnose what is really causing a problem and test this out in action
19 Ability to identify the core issue in any situation from a mass of detail
20 Ability to represent and interpret information in a variety of formats (e.g., graphical, text or multimedia)
Business abilities
21 A willingness to take responsibility for projects including their outcomes
22 Ability to set and justify priorities
23 Knowing how to manage projects into successful implementation
24 Ability to estimate the time required for work-related tasks
25 Having an understanding of how your organisation functions as a business
26 Ability to translate innovation into a viable business plan
27 Ability to understand, appreciate and meet the needs of your clients
28 Ability to be flexible and adaptable to frequent changes of employment
Technical abilities
29 Having the technical expertise relevant to my work area
30 Having a critical understanding of theories and principles in a discipline area
31 Having exposure to ICT professionals prior to my current job
32 Having the practical skills to generate creative solutions to abstract problems
33 Being familiar with current technologies rather than fundamental theories
34 Having a firm grounding in fundamental theories rather than being familiar with current technologies
35 Having experience with industry-based project work
36 Being able to program in relevant languages
37 Having numerical skills

University practices
38 Information delivered via lectures
39 Information available online
40 Lectures that included class discussion
41 Examples from the real world
42 Problem-solving activities on my own
43 Problem-solving activities in a group
44 Laboratory classes where theory was put into practice
45 Tutorials which were used for revision purposes
46 Tutorials with new material
47 Tutorials with group work
48 Interviewing clients to ascertain their ICT needs for a project
49 Working on projects relevant to industry
50 Placement in industry
51 Giving presentations
52 Researching publications to prepare documents/reports/presentations
University experience and employment expectations
53 The technical content of my degree was always up to date
54 My university courses prepared me well for my work
55 My ICT qualification has an advantage over qualifications from other disciplines
56 My part-time job helped me prepare for the workplace
57 I expect to change jobs frequently
58 My company expects me to move on after a few years

Table A2.3 lists the open-ended qualitative questions in the survey of graduates in the workforce.

Table A2.3: Open-ended qualitative questions in the survey of graduates in the workforce

Open-text questions and request for further information
Regarding the rating of your personal/interpersonal skills listed above, add any comments and other information you think would be helpful
Regarding the rating of thinking/cognitive skills listed above, add any comments and other information you think would be helpful
Regarding the rating of business skills listed above, add any comments and other information you think would be helpful
Regarding the rating of technical skills listed above, add any comments and other information you think would be helpful
Regarding the rating of learning and university experiences in the two tables above, add any comments and other information you think would be helpful
59. In what ways did your university course(s) prepare you well for professional work?
60. What aspects were missing from your university courses that you needed for work preparation?
61. Were there other experiences (e.g. part-time work) that had an impact on your professional preparation?
62. What were the most valuable course(s)/topics at university?
63. What were the least valuable course(s)/topics at university?
64. Do you have any suggestions for improvement to your university course(s)?

Table A2.4 shows the smaller set of universities (with number of respondents, N > 20) that was used in a university comparison to try and identify good practices for the benefit of the sector.

Table A2.4: Universities (with respondents, N > 20) used for a comparison to identify good practices

University	Frequency (N)
Central Queensland University (CQU)	141
Curtin University of Technology (CUR)	98
Monash University (MON)	150
Murdoch University (MUR)	33
Queensland University of Technology (QUT)	35
University of Wollongong (UOW)	128
University of Southern Queensland (USQ)	48
University of Technology Sydney (UTS)	37

Table A2.5 shows the significantly different rankings for items (given in Table A2.3) between the eight universities that had sufficient numbers of respondents.

Table A2.5: Significantly different rankings (*p* ≤ 0.05, Kruskal-Wallace Test) between the eight universities with sufficient respondents for the items shown in Table A2.3. PW refers to Professional Work and UC to University Course as given in the left and right columns of Tables 2.1–2.6

Rank Item 1 PW	Rank Item 1 UC	Rank Item 2 UC	Rank Item 3 PW	Rank Item 5 UC	Rank Item 6 PW	Rank Item 6 UC	Rank Item 7 UC	Rank Item 8 UC	Rank Item 10 UC
MON	UOW	QUT	MON	UTS	UOW	CUR	UTS	UTS	UOW
CUR	CUR	CQU	CUR	UOW	CUR	UOW	QUT	UOW	UTS
UTS	CQU	UTS	USQ	CUR	USQ	CQU	UOW	CUR	CUR
CQU	UTS	MON	UOW	QUT	CQU	QUT	CUR	QUT	MON
QUT	MON	UOW	UTS	CQU	QUT	UTS	MUR	CQU	CQU
UOW	QUT	CUR	QUT	MON	MON	MON	MON	MON	QUT
USQ	MUR	USQ	CQU	USQ	UTS	USQ	CQU	USQ	USQ
MUR	USQ	MUR	MUR	MUR	MUR	MUR	USQ	MUR	MUR

Rank Item 11 PW	Rank Item 11 UC	Rank Item 12 PW	Rank Item 12 UC	Rank Item 17 PW	Rank Item 29 PW	Rank Item 29 UC	Rank Item 31 UC	Rank Item 32 UC	Rank Item 33 UC
QUT	CUR	QUT	UOW	CQU	UTS	UTS	UOW	MON	UTS
CQU	UOW	CQU	UTS	USQ	USQ	QUT	UTS	QUT	UOW
CUR	USQ	CUR	CQU	CUR	CUR	CUR	QUT	UOW	QUT
MON	CQU	UOW	CUR	MON	QUT	MON	MON	UTS	MON
UOW	QUT	UTS	QUT	UOW	CQU	UOW	CUR	CUR	CUR
UTS	UTS	MON	MON	UTS	MON	MUR	MUR	USQ	CQU
USQ	MON	USQ	USQ	QUT	UOW	USQ	CQU	MUR	USQ
MUR	MUR	MUR	MUR	MUR	MUR	CQU	USQ	CQU	MUR

Rank Item 35 PW	Rank Item 35 UC	Rank Item 36 UC	Rank Item 37 UC	Rank Item 38 PW	Rank Item 38 UC	Rank Item 42 UC	Rank Item 43 PW	Rank Item 43 UC	Rank Item 44 PW
CQU	UTS	QUT	CUR	QUT	UTS	USQ	UTS	UTS	UTS
UTS	CUR	UOW	QUT	UTS	QUT	UTS	MON	CUR	CUR
CUR	MON	UTS	UOW	UOW	UOW	MON	CQU	UOW	CQU
USQ	UOW	CUR	USQ	CUR	CUR	CUR	UOW	QUT	MON
UOW	QUT	MUR	MON	CQU	MON	UOW	CUR	MON	QUT
MON	CQU	MON	MUR	MON	MUR	QUT	QUT	CQU	UOW
MUR	USQ	CQU	CQU	MUR	CQU	MUR	USQ	MUR	USQ
QUT	MUR	USQ	UTS	USQ	USQ	CQU	MUR	USQ	MUR

Rank Item 44 UC	Rank Item 45 UC	Rank Item 46 PW	Rank Item 47 PW	Rank Item 47 UC	Rank Item 48 PW	Rank Item 48 UC	Rank Item 49 UC	Rank Item 50 PW	Rank Item 50 UC
UTS	QUT	UTS	UTS	UTS	UTS	UTS	UTS	UTS	UTS
CUR	CUR	QUT	CUR	QUT	MON	CUR	CUR	CUR	UOW
QUT	UOW	CUR	CQU	CUR	QUT	QUT	QUT	CQU	CUR
MUR	MON	CQU	QUT	UOW	CQU	MON	MON	MON	QUT
MON	UTS	UOW	MON	CQU	USQ	UOW	UOW	UOW	MON
UOW	CQU	MON	UOW	MON	CUR	MUR	MUR	QUT	MUR
CQU	MUR	USQ	MUR	MUR	UOW	CQU	CQU	USQ	CQU
USQ	USQ	MUR	USQ	USQ	MUR	USQ	USQ	MUR	USQ

Rank Item 51 PW	Rank Item 51 UC	Rank Item 52 UC	Rank Item 54	Rank Item 55
MON	UTS	USQ	CUR	MON
UTS	UOW	MON	UTS	UTS
QUT	CUR	UOW	QUT	CUR
UOW	MON	QUT	MON	QUT
USQ	QUT	CQU	UOW	UOW
CQU	CQU	UTS	USQ	CQU
CUR	MUR	CUR	MUR	USQ
MUR	USQ	MUR	CQU	MUR

Appendix 3: AIIA survey of employers on recent ICT graduate recruits

The Australian Information Industry Association (AIIA) provided an online survey for CEOs regarding their recent ICT graduate recruits. The AIIA has about 450 members and a response was received from 28 CEOs (6% response rate, despite several encouraging attempts). A selection of results is presented in Tables A3.1–A3.8.

Table A3.1: Qualifications of recent ICT graduate recruits

2. What were the qualifications of these recent ICT graduate recruits?	Response Percent	Response Count
Computer Science	65.4%	17
Software Engineering	53.8%	14
Information Technology	**76.9%**	**20**
Information Management Systems /Business Systems	34.6%	9
Electrical/Electronics Engineering	26.9%	7
Computer Engineering	19.2%	5
Telecommunications Engineering	26.9%	7
Multimedia (including Web design)	19.2%	5
Library and Information Management	3.8%	1
Other (please specify)	11.5%	3
	answered question	26
	skipped question	2

Table A3.2: Positions of employment of recent ICT graduate recruits

3. To what positions are, or were, these graduates employed?

	Response Percent	Response Count
Account Manager	3.8%	1
Analyst Programmer	**42.3%**	**11**
Business Development Manager	0.0%	0
Computer Engineer	19.2%	5
Consultant and Contractor	11.5%	3
Database Administrator	11.5%	3
Database Programmer	7.7%	2
Developer	34.6%	9
Hardware Technician	7.7%	2
Information Security Engineer	7.7%	2
Information System Analyst	11.5%	3
IT Architect	11.5%	3
IT Sales and Marketing	3.8%	1
IT Sales Representative	0.0%	0
IT Support / Helpdesk	11.5%	3
IT Support Technician	3.8%	1
IT Trainer	11.5%	3
Multimedia Developer	11.5%	3
Network Administrator	11.5%	3
Network Support	23.1%	6
Programmer	**42.3%**	**11**
Security Analyst	7.7%	2
Security Consultant	3.8%	1
Security Technical Specialist	0.0%	0
Software Developer	23.1%	6

Solutions Architect	7.7%	2
Systems Analyst & Designer	7.7%	2
Technical Instructor	7.7%	2
Training Analyst	0.0%	0
User Support Specialist	7.7%	2

Table A3.3: Extent to which recent ICT graduate recruits met the needs of employers for knowledge and skills

4. To what extent do the recent ICT graduates meet your company's needs for knowledge and skills?

	Doesn't meet our needs	Meets some of our needs	Meets our needs	Not relevant	Response Count
Has baseline skills in literacy & numeracy	4.0% (1)	32.0% (8)	**64.0% (16)**	0.0% (0)	25
Has knowledge in the relevant ICT area	8.0% (2)	24.0% (6)	**68.0% (17)**	0.0% (0)	25
Is skilled in particular computer languages	0.0% (0)	41.7% (10)	**50.0% (12)**	8.3% (2)	24
Is skilled in particular software applications	4.0% (1)	44.0% (11)	**48.0% (12)**	4.0% (1)	25
Has foundation in theoretical principles	12.0% (3)	20.0% (5)	**68.0% (17)**	0.0% (0)	25
Understands business processes	32.0% (8)	**48.0% (12)**	20.0% (5)	0.0% (0)	25
Has project management knowledge	24.0% (6)	**64.0% (16)**	8.0% (2)	4.0% (1)	25
Has commercial awareness	**52.0% (13)**	44.0% (11)	4.0% (1)	0.0% (0)	25
Has written communication qualities	16.0% (4)	**56.0% (14)**	28.0% (7)	0.0% (0)	25
Holds language skills other than English	8.0% (2)	28.0% (7)	20.0% (5)	**44.0% (11)**	25
				Comments (optional)	4
				answered question	**25**
				skipped question	**3**

Table A3.4: Extent to which personal qualities of recent ICT graduate recruits met the needs of employers

6. What is your overall satisfaction with the personal qualities of these recent graduates?

	Doesn't meet our needs	Meets some of our needs	Meets our needs	Not relevant	Response Count
Exercises responsibility	0.0% (0)	43.5% (10)	**52.2% (12)**	4.3% (1)	23
Has self-esteem	0.0% (0)	34.8% (8)	**60.9% (14)**	4.3% (1)	23
Demonstrates sociability	8.7% (2)	30.4% (7)	**56.5% (13)**	4.3% (1)	23
Has integrity/honesty	0.0% (0)	12.5% (3)	**83.3% (20)**	4.2% (1)	24
Demonstrates initiative	8.3% (2)	**45.8% (11)**	41.7% (10)	4.2% (1)	24
Exercises self-management	12.5% (3)	**45.8% (11)**	37.5% (9)	4.2% (1)	24
Demonstrates planning capability	17.4% (4)	**60.9% (14)**	17.4% (4)	4.3% (1)	23
Undertakes ongoing learning	0.0% (0)	33.3% (8)	**62.5% (15)**	4.2% (1)	24
Demonstrates problem solving skills	4.3% (1)	**47.8% (11)**	43.5% (10)	4.3% (1)	23
Willing to get quickly into tasks	0.0% (0)	29.2% (7)	**66.7% (16)**	4.2% (1)	24
Has global perspective	20.8% (5)	**45.8% (11)**	29.2% (7)	4.2% (1)	24
				Comment (optional)	0
				answered question	**24**
				skipped question	**4**

Table A3.5: Extent to which interpersonal skills of recent ICT graduate recruits met the needs of employers

7. What is your overall satisfaction with the interpersonal skills of these recent graduates?

	Doesn't meet our needs	Meets some of our needs	Meets our needs	Not relevant	Response Count
Participates as a member of the Team	0.0% (0)	29.2% (7)	**62.5% (15)**	8.3% (2)	24
Teaches others	16.7% (4)	**50.0% (12)**	16.7% (4)	16.7% (4)	24
Serves clients and customers	4.2% (1)	**58.3% (14)**	33.3% (8)	4.2% (1)	24
Exercises leadership	26.1% (6)	**43.5% (10)**	13.0% (3)	17.4% (4)	23
Negotiates issues and outcomes	21.7% (5)	**47.8% (11)**	17.4% (4)	13.0% (3)	23
Works with cultural diversity	4.2% (1)	25.0% (6)	**58.3% (14)**	12.5% (3)	24
Appreciates social responsibility	0.0% (0)	**45.8% (11)**	**45.8% (11)**	8.3% (2)	24
Undertakes planning	8.3% (2)	**62.5% (15)**	20.8% (5)	8.3% (2)	24
Improves learning & performance	4.2% (1)	41.7% (10)	**50.0% (12)**	4.2% (1)	24
Exercises social responsibility	0.0% (0)	**54.2% (13)**	41.7% (10)	4.2% (1)	24
				Comment (optional)	0
				answered question	**24**
				skipped question	**4**

Table A3.6: Overall employer satisfaction with personal qualities and interpersonal skills of recent ICT graduate recruits

8. What is your overall satisfaction with the personal qualities and interpersonal skills these graduates?

	Response Percent	Response Count
Satisfied	47.8%	**11**
Neutral	39.1%	9
Dissatisfied	13.0%	3
answered question		**23**
skipped question		**5**

Table A3.7: The value of prior industry experience of recent ICT graduate recruits

9. Recent ICT graduates with prior industry experience are more immediately useful than those who come directly from their studies.

	Response Percent	Response Count
Agree	88.0%	22
No difference	8.0%	2
Disagree	4.0%	1
answered question		25
skipped question		3

Table A3.8: How long it takes to get recent ICT graduate recruits up to speed in their employment and how much it costs

12. On average, how long does it take to get recent ICT graduates up to speed?

	Response Percent	Response Count
One month	0.0%	0
2-3 months	0.0%	0
3-6 months	**52.0%**	**13**
6-12 months	40.0%	10
Longer than 12 months	8.0%	2
answered question		25
skipped question		3

13. What is the approximate cost of getting each ICT graduate up to speed? Examples of costs are: induction down time; cost of mentor's time; short course training; familiarisation programs; etc

	Response Percent	Response Count
Less than $1,000	0.0%	0
$1,000 – 3,000	4.0%	1
$3,000 – 5,000	28.0%	7
$5,000 – 10,000	24.0%	6
More than $10,000	**44.0%**	**11**
answered question		25
skipped question		3

References

AC Nielsen Research Services (2000). *Employer Satisfaction with Graduate Skills*, Research Report. Department of Education, Training and Youth Affairs. http://www.dest.gov.au/archive/highered/eippubs/eip99-7/eip99_7pdf.pdf [viewed 22 January 2009].

ACPHIS (Australian Council of Professors and Heads of Information Systems) (2008). http://www.acphis.org.au/ [viewed 18 September 2008].

ACS (Australian Computer Society) (May 2004). *Australian Computer Society Policy Statement on Offshoring.* http://www.acs.org.au/acs_policies/docs/2004/OffshoringPolicy_wNoChecklist.pdf [viewed 31 October 2008].

ACS (September 2006). 'ICT professional status to be boosted by new "Computer Professional" program'. Media release. http://www.acs.org.au/news/260906.htm [viewed 29 October 2008].

ACS (March 2007). 'ICT industry moves towards a global standard of professionalism with international memorandum of understanding'. Media release. http://www.acs.org.au/index.cfm?action=notice&notID=740&temID=noticedetails [viewed 29 October 2008].

ACS (August 2007). *Australian Computer Society Policy Statement on Green ICT*. http://www.acs.org.au/acs_policies/docs/2007/greenictpolicy.pdf [viewed October 24 2008].

ACS (January 2008). *The ICT Industry Report*. http://www.aiia.com.au/docs/ACS%20ICT%20Industry%20Report%202008.pdf [viewed 4 February 2009].

ACS (2008). 'Dire ICT skills forecast – now's the time for 2020 vision'. Media release. http://www.acs.org.au/index.cfm?action=notice&temID=noticedetails&notID=890 [viewed 1 October 2008].

ACS Staff, Information Age (2006). *CP Program Offers Recognised Status as an ICT Professional*. http://www.infoage.idg.com.au/index.php?id=622425388 [viewed 28 October 2008].

AIIA (Australian Information Industry Association) (2008). http://www.aiia.com.au/pages/aboutaiia.aspx [viewed 18 September 2008].

Alford, K.L., Carver, C.A., Ressler, E.K. and Reynolds, C.W. (2004). 'A curriculum framework for evolving an information technology program'. *Proceedings of the 34th ASEE/IEEE Frontiers in Education Conference*, pp. 16–21.

Allen, J. and van der Velden, R. (2007). *The Flexible Professional in the Knowledge Society: General Results of the REFLEX Project*. Research Centre for Education and the Labour Market, Maastricht University, Netherlands. http://www.educpros.fr/uploads/media/reflex_01.pdf [viewed 20 February 2009].

Al-Mahmood, R. and Gruba, P. (2007). 'Approaches to the implementation of generic graduate attributes in Australian ICT undergraduate education'. *Computer Science Education*, 17, 171–85.

ALTC (Australian Learning and Teaching Council) (2008). http://www.altc.edu.au/carrick/go/home [viewed 24 September 2008].

APEC (Asia–Pacific Economic Cooperation) (2006). *Ha Noi Declaration*. http://www.apec.org/apec/leaders__declarations/2006.html [viewed 29 September 2008].

Australian Access Federation (2007). http://www.aaf.edu.au/project [viewed 29 September 2008].

Australian Government (2006). *Overview of the Australian ICT Industry*. http://www.dbcde.gov.au/communications_and_technology/publications_and_reports/2006/november/overview_of_the_australian_ict_industry [viewed 3 February 2009].

Australian Government (2007). *SkillsInfo Vacancy Report*. http://skillsinfo.gov.au/skills/SkillsIssues/VacancyReport.htm [viewed 14 August 2008].

AUTC (2001). *The ICT-Ed Project: The report on learning outcomes and curriculum development in major university disciplines in Information and Communication Technology*, Computing Education Research Group, Faculty of Information Technology, Monash University.

Bates, A. W. (2005). *Technology, E-learning and Distance Education* (2nd edition). Routledge.

Beyer, S., Rynes, K., Perrault, J., Hay, K. and Haller, S. (2003). 'Gender differences in computer science students'. ACM (Association for Computing Machinery) SIGCSE (Special Interest Group on Computer Science Education) Bulletin, Volume 35, pp. 49–53. ACM New York, NY, USA.

Bradley, D. (2008). *Review of Australian Higher Education*. http://www.dest.gov.au/sectors/higher_education/policy_issues_reviews/reviews/highered_review/ [viewed 24 September 2008].

Bradley, D., Noonan, P., Nugent, H. and Scales, B. (2008). *Review of Australian Higher Education: Final Report*. Australian Government. www.deewr.gov.au/he_review_finalreport [viewed 28 January 2009].

Broadband Connect and Australia Connect (2007). Department of Broadband, Communications and the Digital Economy website. http://www.archive.dcita.gov.au/2007/12/broadband_connect [viewed 29 September 2008].

Broos, A. (2005). 'Gender and information and communication technologies (ICT) anxiety: male self-assurance and female hesitation'. *CyberPsychology & Behavior*, 8, 21–31.

Bruce, C.S., Mohay, G.M., Smith, G.P., Stoodley, I.D. and Tweedale, R. (eds) (2006). *Transforming IT Education: Promoting a Culture of Excellence.* Informing Science Press, Publishing arm of the Informing Science Institute, Santa Rosa, California, USA.

Cahill, L. (2006). 'Why sex matters for neuroscience'. *Nature Reviews – Neuroscience*. http://www.cbd.ucla.edu/downloads/Why%20sex%20matters.pdf [viewed 20 November 2008].

Carli, L. L. (2006). 'Gender issues in workplace groups: effects of gender and communication style on social influence'. In *Gender and Communication at Work*, M. Barrett and M. Davidson (eds). Ashgate Publishing Limited, Aldershot, England. Pp. 69–83.

CeBIT (2008). 'ICT sector resists downturn'. Press release. http://www.cebit.com.au/press/press-release/cebit-press-release/142-ict-sector-resists-downturn.html [viewed 3 February 2009].

CEN (2006). *European ICT Skills Meta-Framework – State-of-the-art review, clarification of the realities, and recommendations for next steps*. CEN Workshop Agreement. http://www.pedz.uni-mannheim.de/daten/edz-h/gdb/06/CWA15515-00-2006-Feb.pdf [viewed 21 January 2009].

Chartered Institute of Personnel and Development (2006). *Graduates in the Workplace: Does a degree add value?* http://www.cipd.co.uk/NR/rdonlyres/ABF47E00-4DDE-40EC-9F20-B3C61574A110/0/gradwrkplsr.pdf [viewed 20 February 2009].

Clayton, T. (2005). *IT Investment, ICT Use and UK Firm Productivity*. UK National Statistics. http://www.statistics.gov.uk/articles/nojournal/ICTReportAug05a.pdf [viewed 14 January 2009].

Clever Networks Program (2006). Department of Broadband, Communications and the Digital Economy website. http://www.dbcde.gov.au/communications_for_business/funding_programs__and__support/clever_networks/clever_networks_program_background [viewed 29 September 2008].

CORE (Computing Research and Education Association) (2008). http://www.core.edu.au/ [viewed 22 September 2008].
Croson, R. and Gneezy, U. (2004). *Gender Differences in Preferences*. http://www.hks.harvard.edu/wappp/research/rachelcrosonandurigneez.pdf [viewed 17 November 2008].
Crump, B.J., Logan, K.A. and McIlroy, A. (2007). 'Does gender still matter? A study of the views of women in the ICT industry in New Zealand'. *Gender, Work & Organization*, 14, 349–70.
CSC (Computer Science Curriculum) (2008). *Computer Science Curriculum 2008: An Interim Revision of CS 2001*. Report from the Interim Review Task Force of the Association for Computing Machinery and IEEE Computer Society. http://www.acm.org/education/curricula/ComputerScienceCurriculumUpdate2008.pdf [viewed 20 January 2009].
cs4fn (Computer Science For Fun) (2008). http://www.cs4fn.org/ [viewed 30 October 2008].
Curzon P., McOwan, P. and Black, J. (2008). 'Securing the future of computer science: computer science for fun'. *Proceedings of the 9th Annual Conference of the Subject Centre for Information and Computer Sciences*, 26–28 August 2008, Liverpool Hope University, p. 208.
Davidson, P. (2005). 'The next ICT skills shortage'. *Information Age* http://www.infoage.idg.com.au/index.php/id;1425421837;fp;16;fpid;0 [viewed 9 October 2008].
de Graaff, E & Kolmos, A (eds) (2007). *Management of Change: Implementation of problem-based and project-based learning in engineering*. Sense Publishers, Rotterdam. http://www.sensepublishers.com/catalog/files/90-8790-013-9.pdf#page=41 [viewed 20 October 2008].
Department of Education and Children's Services SA. http://www.decs.sa.gov.au/portal/learning.asp [viewed 29 September 2008].
DEEWR (Department of Education, Employment and Workplace Relations) (2008a). *Undergraduate Applications, Offers and Acceptances 2008*. http://www.dest.gov.au/sectors/higher_education/publications_resources/profiles/documents/Undergraduate_Applications_Offers_and_Acceptances_2008_pdf.htm [viewed 4 February 2009].
DEEWR (2008b). *2007 Full Year Student Summary Tables – All Higher Education*. http://www.dest.gov.au/sectors/higher_education/publications_resources/profiles/documents/2007_students_full_year/2007_Full_All_Higher_Education_Providers_xls.htm [viewed 4 February 2009].
DEST(Department of Education, Science and Training) (2004). *Higher Education Attrition Rates 1994–2002: A brief overview*. http://www.dest.gov.au/NR/rdonlyres/8A245011-4F59-4D99-9D97-A1AD89D0C669/1043/1.pdf [viewed 16 October 2008].
DEST (2008). *Information Communication Technology Policies for Education and Training*. http://www.ictpolicy.edna.edu.au/sibling/search?showallpolicies=yes [viewed 24 September 2008].
Dobson, I.R. (2007). *The IT Education Bubble: An analysis of university student statistics 2002–2005*. Centre for Population & Urban Research, Monash University and Educational Policy Institute.
Doucek, P. and Novotný, O. (2007). 'ICT education and requirements for ICT graduates in the Czech Republic'. *Proceedings of the 2007 Computer Science and IT Education Conference*, pp. 215–31. http://csited.org/2007/49DoucCSITEd.pdf [viewed 15 January 2009].
Draca, M., Sadun, R. and Van Reenen, J. (2006). *Productivity and ICT: A review of the evidence*. Discussion paper. Centre for Economic Performance, London School of Economics and Political Science. http://eprints.lse.ac.uk/4561/ [viewed 14 January 2009].

Dym, C.L., Agogino, A.M., Eris, O., Frey, D.D. and Leifer L.J. (2005). 'Engineering design thinking, teaching, and learning'. *Journal of Engineering Education*, January 2005, 103–20. http://meche.mit.edu/documents/danfrey/danfrey_engineering.pdf [viewed 27 January 2009].
Engineers Australia (2008). http://www.engineersaustralia.org.au/ [viewed 22 September 2008].
Foresighting Working Group (2006). Recommendations available at http://www.acs.org.au/news/181206.htm [viewed 1 October 2008].
Forth, J. and Mason, G. (2003). *The Determinants and Effects of High-Level ICT Skill Shortages: Evidence from the Technical Graduates Employers Survey*. National Institute of Economic and Social Research, London. http://www.niesr.ac.uk/research/ICT/TGES-7.pdf [viewed 14 January 2009].
Forth, J. and Mason, G. (2004). *The Impact of High-Level Skill Shortages on Firm-Level Performance: Evidence from the UK Technical Graduates Employers Survey*. National Institute of Economic and Social Research, London. http://www.niesr.ac.uk/pubs/dps/Dp235.pdf [viewed 5 February 2009].
Forth, J. and Mason, G. (2006). *Do ICT Skill Shortages Hamper Firms' Performance? Evidence from UK Benchmarking Surveys*. National Institute of Economic and Social Research, London. http://www.niesr.ac.uk/pubs/DPS/dp281.pdf [viewed 5 January 2009].
Furnham, A. (2005). *The Psychology of Behaviour at Work*. Psychology Press, Taylor and Francis Group, Hove, England.
Gardner, M. and Steinberg, L. (2005). 'Peer Influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study'. *Developmental Psychology*, 41, 625–35. http://uwf.edu/smathews/documents/peerroleinrisktakinggardnerandsteinberg.pdf [viewed 17 November 2008].
Graduate Careers Australia (2008). *Snapshot: Graduate Outlook 2008*. http://www.graduatecareers.com.au/content/download/3852/16131/file/GOS%202008%20Snapshot%20Report%20-%20WEB.pdf [viewed 28 January 2009].
Gray, J. (1992). *Men Are from Mars, Women Are from Venus: A practical guide for improving communication and getting what you want in your relationships*. Harper Collins, New York.
Gregor, S., von Konsky, B.R., Hart, R. and Wilson, D. (2008). *The ICT Profession and the ICT Body of Knowledge* (Version 4.0). Australian Computer Society, Sydney.
Gresty, M. (2007). *Graduates' Experiences of the Workplace*. http://www.prospects.ac.uk/cms/ShowPage/Home_page/Main_menu___Research/Labour_market_information/Graduate_Market_Trends_2007/Graduates__experiences_of_the_workplace__Spring_2007_/p!elkbbiF [viewed 20 February 2009].
Griffiths, M. and Moore, K. (2006). 'Issues raised by the Women in IT (WINIT) Project in England'. In *Encyclopaedia of Gender and Information Technology*, Eileen Trauth (ed), Hershey, PA, USA: Idea Group Inc. Pp 832–837.
Hagan, D. (2004). 'Employer satisfaction with ICT graduates'. Sixth Australasian Computing Education Conference (ACE2004), Dunedin, New Zealand. *Conferences in Research and Practice in Information Technology*, vol. 30, R. Lister and A. Young (eds), pp. 119–23.
Harris, M. (2007). *National Skills Shortage in ICT: IBM Perspective*. http://www.cs.ru.ac.za/ICTSkills/MarkHarrisPresentation.pdf [viewed 5 February 2009].
Hines, M., Ahmed, S.F. and Hughes, I.A. (2003). 'Psychological outcomes and gender-related development in complete androgen insensitivity syndrome'. *Archives of Sexual Behavior*, 32, 93–101.
Houghton, J.W. (2006). *Australian ICT Trade Update 2006*. http://www.acs.org.au/attachments/AustralianICTTradeUpdate2006(SUMMARY).pdf [viewed 6 February 2009].

Hyde, J. S. (2005). ‘The gender similarities hypothesis’. *American Psychologist*, 60, 581–92. http://bama.ua.edu/~sprentic/672%20Hyde%202005.pdf [viewed 17 November 2008].
ILG (Industry Leadership Group) (2006). http://www.acs.org.au/news/181206.htm [viewed 1 October 2008].
Ilic, V. (2007). ‘Engineering practice: a driver for curriculum change’. Paper presented at the International Conference on Engineering Education, September 3–7, Coimbra, Portugal. http://icee2007.dei.uc.pt/proceedings/papers/280.pdf [viewed 22 January 2009].
Information Economy SA (2008). http://www.informationeconomy.sa.gov.au/home_public [viewed 29 September 2008].
Information Technology (2008). *Curriculum Guidelines for Undergraduate Degree Programs in Information Technology*. Association for Computing Machinery (ACM) and IEEE Computer Society. http://www.acm.org/education/curricula/IT2008%20Curriculum.pdf [viewed 20 January 2009].
IS Curriculum Wiki (2008). http://blogsandwikis.bentley.edu/iscurriculum/index.php/Main_Page [viewed 15 January 2009].
Jancauskas, E., Atchison, M., Murphy, G. and Rose, P. (2000). *Unleashing the Potential of Work-Integrated-Learning through Professionally Trained Academic and Industry Supervisors*. http://www.waceinc.org/pdf/Erin_Jancauskas_6_14_00.pdf [viewed 6 January 2009].
Joint Ministerial Statement (2008). *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008–2011*. http://www.aictec.edu.au/aictec/webdav/site/standardssite/shared/JMS%20on%20ICT%20in%20Australian%20Education%20and%20Training.pdf [viewed 24 September 2008].
Kahn, P. and O’Rourke, K. (2005). ‘Understanding enquiry-based learning’. In *Handbook of Enquiry & Problem Based Learning*, T. Barrett, T., I. Mac Labhrainn and H. Fallon (eds). CELT, Galway. Pp. 1–12. http://www.nuigalway.ie/celt/pblbook/ [viewed 20 October 2008].
Kennan, M.A., Cecez-Kecmanovic, D., Willard, P. and Wilson, C.S. (2008). ‘IS knowledge and skills sought by employers: a content analysis of Australian IS early career online job advertisements’. *Australasian Journal of Information Systems*, 15, 57–78.
Keogh, C., Tattersall, A. and Richardson, H. (2007). *The Directing Equal Pay in ICT (DEPICT) Final Report*. http://www.iris.salford.ac.uk/GRIS/depict/Documents/DEPICT-final-Report.pdf [viewed 24 November 2008].
King, R , (2008), *Addressing the Supply and Quality of Engineering Graduates for the New Century*. Discipline-based scoping report for the Carrick Institute. http://www.altc.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/Grants_DBIprojec_engineeringquality_project%20report_25march08.pdf [viewed 23 September 2008].
Koppi, T., Naghdy, F. and Chicharo, J. (2008). ‘ICT education issues and challenges in Australia and the UK’. *Proceedings of the 9th Annual Conference of the Subject Centre for Information and Computer Sciences*, 26–28 August 2008, Liverpool Hope University, p. 209.
Koppi, T., Sheard, J., Naghdy, F., Chicharo, J., Edwards, S. L., Brookes, W. and Wilson, D. (2009). ‘What our ICT graduates really need from us: a perspective from the workplace’. Eleventh Australasian Computing Education Conference (ACE2009). *Conferences in Research and Practice in Information Technology*, vol. 95, M. Hamilton and T. Clear (eds), pp 101–110.
KPMG (2008). ‘Skills shortage looms for IT sector’. Press release. http://www.kpmg.com/Global/PressRoom/PressReleases/Pages/Skills-shortage-looms-for-IT-sector.aspx [viewed 5 February 2009].
Learner Identity Management (2006). http://www.aictec.edu.au/aictec/go/home/priorities/pid/90 [viewed 24 September 2008].

LeMay, R. (December 2008). 'Australia's ICT industry is panicking'. http://www.zdnet.com.au/insight/business/soa/Australia-s-ICT-industry-is-panicking/0,139023749,339293604,00.htm [viewed 4 January 2009].
Lewis, S., McKay, J. and Lang, C. (2006). 'The next wave of gender projects in IT curriculum and teaching at universities'. Eighth Australasian Computing Education Conference (ACE2006). *Conferences in Research in Practice in Information Technology*, vol. 52, D. Tolhurst and S. Mann (eds), pp 135–142.
Lewis, S., Lang, C. and McKay, J. (2007). 'An inconvenient truth: the invisibility of women in ICT'. *Australasian Journal of Information Systems*, 15, 59–76.
Lippa, R. A. (2002). *Gender, Nature, and Nurture*. Lawrence Erlbaum Associates, Mahwah, New Jersey.
Lippa, R. A. (2008). *Sex Differences in Personality Traits and Gender-Related Occupational Preferences across 53 Nations: Testing evolutionary and social-environmental theories*. Springer Science+Business Media. http://kwb.ki.se/navigation/programmes/psykolog/termin3/2PS005/mermaterial/ahorarkopior_/sex_differences_in_personality_traits_and_gender-related.pdf [viewed 25 November 2008].
Lomas, N. (2009). 'More UK IT jobs to go'. http://www.zdnet.com.au/news/business/soa/More-UK-IT-jobs-to-go/0,139023166,339294767,00.htm?ocid=nl_TNB_05022009_fea_l9 [viewed 5 February 2009].
Maslow, A.H. (1943). 'A theory of human motivation'. Originally published in *Psychological Review*, 50, 370–396, and available at http://psychclassics.yorku.ca/Maslow/motivation.htm [viewed 27 October 2008].
McCallum, S. (2006). *Computer Science Graduate Shortage*. Technical Report OUCS-2006-10, Department of Computer Science, University of Otago, New Zealand. http://sadalbari.otago.ac.nz/research/publications/oucs-2006-10.pdf [viewed 15 November 2008].
McDermott, K.J. (2007). 'Enhancing the work readiness of engineering graduates'. *World Transactions on Engineering and Technology Education*, 6, 113–17.
McIlveen, P., Brooks, S., Lichtenburg, A., Smith, M., Torjul, P. and Tyler, J. (2008). *Career Development Learning and Work-integrated Learning in Australian Higher Education: A discussion paper*. National Association of Graduate Careers Advisory Services, Australia, Inc. http://www.usq.edu.au/resources/cdlandwilpaper.pdf [viewed 6 January 2009].
McLennan, B. and Keating, S. (2005). *Making the Links to Student Learning*. Paper prepared for the Academic and Vocational Education Boards, Victoria University. http://tls.vu.edu.au/PEC/PEC_docs/Making%20the%20links%20to%20student%20learning.pdf [viewed January 2009].
McMillan, J. (2005). *Course Change and Attrition from Higher Education*. Research Report 39. Australian Council for Educational Research. http://www.ncver.edu.au/lsay_pubs/research/LSAY_lsay39.pdf [viewed 17 October 2008].
Mingay, S. (2007). *Green ICT: A New Industry Shockwave*. Gartner. http://www.ictliteracy.info/rf.pdf/Gartner_on_Green_IT.pdf [viewed 24 October 2008].
Monaghan, L. and Goodman, J. (eds) (2006). *A cultural approach to interpersonal communication*. Blackwell Publishing Ltd, Malden USA, Oxford UK, Carlton Australia.
Moore, K., Griffiths, M. and Richardson, H. (2005). 'Moving in, moving up, moving out? A survey of women in ICT'. Paper presented at the 3rd European Symposium on Gender and ICT: Working for Change, Manchester Conference Centre, 1 February 2005. http://www.iris.salford.ac.uk/GRIS/winit/Publications/Symposium_on_Gender_and_ICT_Main_paper_pdf.pdf [viewed 24 November 2008].
Mulac, A. (2006). 'The gender-linked language effect: do language differences really make a difference?' In *Sex Differences and Similarities in Communication* (2nd edition), K. Dindia and D.J. Canary (eds). Erlbaum, Mahwah, New Jersey. Pp 219–239.

MMV (Multimedia Victoria) (2004a). *Attitudes to ICT Careers and Study among 17–19 Year Old Victorians*. http://www.mmv.vic.gov.au/Skillsandcareers [viewed 2 February 2009].
MMV (2004b). *ICT Combined Advantage Study*. http://www.mmv.vic.gov.au/Skillsandcareers [viewed 30 September 2008].
MMV (2007a). *Attitudes to ICT Careers and Study among 14–19 Year Old Victorians (Years 9–12)*. http://www.mmv.vic.gov.au/Skillsandcareers [viewed 30 September 2008].
MMV (2007b). 'ICT Week will drive Victorian skills from strength to strength'. Media release. http://www.mmv.vic.gov.au/NewsICTWeekWillDriveVictorianSkillsFromStrengthToStrength?searchTerms[]=vitta [viewed 30 September 2008].
MMV (2008). http://www.mmv.vic.gov.au/ [viewed 30 September 2008].
Neumann, R. (1992). 'Perceptions of the teaching–research nexus: a framework for analysis'. *Higher Education*, 23, 159–71. http://www.springerlink.com/content/h65l6378820541j3/fulltext.pdf [viewed 20 October 2008].
Nagarajan, S. and Edwards, J. (2008). 'Towards understanding the non-technical work experiences of recent Australian information technology graduates'. Tenth Australasian Computing Education Conference (ACE2008), Wollongong, Australia. *Conferences in Research and Practice in Information Technology*, vol. 78, S. Hamilton and M. Hamilton (eds), pp. 103–12.
Naghdy, G. (2001). 'Women in engineering, from rarity to minority! A retrospective analysis'. Paper presented at the 10th Women in Leadership Conference, 2001, Perth.
NICTA (2007). 'National crisis: ICT skills shortage'. http://www.sciencealert.com.au/opinions/20070706-15970.html [viewed 5 February 2009].
NICTA (National ICT Australia) (2008). http://nicta.com.au/ [viewed 18 September 2008].
Oliver, D. (2006). 'Undergraduate student employment and its effect on graduates' attitudes toward work, employment and trade unions'. Ph.D. thesis, Department of Industrial Relations, Griffith Business School, Griffith University. http://www4.gu.edu.au:8080/adt-root/uploads/approved/adt-QGU20080416.165334/public/02Whole.pdf [viewed 15 November 2008].
O'Mahony, M. and Robinson, C. (2003). 'The growth of ICT and industry performance – manufacturing in the US and UK compared'. *National Institute Economic Review*, 184, 70–83. http://www.niesr.ac.uk/research/epke/maryrev.pdf [viewed 13 January 2009].
Orrell, J. (2004). 'Work-integrated learning programmes: management and educational quality'. *Proceedings of the Australian Universities Quality Forum 2004*, AUQA Occasional Publication, pp 1–5. http://www.auqa.edu.au/auqf/pastfora/2004/program/papers/Orrell.pdf [viewed 6 January 2009].
OzWIT (2006). *Australian Women in Information Technology. Statistics for the IT Industry in 2006*. http://www.ozwit.org/version_three/index.php?option=com_content&task=view&id=15&Itemid=34 [viewed 25 November 2008].
Pauling, J.W. and Komisarczuk, P. (2007). 'Review of work experience in a Bachelor of Information Technology'. Ninth Australasian Computing Education Conference (ACE2007), Ballarat, Victoria, January 2007. *Conferences in Research in Practice in Information Technology*, vol. 66, S. Mann and Simon (eds) Pp. 125–132.
Petersen, A.W., Revill, P., Ward, T. and Wehmeyer, C. (2004). 'ICT and e-business skills and training in Europe'. http://www.e2vet.org/typo/fileadmin/docs/eSkillsICT.pdf [viewed 14 January 2009].
Petrova, K. and Claxton, G. (2007). 'Curriculum change and alignment with industry: the student perspective'. In *Information Systems and Technology Education: From the university to the workplace*, G. Lowry and R. Turner (eds). Idea Group Inc. Hershey PA USA, London UK. Pp. 128–58.

Poppins, P. and Singh, M. (2005). 'Work integrated learning in information technology education'. In *Information and Communication Technologies and Real-Life Learning: New education for the knowledge society*, T. van Weert and A. Tatnall (eds). Springer, New York, USA. Pp. 223–30.
PricewaterhouseCoopers (2008). *Millennials at Work: Perspectives from a new generation*. http://www.pwc.com/extweb/pwcpublications.nsf/docid/18E31741D06BA7A0852575120073CEBA [viewed 20 February 2009].
Raison, M. and Etheridge, M. (2006). *Macquarie University Science, Engineering and Technology Study*, Macquarie University. http://www.pr.mq.edu.au/SET/MQ-SET-Study.pdf [viewed 5 January 2009].
Roslöf, J. (2006). 'On the quality of future ICT Professionals – defining competence requirements of Finnish ICT Engineers'. *Proceedings of the 13th European Conference on Information Technology*, D. Remenyi and A. Brown (eds). Academic Conferences Limited. Pp. 407–12.
Sami, L., Mari, T. and Tarja, M. (2004). *Professional Skills in the ICT Industry*. http://is2.lse.ac.uk/asp/aspecis/20040092.pdf [viewed 5 January 2009].
Scholarios, D., Van der Schoot, E. and Van der Heijden, B. (2004). *The Employability of ICT Professionals: A study of European SMEs*. http://www.e-innovation.org/stratinc/files/library/ict/36.ICT_SMEs.pdf [viewed 15 January 2009].
Scott, G. (2003), 'Using successful graduates to improve the quality of curriculum and assessment in nurse education'. Paper presented at the Australasian Nurse Educators Conference, Rotarua, New Zealand, September 2003.
Seymour, L., Scott, E., Malamoglou, S., Meyerowitz, J. and Morar, A. (2006). 'Skills learnt during a systems development course: graduate perceptions of skills transfer and industry alignment'. *Information Systems Education Journal*, 4(85), pp. 3–13. http://isedj.org/4/85/ISEDJ.4(85).Seymour.pdf [viewed 22 January 2009].
SFIA (Skills Framework for the Information Age) (2008). http://www.sfia.org.uk/ [viewed 30 October 2008].
Sheard, J., Carbone, A., Markham, S., Hurst, A.J., Casey, D. and Avram, C. (2008). 'Performance and progression of first year ICT students'. Tenth Australasian Computing Education Conference (ACE2008), Wollongong, Australia, January 2008. *Conferences in Research and Practice in Information Technology*, vol. 78, S. Hamilton and M. Hamilton (eds), pp 119–127
Skilling Australia for the Future (2008). Department of Education, Employment and Workplace Relations. http://www.productivityplaces.deewr.gov.au/NR/rdonlyres/1FB46BC3-1F99-4053-BDBF-363DC5450067/20903/SAFF_discussion_paper_020408.pdf [viewed 3 October 2008].
Skills Australia (2008). http://www.skillsaustralia.gov.au/ [viewed 24 September 2008].
Skills Australia Act 2008. 'An Act to establish Skills Australia, and for related purposes'. http://www.dest.gov.au/NR/rdonlyres/1D366F77-7E54-4FA2-BB9F-641D0ECDAAAC/21425/SkillsAustraliaAct2008.pdf [viewed 3 October 2008].
SmartONE Victoria. http://www.education.vic.gov.au/ [viewed 29 September 2008].
Staff Writers, ZDNet Australia (October 2004). 'Offshoring on the rise: Meta'. http://www.zdnet.com.au/news/business/soa/Offshoring-on-the-rise-Meta/0,139023166,139162045,00.htm?feed=pt_outsourcing [viewed 31 October 2008].
Still, L.V. (2006). 'Gender, leadership and communication'. In *Gender and Communication at Work*, M. Barrett and M. Davidson (eds). Ashgate Publishing, Ltd. Pp. 183–94.
Stucky, W. and Weiss, P. (2008). 'E-Skills and Standards – Prerequisites to fully exploit the potential of ICT in Europe'. In *Information Systems and e-Business Technologies*, R. Kaschek, C. Kop, C. Steinberger and G. Fliedl (eds). Springer Berlin Heidelberg. Pp. 306–17.
Sumner, M. and Yager, S.E. (2008). 'An investigation of preparedness and importance of MIS competencies: research in progress'. *Proceedings of the 2008 ACM SIGMIS CPR*

Conference on Computer Personnel Doctoral Consortium and Research, pp. 97–100. http://portal.acm.org/author_page.cfm?id=81100123452 [viewed 11 September 2008].
TAFE NSW. https://www.tafensw.edu.au/howex/servlet/Course?Command=GetSpecialistCourses&SponsorNo=2385 [viewed 30 September 2008].
TAFE Victoria. http://www.tafe.vic.gov.au/TAFECourses/ [viewed 30 September 2008].
Taft, D.K., (2007). 'Programming grads meet a skills gap in the real world'. http://www.eweek.com/article2/0,1895,2178319,00.asp [viewed 15 November 2008].
Tan, G. and Venables, A. (2008). 'Survival mode: the stresses and strains of computing curricula review'. J*ournal of Information Technology Education: Innovations in Practice*, 7, 33–43. http://informingscience.org/jite/documents/Vol7/JITEv7IIP033-043Tan429.pdf [viewed 15 November 2008].
Tannen, D. (2001). 'What do you mean? Women and men in conversation'. In *Down to Earth Sociology Introductory Readings* (11th edition), J.M. Henslin (ed). New York Free Press. Pp. 168–73.
Taranto, J. (2008). 'Difficult times inspire ICT industry'. http://www.cebit.com.au/press/media-coverage/144-difficult-times-inspire-ict-industry.html [viewed 3 February 2009].
Trowler, P. and Wareham, T. (2008). *Tribes, Territories, Research and Teaching: Enhancing the teaching–research nexus*. The Higher Education Academy, York, UK. http://www.heacademy.ac.uk/assets/York/Trowler_Final_Report.pdf [viewed 20 October 2008].
Tucker, A.B. and Wegner, P. (1996). 'Computer science and engineering: the discipline and its impact'. In *The Computer Science and Engineering Handbook*, A.B. Tucker (ed). CRC Press, pp 836–845.
Turcotte, J. and Rennison, L.W. (2004). *Productivity and Wages: Measuring the effect of human capital and technology use from linked employer–employee data*. Working Paper, Department of Finance, Canada. http://epe.lac-bac.gc.ca/100/200/301/finance/working_papers-ef/2004/01/wp2004-01e.pdf [viewed 13 January 2009].
Universities Australia (2008a). *A National Internship Scheme: Enhancing the skills and work-readiness of Australian university graduates*. Position Paper No. 3/08, May 2008. http://www.universitiesaustralia.edu.au/documents/publications/discussion/National-Internship-scheme-May08.pdf [viewed 6 January 2009].
Universities Australia (2008b). *Universities Australia Submission to the Review of Australian Higher Education*. http://www.universitiesaustralia.edu.au/documents/publications/policy/submissions/Bradley-Submission-July2008.pdf [viewed 16 October 2008].
Valenduc, G and Vendramin, P. (2005). 'Work organisation and skills in ICT professions: the gender dimension'. Paper presented at Conference ICT, the Knowledge Society and Changes in Work, Den Haag, 9–10 June 2005. http://www.talentendag.org/files.nsf/pages/NWOP_6CYE8P/$file/ICT_Valenduc.pdf [viewed 20 February 2009].
VITTA (Victorian Information Technology Teachers Association). http://www.vitta.org.au/ [viewed 30 September 2008].
Vu, L.N., Tan, T.K. and Maneerat, P. (2004). 'Incorporating open-source software development into computer science and software engineering education at university level'. *Proceedings of the Second Australian Undergraduate Students' Computing Conference*. http://www.cs.berkeley.edu/~benr/publications/auscc04/papers/vu-auscc04.pdf [viewed 17 January 2009].
Webster, J. (2007). *Diversity Management in the ICT Industry: Challenges and issues for social dialogue*. Report prepared for Union Network International. http://www.emf-fem.org/content/download/16930/180324/file/ReportFinal_DiscPaper_vers2_en.pdf [viewed 15 January 2009].

Weiss, P., Dolan, D., Stucky, W. and Bumann, P. (2006). *ICT-Skills Certification in Europe*. http://www.ictliteracy.info/rf.pdf/eSkills_Certification_final_report.pdf [viewed 15 January 2009].

Winterford, B. (2008). 'Aussie IT jobs market still buoyant'. http://www.zdnet.com.au/news/business/soa/Aussie-IT-jobs-market-still-buoyant/0,139023166,339292774,00.htm?ocid=nl_TNB_23102008_fea_l4 [viewed 23 October 2008].

Wood, J.T. (2005). *Gendered Lives: Communication, Gender, and Culture*. Thomson Wadsworth, Belmont, CA, USA.

Yen, D.C., Chen, H-G., Leea, S. and Kohc, S. (2003). 'Differences in perception of IS knowledge and skills between academia and industry: findings from Taiwan'. *International Journal of Information Management*, 23, 507–22.