Addressing ICT curriculum recommendations from surveys of academics, workplace graduates and employers

Final Report 2013

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Abbreviations and acronyms

ACDICT	Australian Council of Deans of ICT
ACED	Australian Council of Engineering Deans
ACS	Australian Computer Society
ACS BOK	ACS Body of Knowledge
AIIA	Australian Information Industry Association
ALTA	ACDICT Learning and Teaching Academy
ALTC	Australian Learning and Teaching Council Ltd.
AMT	Australian Mathematics Trust
ATN	Australian Technology Network
AUQA	Australian Universities Quality Agency
CBOK	Core Body of Knowledge
CDU	Charles Darwin University
CQU	Central Queensland University
DSS	Discipline Support Strategy
ECU	Edith Cowan University
EN	Education Network
FITT	Females in Information Technology and Telecommunications
FoEO2	Field of Education Information Technology
GAP	Graduate Attributes Project
IBL	Industry Based Learning
ICT	Information and Communication Technology
ITU	Innovative Technical Universities
NGUs	New Generation Universities

NICTA	National ICT Australia
OECD	Organisation for Economic Co-operation and Development
OLT	Australian Government Office for Learning and Teaching
OzWIT	Australian Women in Information Technology
RMIT	Royal Melbourne Institute of Technology
SFIA	Skills Framework for the Information Age
TEQSA	Tertiary Education Quality and Standards Agency
TRIL	Teaching-Research-Industry-Learning
UTS	University of Technology Sydney
VU	Victoria University
WEI	Work Experience in Industry
WIL	Work Integrated Learning

Executive summary and recommendations

Introduction

This project is based on selected Recommendations of the Information and Communications Technology (ICT) scoping study (Koppi and Naghdy, 2009), in particular: improving community perceptions of the ICT profession (Recommendation 2); understanding students better in relation to attrition, women in ICT and gender-inclusive pedagogy (Recommendation 4); further investigations of work integrated learning (Recommendation 6); and improving the understanding between the teaching-research-industry-learning nexus (Recommendation 8).

The project team of this current project funded by the Australian Learning and Teaching Council Ltd. formulated those Recommendations into five key project areas:

- Perceptions
- Attrition
- Gender
- Teaching-Research-Industry-Learning nexus
- Work Integrated Learning.

These areas are interrelated in numerous ways to different degrees and have multiple curriculum implications; for example, the connection between teaching and industry is influenced by the actual and perceived value that it brings to students and therefore influences work integrated learning approaches. Likewise, the relatively high rate of attrition of male and female students from ICT courses (in a climate of large skills shortages in industry) is linked to their university experience, which is influenced by their perception of the relevance of their studies to the workplace. The male-dominated culture of ICT in OECD countries is propagated by public perceptions and consequent practices in education and industry, some of which impact adversely on the enrolments of female students.

Each of the five project areas was led by a member of the project team and investigated by consulting (through surveys or directly in person) academic leaders of ICT education and industry professionals. Students who had discontinued their ICT course were also consulted. The main findings from each project area are summarised here before conclusions and recommendations pertinent across the five areas are presented.

Perceptions

A considerable body of prior and more recent evidence indicates that poor perceptions of the ICT industry and profession are having a severe impact on the quality and quantity of people being attracted to ICT careers. Consequently, surveys of a range of ICT industry professionals (about 130 responses) and academic leaders (22 responses) were carried out to verify this impression and to identify remedial promotional and outreach activities that may help build the right image.

Both groups reinforced the need for improving perceptions of ICT professions and raising the professional profile of ICT in a number of ways. The success and value of greater coordinated industry-oriented profile-raising was identified, as was collaboration between industry, academe and government.

The key issues resulting from the surveys are:

- a lack of knowledge/understanding of how different factors actually affect ICT enrolments
- collaborative activities between natural competitors (for students and graduates) are effective
- the concept of the "ICT profession" (really comprising a number of ICT professions) is complex, deriving at least in part from its multifaceted nature, and is neither well specified, communicated to, nor understood by the public
- improved understanding and perception of ICT is needed in terms of social and industrial benefit rather than in academic or technical terms.

It is concluded that Australian-based initiatives in response to the findings of this report have the opportunity to set an example of global impact and benefit.

Attrition

The survey addressed to the 2868 students who had left their ICT courses from the four partner institutions during 2005 and 2010 yielded 154 responses and revealed that there are many factors that contribute to the attrition of ICT students, only some of which are beyond the control of universities.

Many ex-students cited reasons for leaving that were associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. An issue associated with the university environment was the difficulty in obtaining help when required, including support during the difficult transition from school to university and when students needed to make changes to their enrolment because of other changes in their lives.

The major course-related issues that contributed to withdrawal were associated with the style of teaching and the nature of the ICT course. Some of the issues identified include boring classes, teaching too fast, and poorly explained exercises. Similarly, continuing ICT students reported low levels of enriching educational experiences and higher order thinking (ACER, 2010). Suggested improvements in the ICT education literature include increasing the use of small group class activities (Barker et al., 2009; Powell, 2008) for more active learning to alleviate boredom (Schweitzer and Brown, 2007). Increasing interaction between students and with teaching staff would also promote feelings of belonging and a supportive environment.

ICT graduates also reported that courses lacked a workplace or business focus and also a practical application (Koppi et al., 2010). Improving the relevance and context of ICT teaching can be achieved by a variety of means such as case-based teaching (Mukherjee, 2000; Weng et al., 2010); providing forms of work integrated learning; and team-based projects that address industry or community problems. Ensuring that students perceive the relevance of coursework may provide the incentive to continue under other adverse conditions.

A perception that they did not have the expected background knowledge influenced some students' decisions about withdrawal, as also reported by Barker et al. (2009). Implementing alternate pathways can provide the opportunity to develop the skills and confidence to be successful, particularly in addressing the attrition of female students who believe that they do not have the necessary background (Powell, 2008). Other strategies that have had success in improving female student retention include ensuring a gender balance amongst teaching staff and providing mentoring (Cohoon, 2001).

Gender

There is a gender imbalance in ICT in academia and industry, and female enrolments are 25% or less than that of males in university ICT degrees. Males dominate academia and industry, and the culture is acknowledged to be masculine with uncertainty as to whether or not the university ICT curriculum is gender inclusive, as revealed by a survey of 46 academic staff who are considered to be representative of the sector.

A significant proportion of the ICT academics surveyed (assumed to be predominantly males) appreciated that there are different gender perspectives and interests in ICT between males and females. However, most felt that this awareness had not translated into a gender-inclusive curriculum because of uncertainty as to what such a curriculum would entail. A strong desire was expressed for informed guidelines on developing a gender-inclusive curriculum for ICT.

The discipline of engineering has a similar gender imbalance, and conclusions from their research indicate that a comprehensive approach to curriculum design needs to be adopted to make it more inclusive, and that emphasis should be more on inclusivity rather than on gender alone (Mills et al., 2010). Such comprehensive revision is likely to be protracted because of innate conservatism and the slow pace of curriculum change in the ICT sector (Gruba et al., 2004).

Perhaps female enrolments will not reach parity with that of males until the general public perception of ICT is one that caters for all interests in an inclusive environment. While there is this imbalance, responses from 132 industry ICT professionals indicate their support for addressing gender issues in the curriculum to help prepare graduates for the workplace.

Teaching-research-industry-learning (TRIL) nexus

A review of both the general and ICT-specific relevant literature provided the basis for understanding the varied ways in which the TRIL connections can be forged. The opinions of

ICT academic leaders (22 survey respondents) and those working in industry (up to 181 respondents) were also explored. There are numerous possible connections between the four components, and the greater the connections, the richer the potential learning experience for all participants.

The academic teacher plays a key role in the TRIL nexus with the potential to make the most connections. The results of the survey of Australian ICT academic leaders show that when their research is brought into teaching, it enriches students' understanding of subjects and stimulates their interest and enthusiasm. ICT academic leaders strongly believe that there are important benefits to students and staff from strengthening the industry component of the TRIL nexus. The industry participants in the study mirrored this sentiment.

Analysis of the literature on various components of the TRIL nexus has revealed several strategies for reaping the benefits associated with strengthening the connections. The various approaches need to have a holistic and integrated perspective of the TRIL components that includes the whole curriculum. The student experience should include that afforded by the broad aspects of professional practice and research that encompasses enquiry, and fundamental and applied research that involves industry wherever possible. The academic experience should include the same affordances as well as engaging with industry practitioners for learning and teaching purposes and learning more about industry needs.

Work integrated learning (WIL)

The results of the university survey of senior ICT academic staff and forum discussions with associate deans (or equivalent) of ICT learning and teaching (a total of 52 responses from academia) indicate that universities value WIL highly and employ a range of practices from industry placement to simulated WIL experiences within the university, such as project work and case studies. Resources, priorities, student capabilities and interests, and relations with local industries influence the models practised, as well as Accreditation Guidelines (ACS, 2009) that require authentic learning experiences.

From our study, academics and industry hold different views on what constitutes an authentic WIL experience. Universities support the development of virtual or simulated models, particularly where direct experiences are difficult to achieve, whereas the results of the industry survey (a total of 182 responses from industry professionals) indicate that industry values more direct experience within a workplace.

Findings from the university and industry surveys indicate that a successful WIL experience provides students with an improved understanding of professional responsibility and the attainment of generic skills which are strongly valued by industry. Industry also valued the development of technical skills and work readiness as products of a WIL experience. Academics, on the other hand, were more concerned with a holistic education and a focus on lifelong learning rather than producing work-ready graduates. This issue was recognised as an "expectations gap" in the ALTC WIL Project (Patrick et al., 2008) that recommended an integrated consultative stakeholder approach to WIL developments.

It seems that both academia and industry have an outcomes-focused approach and that differences in agreement are concerned both with the nature of the outcomes and with the teaching methods to achieve the desired outcomes.

This movement towards outcomes-based education (as with engineering education) may promote a common understanding of the value of the full spectrum of WIL models because there is less focus on the teaching methods. The outcomes-based approach encourages diversity and innovation in delivery and has brought significant benefits to engineering education (Palmer and Ferguson, 2008).

The development of clear outcomes-based learning objectives with the support of all stakeholders – including universities, industry, professional bodies, industry associations and particularly students – will provide the basis for the development of a range of external models (e.g. internships and community projects) and internal models (e.g. case studies and industry-linked projects) of WIL. Authenticity of professional practice experiences can then be objectively evaluated according to the actual outcomes rather than perceptions.

Such an outcomes-based approach is similar to the current Engineering Australia accreditation requirements for professional engineering degrees (EA, 2008) that require "a minimum of 12 weeks of experience in an engineering-practice environment (or a satisfactory alternative)". This broad stakeholder acceptance of authentic alternative exposure to professional practice provides an outcomes-based approach that can accommodate university and student diversity.

Recommendations

Each project area (chapter) contains its own recommendations; this section is concerned with presenting the recommendations that overlap to varying degrees, or express a specific need revealed by survey findings, and hence are those concerning the project as a whole.

Recommendation 1: learning and teaching approaches

To encourage student engagement, the learning and teaching methods should include:

- frequent references and demonstrations as to the relevance to industry and society of subject material being taught
- adequate support for students who may not have the necessary background collegial and interactive environment between students and between staff and students.

Recommendation 2: collaborative learning and teaching interactions

To maximise benefits to students, academic staff and industry, there must be a means to:

- improve interactions between teaching and research and the needs of industry
- provide professional practice experiences to students in relation to needs identified collaboratively by academia and industry.

Recommendation 3: clarifying authentic learning experiences

A concerted effort between academia, industry and the accrediting body for ICT courses/degrees needs to be organised to develop mutually acceptable practices and outcomes that constitute authentic and verifiable learning for professional practice experience.

Recommendation 4: inclusive curriculum

An investigation is required to identify best practices in the provision of an inclusive (including gender) ICT curriculum to develop inclusive ICT curriculum guidelines to meet the needs expressed by ICT teaching staff.

Recommendation 5: a whole of curriculum approach

To be effective, the implementation of Recommendations 2–4 requires a whole curriculum approach – in collaboration with industry – to ensure comprehensive synergy between the desired interactions and learning outcomes and to provide the students with clear, relevant learning activities.

Recommendation 6: collaboration for improving perceptions

Academia and industry must collaborate to improve the general perceptions of ICT by clearly defining the many ICT professions and emphasising the social benefits in order to improve general ICT standing in the community and increase student enrolments. The observed collaboration between industry and academia that indicates integration between the professions is important in influencing how current students perceive ICT.

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Authors: Tony Koppi and Madeleine Roberts

Background, origins and project ramifications

The project was a follow-on project from recommendations made by Koppi and Naghdy (2009) in the ALTC-funded ICT scoping project. The outcomes of that project and those of a parallel ALTC-funded scoping project for Engineering (King, 2008) have led to productive and useful associations and networks as summarised in Figure 1. The network connections indicated have contributed to the evolution of this project (shaded in Figure 1) which has in turn had an impact in several areas.

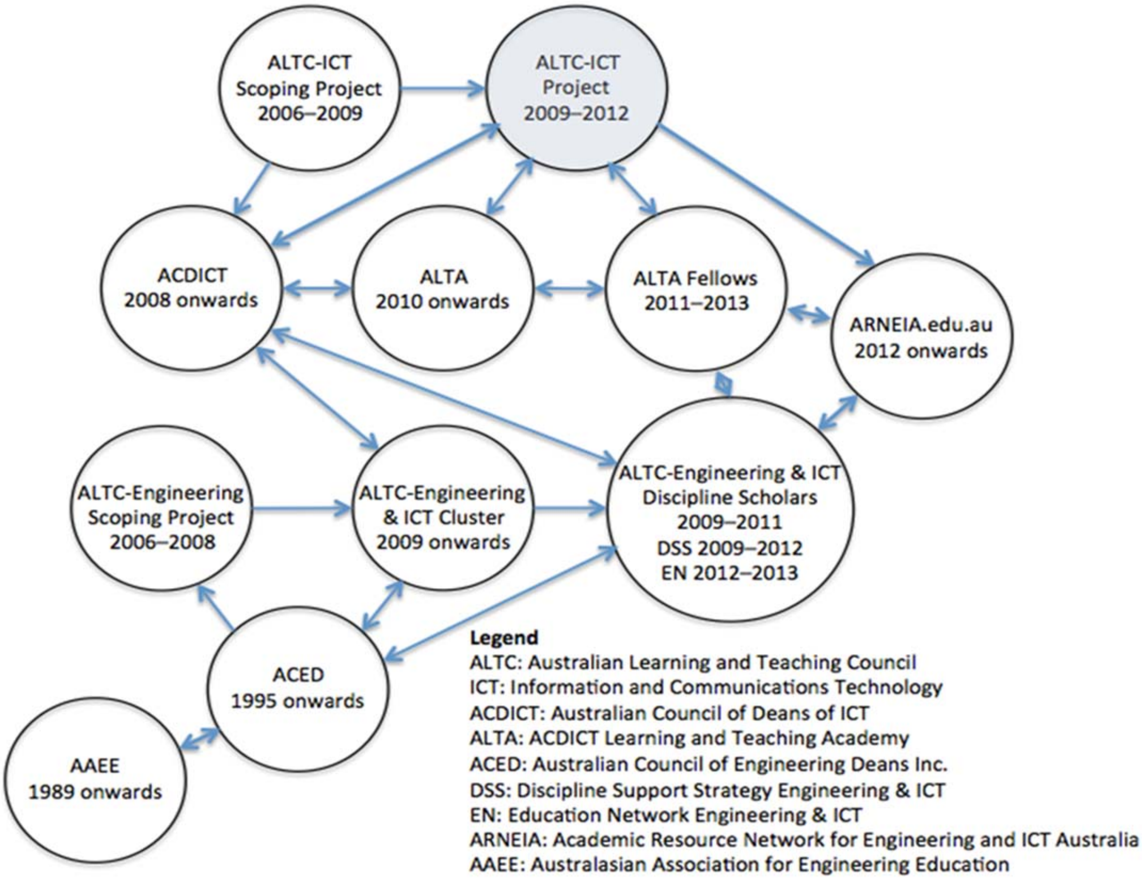

Figure 1 The origin of the current project, network connections and associated outcomes

Figure 1 shows that during the ALTC-funded ICT scoping project, the Australian Council of Deans of ICT (ACDICT: <acdict.edu.au>) was formed. This resulted from consultations with academic leaders of ICT at numerous institutions, all of whom were concerned about the fragmented nature of ICT and perceived the benefit of a peak academic body which could represent the numerous disciplines comprising the ICT spectrum. ACDICT subsequently created the ACDICT Learning and Teaching Academy (ALTA), members of which have contributed to the current project which has been the subject of learning and teaching workshops at ALTA forums. Members of ACDICT have also contributed directly to the current project via survey responses and individual contributions, and ACDICT members have been informed of project outcomes.

With support from the Discipline Support Strategy (DSS) and Education Network (EN) of the Engineering and ICT cluster created by the ALTC, ALTA created four ALTA Fellowships and the recipient of each has a project for two years to help promote learning and teaching amongst the ICT higher education community. Two of the ALTA Fellows (supported by the other two Fellows) will be working specifically on outcomes related to the current ALTC project that is the subject of this report. The Engineering and ICT cluster and DDS and EN projects are also supported by ACDICT and ACED (Australian Council of Engineering Deans). (The two Councils have a Memorandum of Understanding for onging mutual support in enhancing learning and teaching.) An outcome of the DSS project, and to which the current project has contributed, is the Academic Resource Network for Engineering and ICT Australia (<arneia.edu.au>) which will be used by the ALTA Fellows and the Engineering and ICT learning and teaching community.

As Figure 1 indicates, the outcomes of the ICT and Engineering scoping projects (both begun in 2006) have led to considerable and far-reaching ongoing ramifications – including this project – that are of potential benefit to the ICT and Engineering higher education community.

Context

This project is based on selected recommendations of the scoping study reported by Koppi and Naghdy (2009). Recommendation 2 was concerned with improving community perceptions of the ICT profession. The present project team felt that further research was required into perceptions of the ICT profession amongst academia and industry. Recommendation 4 was concerned with understanding students better in relation to attrition, women in ICT and gender-inclusive pedagogy. Recommendation 6 was concerned with further investigations of work integrated learning, and Recommendation 8 was concerned with improving the understanding between the teaching-research-industry-learning nexus.

Based on those selected recommendations from the Koppi and Naghdy (2009) report, and deliberations amongst the present project partners, five project areas were chosen:

- Perceptions
- Attrition
- Gender
- Teaching-Research-Industry-Learning nexus
- Work Integrated Learning.

These five areas (elaborated on further below) each have curriculum implications and are interrelated in many different ways; for example, the rate of attrition and apparent masculine culture in the workplace would influence the perception of ICT; and the relationship of ICT teaching and learning with industry would also influence the perception of ICT as a profession. This report demonstrates the interrelationships of the five areas as much as possible.

ICT enrolment trends are presented first because they are a major concern of academia and industry and provide relevant contextual information as well as reflecting the status of ICT in relation to the needs of industry and the Australian economy. These data are also indicative of the general perceptions of ICT and the desirability for study of the spectrum of disciplines comprising ICT, as well as indicating the capability of the sector to respond to change.

Enrolments

There is a crisis in ICT because of falling enrolments since the early part of the millennium (Australian Government, DEEWR, 2011) and the related skills shortage (NICTA, 2007). In 2010, the total number of students enrolled in "Information Technology" in all Australian universities was 5.1% less than in 2009 (DEEWR, 2011). The ACS (2008) identified a shortfall of 28,488 ICT staff for 2008 and projected a massive increase on this shortfall over the following decade. The more recent ACS (2011) Statistical Compendium supports these predictions.

Table 1 Recent national enrolment trends for all students in ICT by numbers and gender (based on DEEWR (2011) data)

Year	Female	Female % of total	Male	Total
2001	7,902	26.8%	21,544	29,446
2002	7,859	24.9%	23,670	31,529
2003	6,223	22.5%	21,336	27,559
2004	5,132	19.6%	20,926	26,058
2005	4,173	19.7%	16,981	21,154
2006	3,488	19.1%	14,797	18,285
2007	3,451	18.9%	14,772	18,223
2008	3,983	20.5%	15,383	19,366
2009	4,160	20.2%	16,411	20,571
2010*	3,905	20%	15,621	19,526

* Gender split not supplied by DEEWR and based on 20% female share of total

Table 1 provides information on enrolment trends by gender. These data are expressed graphically in Figure 2 and suggest that the decrease in enrolments experienced in the first half of the decade appears to have ended, even though there was a small decrease from 2009 to 2010.

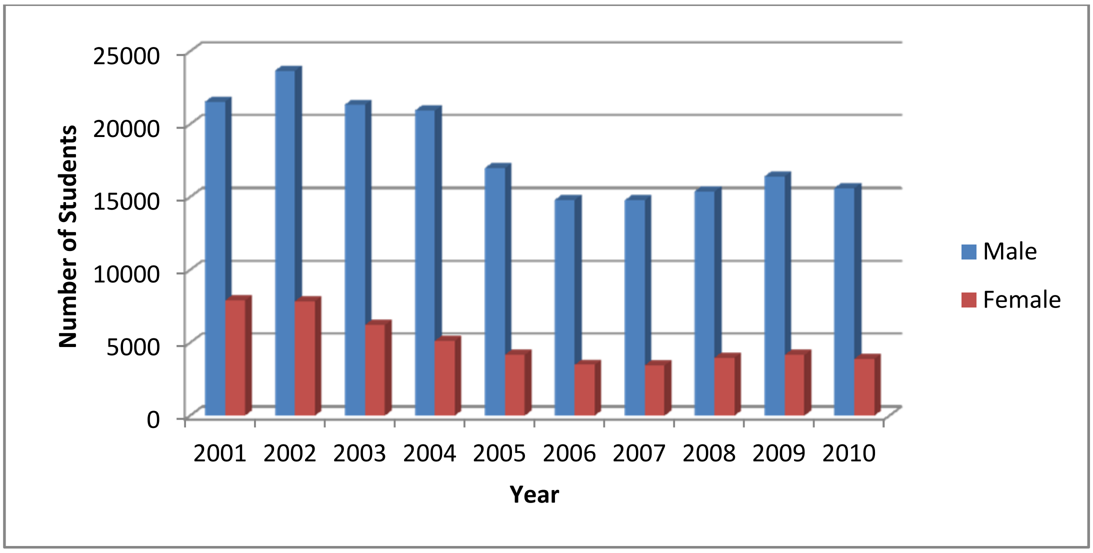

Figure 2 Total ICT enrolments 2001–2010 shown by gender (based on DEEWR (2011) data)

Figure 2 also clearly shows that males dominate enrolments in ICT. This male domination carries over into the workplace (e.g. ACS (2011)) and is a chronic characteristic of ICT in academia and industry in the Western world, along with the general decline in enrolments, for example, as shown by the similar pattern of United Kingdom ICT enrolments in Figure 3.

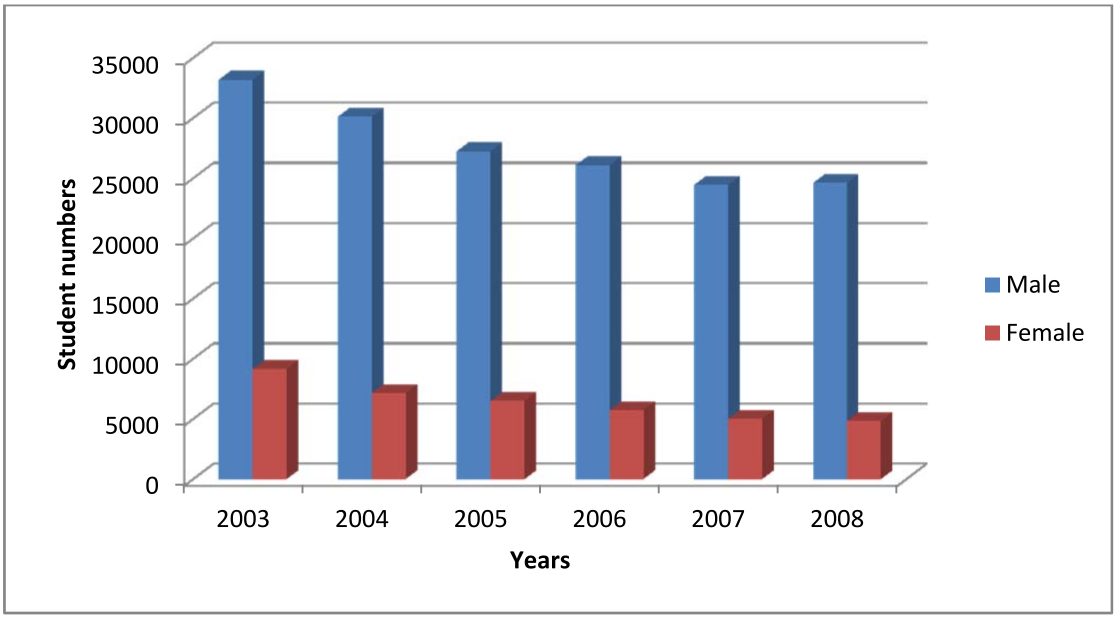

Figure 3 United Kingdom ICT enrolments (data from HESA, 2010)

Outreach programs to increase enrolments in ICT

There have been numerous attempts to reverse the downturn in interest in ICT, but the evidence for success is difficult to find. The following are examples of both local and national programs and events aimed at attracting the interest of students:

- National ICT Careers Week "Start Here, Go Anywhere" campaign (Multimedia Victoria, 2011)
- NICTA (National ICT Australia) School Outreach program and sponsorship of National Computer Science School (National ICT Australia Limited, 2011)
- AMT (Australia Mathematics Trust) Australian Informatics Olympiad (Australian Mathematics Trust, 2012)
- Victorian Government (VICT) Skills Initiatives (Victorian Government, 2012)
- Queensland Government "Learning Place" initiative (Queensland Government, 2011) which includes the "Cyber Sisters" program of female high school students mentoring female primary school students
- Swinburne's Year 11 & 12 Holiday Program (Swinburne University of Technology, 2011)
- The University of Queensland's "ICT Connects" and "Robotics" workshops (University of Queensland, 2012)
- The University of Wollongong's "iPhone App" workshop (University of Wollongong, 2009).

The following are examples of overseas trends and outreach activities aimed at increasing enrolments in ICT; likewise with limited or no evidence of success:

- UK government's 3-year "More Maths Grads" project launched in 2007 (HEFCE, 2010); and the Research Councils UK's "Researchers in Residence" program established in 1995 and ended in January 2012 (Research Councils UK, 2012)
- The US Gary and Jerri-Ann Jacobs "High Tech High Learning Network" (High Tech High, 2010); and Harrisburg's "Sci-Tech High" feeder school for the newly established Harrisburg University (Sci Tech High, 2010)
- In Pakistan, the National ICT R&D Fund Scholarship Program (Ministry of Information Technology, Pakistan, 2010a), and Outreach Scholarship Program (Ministry of Information Technology, Pakistan, 2010b) are aimed at training students and teachers from remote areas
- In Uganda, the Education Ministry's decision in 2008 to make Computer Science compulsory in secondary schools (Education Ministry, Uganda, 2009)
- In Dubai, the Zayed University partnership with Injazat to provide internships for ICT students (ICT Community Portal, 2012)
- The Singapore Government's "Infocomm Clubs" targeted at primary, secondary and junior college students (iDA, 2012).

There have also been outreach activities aimed at increasing female enrolments in ICT, again mostly with limited or no evidence of success, such as:

- Australia: "Digital Divas" (ACS, 2012); "Go Girl, Go for IT" (Victorian ICT for Women, 2012); "Go Go Gidgits" (Queensland Government, 2012); "Tech Girls are Chic! (not just geek!)" (Tech2morrow.org, 2012); FITT (Females in Information Technology and Telecommunications) presentations by career women at high schools (FITT, 2012)

- European Union: “Cyberellas are IT!” (European Commission, 2009) and “Gender-IT” (European Commission, 2012) projects
- US: Carnegie Mellon Summer Institute for Advanced Placement Computer Science Teachers (Margolis and Fisher, 2002) (an exceptionally successful program, as shown below); University of Illinois “Games4Girls” (University of Illinois, 2012); MIT “Women's Technology Program” (Massachusetts Institute of Technology, 2011); and the National Center for Women & Information Technology’s “Award for Aspirations in Computing” (NCWIT, 2012).

Although there have been many programs intended to increase student, and specifically female, enrolments in ICT, there is little or no evidence that these programs have been successful. An exception is Carnegie Mellon University, whose School of Computer Science increased its female student intake by 40% as a result of changes instigated by Margolis and Fisher (2002). Their documentation of the work done to change both the administrative criteria and the academic culture of the School of Computer Science puts the efforts of Carnegie Mellon in stark contrast to other programs intended to increase student enrolments. Craig (2010) recognised this failure of most programs and proposed an evaluation framework for existing and future outreach programs designed to attract women to the ICT discipline.

Introduction to the five project areas

In this report, each project area is presented as a stand-alone chapter with its own introduction, methods, findings, discussion and conclusions. A brief introduction and rationale to each project area is given here.

Perceptions

The *perception of ICT and the ICT professions* throughout the community is poor and erroneous (Koppi and Naghdy, 2009) and has a range of consequences including low enrolments, enrolment of less able students, few female enrolments, decreased teaching capacity, and a national skills shortage of ICT professionals. It seems ironic that a profession concerned with the ubiquitous use of ICT in society and its essential role in most businesses and widely-used everyday technologies that engage young people in ever increasing numbers needs to improve its image.

This project area examined general perceptions of ICT amongst academia and industry and any industry strategies for improving perceptions. Wherever enrolments of students in ICT have increased, the implication is that ICT is seen in a more favourable light and that perceptions have improved. Wherever possible, increased enrolments will be related to activities (such as outreach activities locally and overseas) that may have influenced perceptions of students or the people who influence the students.

Attrition

Academic staff generally felt that there was a deficiency in understanding students (Koppi and Naghdy, 2009). This lack of understanding includes their perception of and attitudes towards ICT; motivation in choosing to study ICT (or not); poor enrolment of women; participation and attendance in class; and relatively high attrition.

Declining enrolments *into* ICT courses is one side of the coin; the other side is the attrition of students *from* ICT courses. This project area is concerned with the reasons why students leave their ICT courses or programs; some attrition data are given in Figure 4 as part of the context of this project.

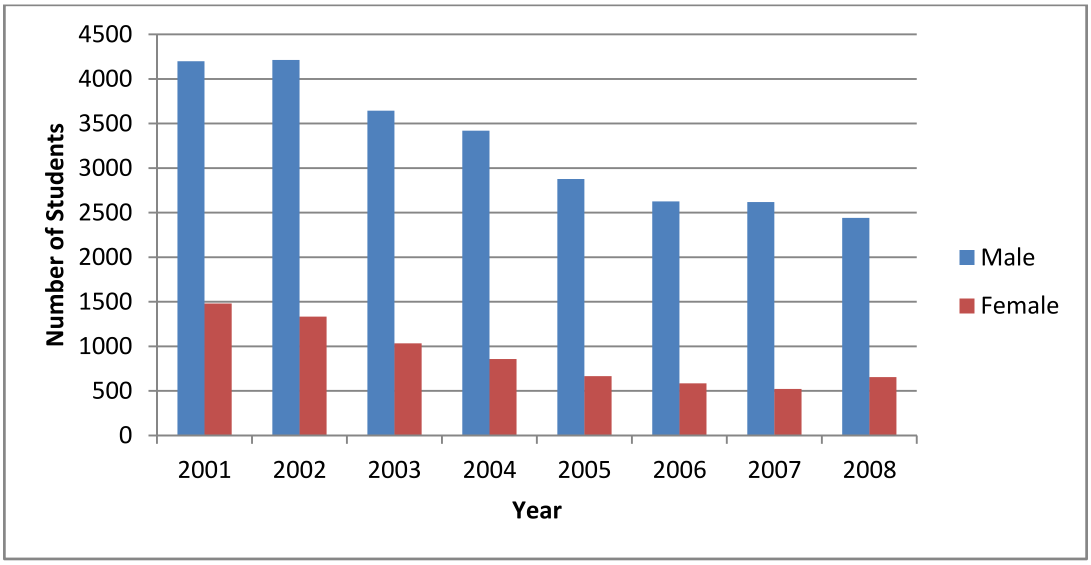

Figure 4 Attrition of ICT students from ICT courses or programs 2001–2008 (Data purchased by the project from DEEWR (2010))

As Figure 5 shows, the proportion of attrition based on number of commencing students is generally slightly greater amongst males.

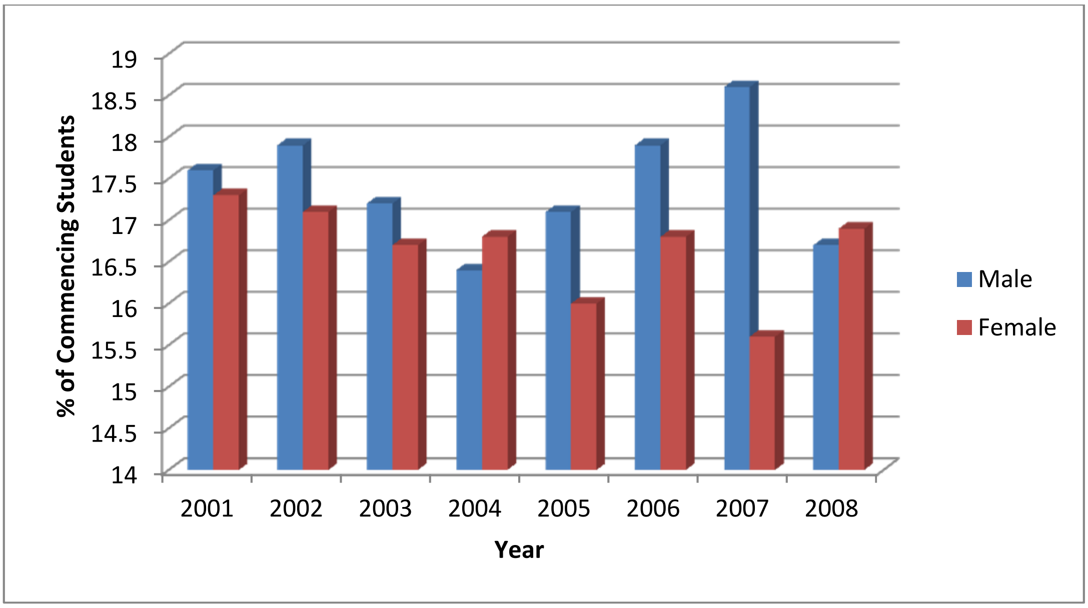

Figure 5 ICT attrition as percentages of commencing students (calculated from available DEEWR data)

There is general concern about high attrition rates from ICT, including that of women (Sheard et al., 2008), and a national study found Information Technology to have a greater attrition rate than the following fields of education: Engineering and Related Technologies; Natural & Physical Sciences; Medicine, Dentistry, Veterinary Science, Law; Health (excluding Dentistry, Medicine, Veterinary Science); and Management & Commerce (McMillan, 2005). For Engineering, King (2008) reported that the attrition rate is about 40% for women and nearly 50% for men. These data are comparable to a 40% attrition rate of women from computer science in 2003 at Victoria University (Miliszewska et al., 2006). Connolly and Murphy (2005) report an above average rate of 27% attrition from computer science in Ireland. The data given here in Figures 4 and 5 show that attrition from ICT is approaching 20% of commencing students, which is less than in the references cited here but nevertheless support the academic perception that attrition rates from ICT courses are high.

This project area focused on the reasons why students left ICT and gathered both quantitative and qualitative data on this via an online survey and either face-to-face or telephone interviews of former ICT students from the four partner universities.

Gender

As implied by the enrolment data given above, ICT is a male-dominated culture. Australian Women in Information Technology (OzWIT, 2006) reported 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) reported that there are less than 15% women in many ICT courses in Australia. Perhaps few women enrol in ICT because of the perceived masculine stereotype (Cory, Parzinger and Reeves, 2006), which is reinforced by stereotypical high school teacher behaviour (Dee, 2007). Anxiety and lack of confidence in using computers is more prevalent among women than men, even amongst experienced users (Beyer et al., 2003; Broos, 2005).

It seems that circumstances and feelings towards using computers, perhaps as a consequence of high school experiences, discourage women from taking up an ICT career. It follows that to encourage more women to take up ICT requires university outreach to high schools, and then once enrolled, it requires a university curriculum that is conducive to retaining women. This is problematic because ICT curricula are more biased towards masculine technology-centred topics rather than being more inclusive to social and human concerns (Lewis, McKay and Lang, 2006; Lewis, Lang and McKay, 2007), which would benefit all students.

Given such a discipline with many more males than females, the perception and application of a gender-inclusive curriculum amongst academic staff were investigated in this project area. This project area was also concerned with identifying any outreach activities amongst Australian or overseas universities that have led to greater enrolments by women in ICT.

Teaching-research-industry-learning nexus

Many ICT academics have considered the *Teaching–Research–Industry–Learning (TRIL) nexus* to be important from a variety of perspectives, yet it was not able to be clearly articulated, nor were the implications clear in relation to teaching practices which were seen as needing improvement (Koppi and Naghdy, 2009).

While the TRIL nexus may seem somewhat esoteric, the relationship and functioning of the components are very relevant to the curriculum and student experience. Graduates in the workplace and industry leaders strongly advocated more workplace experience. The attainment of that goal realistically requires a holistic approach whereby teaching, research, industry and learning in ICT are considered together. In this context, "research" is concerned with all aspects of academic and industry research in the discipline, including educational research. Greater cooperation between academia and industry that includes teaching and research (e.g. industry-based research projects involving students) would benefit the learning of all participants. Healy (2009) illustrates the concerns of peak business bodies that want closer links with academia in regard to the development of graduate capabilities. This project area clarifies the interrelationships of the TRIL nexus in the ICT context.

Work integrated learning

The term "Work Integrated Learning" (WIL) is now commonly regarded as an umbrella term that covers a "range of approaches and strategies that integrate theory with the practice of work within a purposefully designed curriculum" (Patrick et al., 2008).

The *lack of real-world experience* felt strongly by recent ICT graduates in the workplace was also one of the main concerns of ICT employers (Koppi and Naghdy, 2009). High on the list of concerns from employers was that students should gain workplace experience as part of their study. Other investigators also found that employers wanted ICT recruits with workplace experience or work-oriented skills, even if they had only just graduated (Hagan, 2004; Pauling and Komisarczuk, 2007; Kennan et al., 2008).

There was a significant mismatch between what the graduates in the workplace considered important abilities for their work and how they perceived universities had prepared them for those abilities (Koppi and Naghdy, 2009). Furthermore, a major concern from all three perspectives (academics, graduates and industry) was the lack of industry involvement in the design and implementation of the curriculum.

This project area focused on WIL and the student professional practice experience in an attempt to describe and reconcile the academic and industry positions.

Intended deliverables and actual achievements

For each of the five project areas, the project team designed the project approach, methodology and surveys, and each project area had a dedicated individual or team. Each project area has a report which is presented as a chapter of this report.

Table 2 Deliverables intended at the project outset and summary of subsequent achievements

Deliverables intended	Achievements
1. Industry contributions to improve perceptions of ICT	Derived from a survey of ICT professionals in industry
2. Recent national enrolment trends in ICT by numbers and gender	Derived from DEEWR data
3. Outreach programs linked to increased enrolments in ICT	Literature surveys and questionnaires revealed the kinds of outreach activities being undertaken and their perceived success
4. Overseas trends and outreach activities linked to increasing enrolments in ICT	Identified from the literature
5. National attrition rates for ICT courses	Gathered from DEEWR data for all Australian universities and the Registrars (or equivalent) from the four partner institutions
6. Reasons for leaving ICT from a survey of students	Identified from a survey of students from the four partner institutions who had left their ICT course or program
7. Outreach activities leading to greater enrolments by women in ICT	Gathered from surveys of Australian ICT academics, and the literature
8. Gender-inclusive ICT curricula: theory and practice	Perceptions of a gender-inclusive ICT curriculum obtained from a survey of Australian ICT academics
9. ICT industry position paper on curriculum design and delivery	The industry position was derived from a survey of ICT professionals rather than a paper prepared by ICT industry representatives
10. ICT industry position paper on work integrated learning	Derived from a survey of ICT industry professionals and the published Australian Computer Society position rather than a paper prepared by ICT industry representatives
11. Policy and practices (including assessment) in WIL in the university ICT sector	Derived from a survey of ICT academics

12.	The Teaching–Research–Industry–Learning nexus concept amongst academic leaders of ICT, and implications for practice	Compiled from an extensive literature search and a survey of ICT academics

Table 2 shows the deliverables that were intended at the project outset and the subsequent achievements. All of the intended deliverables have been addressed to a greater or lesser extent. The achievements summarised in Table 2 are detailed further in the chapters for each project area.

Surveys

Each project area employed one or more surveys, as indicated in Table 3, to address the selected recommendations (noted above) from the Koppi and Naghdy (2009) report and issues considered important by the present project team.

Table 3 Surveys for each project area

Project area	Survey respondents
Perceptions	• Members of the Australian Council of Deans of ICT (ACDICT)[1] • ICT industry professionals[2]
Attrition	• Students who had left ICT[3]
Gender	• Members of the Australian Council of Deans of ICT (ACDICT) [1] • Associate Deans for Learning and Teaching (or their equivalent) in ICT[1] • ICT industry professionals[2]
Teaching-Research-Industry-Learning nexus	• Members of the Australian Council of Deans of ICT (ACDICT) [1] • ICT industry professionals[2]
Work Integrated Learning	• Members of the Australian Council of Deans of ICT (ACDICT) [1] • Associate Deans for Learning and Teaching (or their equivalent) in ICT[1] • ICT industry professionals[2]

[1]Survey 1
[2]Survey 2
[3]Survey 3

The survey respondents shown in Table 3 were given the same survey (as indicated by the superscript) with multiple components addressing each particular area, and the survey for the Deans and Associate Deans was the same; there were thus three different surveys employed in the project. The surveys used questions with multiple-choice responses and open-ended text questions. The relevant issues, questions, responses and analysis of each survey are given in the respective project area chapter.

CHAPTER 1: Perceptions of ICT

Author: Paul Bailes

Background

The “Attrition” chapter of this report documents the growing global shortage of ICT professionals. KPMG Econtech (2012) summarises the Australian situation, stating, *inter alia*, “The winners in the Australian job market in this past quarter were managers in corporate services and advertising and sales, and professionals in engineering and ***ICT*** as demand for their skills continues to outstrip availability of the right people” (author’s emphasis).

As noted by Koppi and Naghdy (2009), one factor plausibly contributing to this shortfall could be poor perceptions of the ICT industry/profession by those with the potential to undertake ICT careers, particularly potential recruits into university programs. Studies of the perceptions of high school students in respect to ICT and an ICT career reveal that the nature of ICT work is not accurately perceived (Multimedia Victoria, 2004; 2007).

ICT programs have been identified as having relatively low appeal to the highest-achieving students, at least in Australia, being compared with teacher education in terms as follows: “along with information technology with 5.9 per cent of offers for those with ATARs below 50, were the least popular subject areas for high-achieving students. Only 5 per cent of offers for students with 90 or above were for teaching and 7.3 per cent for IT” (Hare, 2012). See also Head (2012). This compares unfavourably with some other jurisdictions, particularly in developing economies, where ICT attracts an academic elite for reasons yet to be determined, though it’s easy to speculate that ICT may be seen as a metaphor for a comprehensive “developed” lifestyle, and an ICT qualification as a pathway to a prestigious and prosperous career either at home or abroad. By comparison, in a developed economy such as Australia, pathways to prosperity abound.

This chapter aims to help understand the factors contributing to poor perceptions of ICT and how they might be resolved. Addressing each of academic and industry perspectives, it first summarises the responses of surveys of key individuals and then analyses them. In the course of these analyses, and based upon them, it then makes recommendations for further action.

Methods

The aim of this project team was to obtain an understanding of the representative view held by leading Australian ICT academic staff and industry figures about perceptions of ICT: the need for improved perceptions; what benefits might result from improved perceptions; and how these improvements might be effected. This was achieved by surveys of the foregoing populations.

The academic leader of ICT in each of the 38 Australian universities belonging to the

Australian Council of Deans of ICT (ACDICT) was contacted to participate in a survey designed by the project team. Ultimately, 22 responses were received from 18 universities (a few universities provided responses from different ICT areas), and these are taken as providing a representative view of ICT from the perspective of those leading the discipline and guiding the development and teaching of ICT in higher education in Australia.

The industry professionals surveyed consisted of ACS members and Industry Advisory Board members for ICT at the four partner institutions. A combination of paper-based and online surveys (designed by the project team) were used to survey Advisory Board members, and a total of 68 responses were received from them. A request on the ACS homepage and an emailed branch newsletter asked ACS members in the workplace to complete an online survey (designed by the project team); a total of 114 responses were received from ACS members, making a total of 182 responses from ICT industry professionals. However, the total number of responses to specific questions relating to the Perception component of the surveys differed throughout the survey, and the numbers of responses to specific questions are given in the relevant tables.

Academic perceptions: findings and discussion

The 22 responses to the survey of leading academics were received from a diversity of sources which heightens confidence in the authority of the information:

Some universities submitted multiple responses (from the several org. units engaged in ICT teaching), e.g. from Wollongong, responses were received at least from schools of Maths & Applied Stats; Electrical, Computer and Telecommunications Engineering; and Informatics. An anonymous regional university appears to have submitted three responses, from Maths & Computing; Information Systems; and Network Telecoms.

- Members of the Go8 to respond included, at least, Melbourne; Monash; Queensland (apparently); Sydney.
- Members of the former ITU (Innovative Technical Universities) group to respond included CDU; Murdoch; and Newcastle.
- Members of the ATN (Australian Technology Network, of former metropolitan institutes of technology) to respond included RMIT and UTS.
- NGUs (New Generation Universities) to respond included CQU; ECU; and VU.
- Regional universities to respond included, at least, CDU; CQU; and the anonymous multiple respondent cited above.

Academic perceptions of the current situation

Academic leaders were asked three questions reflecting their impressions on successes to date and standing challenges pertaining to the perception-raising problem. The first question was concerned with undergraduate enrolment numbers and the results are given in Table 4.

Table 4 Total domestic undergraduate enrolment numbers given by the academic respondents

	Number/22 total	%
Steady	11	50
Falling	4	18
Increasing	6	27

This question sets the broad context for the "perceptions" problem. In the light of the post-2000 decline in enrolments with only limited subsequent regrowth, the lack of strong signs of current increasing enrolments at least partially corroborates the underlying premise that for some reason, ICT is not as attractive to students as it should be – that is, as it once was.

The raw impressions presented, however, highlight a number of possible questions/issues for further analysis/research including:

a) To what extent did ICT enrolments regrow from the lowest post-2000 base?
b) Was the regrowth uniform (e.g. across the different university groupings identified above)?
c) Did regrowth reflect new academic emphases (e.g. traditional Computer Science vs. Information Systems vs. Software Engineering vs. Multimedia/Interaction Design cs. etc.)?
d) To what extent has student quality been maintained/improved/diminished during this supposed regrowth period?
e) Is further growth wanted and if so why?
f) Have latest data (i.e. for 2011 and 2012) changed our impressions?
g) Is there any correlation between enrolment regrowth and outreach:
    - by location of institution?
    - by class of institution (e.g. research- vs. teaching-intensive)?
    - by investment in outreach?
    - by industry collaboration in outreach?

These latter questions, especially, are designed to determine if there is benefit in any kind of discriminated approach (between regions or institutions) in dealing with the "perceptions" problem. Thus, it would be helpful if further research were undertaken to determine how enrolment growth (in quality and quantity) in ICT is differentiated by various factors and in particular how this growth may be correlated with any specific kinds of outreach activity. Without these, further detailed research results and conclusions, while evidence-based, will necessarily be somewhat tentative.

The second question maintains the assumption that increased ICT enrolments are desired, and it explicitly tests the connection between this desired outcome and perception problems. The results from this question are given in Table 5.

Table 5 The perceived link between enrolments and student perceptions

Enrolments and student perceptions of ICT	SD	D	N	A	SA	
Q 2. To increase enrolments in ICT, student perceptions of the ICT profession would need to be more positive				8	14	number/22 total
				36	64	%

There's unsurprisingly overwhelming support for the proposition (100% agreement to some degree). However, it's not clear exactly what problem would be solved by the improved perceptions called for here – there's an underlying assumption of dissatisfaction with current ICT students, which is about student numbers as per the question (but may actually be about student quality for which numbers may be a proxy), but the validity of the assumption and the degree and nature of the dissatisfaction remains open to speculation – which could be resolved by the potential further analyses/research from the first question.

It may be useful at this stage to note that the concept of "ICT profession" or "ICT professions" lacks definition. While it's arguable that there's an ICT industry (just as there is a health industry), the HR-wise homogeneity (i.e. cohesive professionalism) of ICT is far from proven, and the HR-wise heterogeneity of other industries actually offers evidence to the contrary. (See Industry Leaders Survey Q77–82 below for related results, discussion and conclusions.)

Question 3 assumes some implicit measure of effectiveness of ICT outreach (in the context of Q2 presumably the "increase[d] enrolments" resulting from the "more positive" "student perceptions of the ICT profession"). It's thus presumed that this question has been interpreted to relate to outreach to potential ICT students, for example, pupils in secondary and possibly primary schools (as evidenced by the detailed responses to Q4 below).

Table 6 Perceptions of the effectiveness of ICT outreach programs

Effectiveness of outreach programs	SD	D	N	A	SA	
Q3. Our school/faculty has an effective ICT outreach program		1	6	13	2	number/ 22 total
		5	27	59	9	%

The apparent contradiction between Q2 and Q3 responses is somewhat perplexing. How can (Q2) 22/22 (100%) respondents agree (to varying extents, but still agree) that positive perceptions of the ICT profession/industry need to be more positive, but so many (Q3) – that is, 15/22 (68%) respondents – find their school/faculty ICT outreach to be effective, and indeed only 1/22 (5%) finds theirs to be definitely ineffective? In other words, how can such outreach programs be so effective yet still fail to produce sufficiently positive perceptions of

ICT? Possible explanations for this anomaly are canvassed in the analysis of responses to Q4 (about actual outreach activities) immediately below.

Outreach programs linked to increased enrolments in ICT

Academic leaders were then asked four questions (Q4–7) about existing or aspired-to activities that have the potential to improve enrolments through improved perceptions of ICT. In each case, responses from the 22 respondents can be summarised as follows:

Q4. Effective outreach activities at my institution that are attracting students to ICT are:

The following broad classes of activity are discernible (with examples quoted from actual questionnaire responses).

A. Promotional activities including visits to schools: 2 responses, e.g.:

   "National Computer Science School, Girls' Programming Network, Programming Challenge, Science in the City High School Expo"

B. Extra-curricular activities for school pupils: 8 responses, e.g.:

   "Workshop activities for high school students, university open day with activities, involvement of ICT practitioners in promotion"

   "Academic liaison position created to engage with local schools in various ways, e.g., through Experience Days etc"

C. Enhancement of school curriculum (distinct from the above): 4 responses, e.g.:

   "Offering our first programming course to gifted and talented high school students"

   "Once a year we provide a 'curriculum enrichment' program to students doing VCE physics. In the program we give the students some background on their material from a different perspective and relate it to some of their everyday activities such as gaming, mobile comms etc. In addition we do school visits to make students aware of possible choices for their careers."

D. Developmental activities for school staff: 2 responses, e.g.:

   "IT Teachers PD days"

While all of the activities reported in response to Q4 are potentially consistent with perception-improving, it remains (from Q2 and Q3) that academics distinguish their "effectiveness" in outreach (Q3 68%) from the need for improved perceptions of ICT (Q2 100%). This seems strongly suggestive of outreach activities that are not designed to raise overall ICT perceptions and thus overall student numbers, but rather to improve an individual institution's market position. The paucity of responses in the Q4 list of activities that seem genuinely collaborative with other institutions and/or industry substantiates this suspicion.

Q5. Additional activities that we should be doing as an institution to improve perceptions of ICT and thereby attract more students are:

Various kinds of current activities have also been suggested as "additional", possibly by institutions not currently engaging in same, or perhaps as variations on current activity. Distinctively novel kinds of outreach proposed (with examples quoted from actual questionnaire responses) include:

A. Promotion of the quality of ICT careers/employment: 5 responses, e.g.:

   "Publicising high levels of employment of our graduates more"

   "More aggressive publicity, focussing on job opportunities, diverse sectors and interests, scientific as well as social aspects"

B. Improved ICT programs at universities: 2 responses, e.g.:

   "Flexibility of courses"

C. Improved actual quality of ICT careers/employment: 2 responses, e.g.:

   "Creating an ICT profession which is genuinely inclusive, and light on in terms of geeks"

D. More genuine outreach (including involvement by industry): 3 responses, e.g.:

   "Real advocacy from Industry (not another recruitment/advertising for their company)"

It's welcome to see that the future activities suggested in response to Q5 are all, to varying degrees, collaborative in nature (including collaboration with industry). In other words, the perception among academics of problems with current outreach activities matches our own analysis of Q2, Q3 and Q4.

Q6. A collective activity by universities that would improve ICT perceptions amongst the general public is:

Many of the themes identified as current or additional activities above were identified for collective activity (with examples quoted from actual questionnaire responses):

A. Promotional activities including visits to schools: 3 responses, e.g.:

   "We have participated in the past, in the National ICT Week activities, but should do more. The objectives of any activity should be to increase the size of the ICT 'pie' rather than carving it between universities."

B. Extra-curricular activities for school pupils: 3 responses, e.g.:

   "An equivalent to the national Science and Engineering Challenge"

C. Promotion of the quality of ICT careers/employment: 6 responses, e.g.:

   "Through the links and set up in item 5 above have information sessions for these students and their parents to provide advice when certain business decisions may give the impression that the future looks grim, i.e., 'Telstra sacks 900', 'NAB outsources jobs'"

   "Promotion of achievements of ICT in industry, health, finance, mining etc."

D. More genuine outreach (including involvement by industry): 3 responses, e.g.:

"State based events where schools of IT/SE etc join together – not to sell their wares but to talk up the sector alongside industry representatives"

Q7. Is there anything that universities and industry have done or should be doing together to improve perceptions of ICT amongst the general public?

Q7's explicit introduction of "industry" followed the at least implicit opportunities to raise industry collaboration in responses to Q5 and Q6. Explicit mention of "industry" seems to have stimulated some more employment-related issues in broad categories as follows:

A. Promotion of the quality of ICT careers/employment: 4 responses, e.g.:

"Universities need to combine efforts to highlight the pervasive role of ICT in everyday lives, e.g. through a marketing campaign on ICT careers."

"Funding a TV program projecting the success in an ICT career either through stories or documentaries"

B. Improved actual quality of ICT careers/employment: 1 response:

"developing family-friendly work environments"

The final question (Q8) gave academic respondents a final opportunity to add any other comments. One response significantly impacted on outreach, reinforcing the need for industry participation:

"Peculiar questionnaire generally, but the real issue I have with it is that it emphasises an age old bias - universities have much to do and industry is waiting. No! Industry, get involved!!!!! We can't do it alone, and that is the thrust of many questions here."

In view of Q5 asking for "additional activities", and the results emphasising various kinds of collaboration, it's significant that the responses to Q6 which explicitly sought further "collective activity" remained so fruitful and maintained the focus on collaborative activities. Q7 and Q8 responses served to corroborate the perceived value of collaborative activity.

The inescapable conclusion is that university outreach activities be less-focused on institutional promotion and more focused on raising ICT industry perceptions; and that collaborative efforts with industry and other institutions be undertaken as appropriate in pursuit of this goal.

Industry perspectives: findings and discussion

As noted in the methods above, the industry respondents consisted of members of the Industry Advisory Boards of each partner institution (68 in total) and up to 114 other ICT professionals (not everyone answered all questions) who were members of the ACS. Advisory board members are industry professionals with an interest in ICT education, and the ACS members are industry professionals from an unknown range of positions.

Status quo

To assess the current situation, industry leaders were first polled about their views on perceptions of ICT and on how they were working to improve them. The results are shown in Table 7.

Table 7 Perceptions by industry on ICT perceptions of the general public and improvement attempts made by industry

Industry perceptions	SD %	D %	N %	A %	SA %		Total Responses
Q70. ICT has a poor perception amongst the general public	2	30	25	33	10		132
Q71. The ICT industry in general tries to improve those perceptions	5	20	33	40	3		132

While the tendency of the response to Q70 was to confirm the existence of a poor perception of ICT (43% agreed to some extent vs. 32% disagreed to some extent), neither agreement nor disagreement could be said to be a majority viewpoint. These responses to Q70 reveal some apparent questions and contradictions. There is no clear consensus among industry professionals that the general population has (or has not) a poor perception of ICT: 57% didn't agree (including undecided) vs. 68% didn't disagree (including undecided). It could be that the framing of the question led to a large "Neutral" response, for example, does "ICT" refer to the profession/industry or to the overall social/economic impact of ICT? It's not inconceivable that the negative (in this context SA) responses could have signified the following distinct positions:

1. Despite the high standing of the ICT profession and its members, public impressions of failed or problematic ICT systems and applications, either directly or through media reports, reflect badly on the "ICT" label.
2. Despite the manifest benefits of ICT to society, these are the result of factors other than the expertise and other professional attributes of their developers.
3. ICT systems to date are successful and beneficial which may or may not be the result of the professionalism of their developers, but progress has its limits and future ICT systems pose a threat to employment etc.

Positive responses could equally have signified the distinct complements of these positions.

Perhaps more fundamentally, a problem with Q71 may be that it is actually one of perceptions of perceptions, that is, perceptions by ICT professionals of the perceptions of the general public about ICT (whatever "ICT" may mean, as expanded above).

There seemed to be some agreement that some remedial effort from industry (43% agreement in Q71 matching Q70) at least matched the poor perceptions of ICT. Q71, however, reveals some further apparent questions and contradictions. Rather fewer disagreed that industry was trying to improve perceptions (Q71 24%) than who disagreed that there was a poor perception in the first place (Q70 32%). In other words, there is at least a slight suggestion that industry ICT professionals are more impressed by industry's perception-improving efforts than they are by the need for these efforts. A possible conclusion that might be drawn from this discrepancy is that there is a (by no means overwhelming) view that industry-based perception-improving efforts may in fact be addressing a non-existent problem; there is, however, so much evidence in other responses that industry takes the perception problem seriously that this conclusion can be discounted. Nevertheless, this confusion also needs to be resolved.

Thus, from Q70 and Q71 it seems that more research is needed to measure the depth and precise nature of the ICT perception problem. Exactly what component(s) of the population perceives ICT badly? What do they mean by "ICT" in those negative perceptions?

Somewhat stronger differentiation was elicited by the specific Q72 about the success of industry efforts, as given in Table 8.

Table 8 Industry attempts to improve perceptions of ICT

Industry perception improvements	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total Responses**
Q72. Industry attempts to improve perceptions are successful	6	24	58	11	1		132

One might expect that only those who agreed with the propositions of Q70 and/or Q71 (that there is an ICT perceptions problem and that industry is making remedial efforts) would have had an opinion on this, the subject of the success of these efforts. Indeed, the overall 42% with other than "Neutral" for Q72 closely matches the proportion of responses to Q70 that acknowledged the perceptions problem and to Q71 that at least acknowledged the existence of the remedial efforts. Of the responses to Q72, there was clear preponderance in the negative (30% vs. 12% positive), indicating a clear dissatisfaction by industry leaders with their own sector's profile-raising efforts.

The clear conclusion is that "something must be done" – exactly what will be revealed by analysis of further responses from ICT professionals below.

The ICT professionals were then asked to give specifics about "noteworthy" (not necessarily successful) efforts to improve perceptions in which industry was at least involved (though some respondents may conceivably have interpreted the question as referring to industry-led efforts).

Q73 - A noteworthy example of industry attempts to improve perceptions is:

Of 27 significant responses, 5 different kinds are discernible:

A. Explicit nils (to be distinguished from and more significant than a non-response): 14 responses, e.g.:

“Can't think of a single one”

“none that I know of”

“None. ACS is focussed on making themselves look good not the industry.”

B. The natural achievements of the ICT industry without other special effort: 4 responses, e.g.:

“Mainstream entertainment – ‘The Social Network’”

“ICT is not noticed till it breaks, then we have not done our jobs.”

C. Efforts with government input of some kind: 2 responses, e.g.:

“I choose technology program”

D. Actual direct industry/professional outreach: 3 responses, e.g.:

“IBM Excite programs”

E. Collaboration with schools: 4 responses, e.g.:

“ICT Awards (however we don’t tend to promote that well outside the ICT industry), careers events at schools and universities”

“Arranging visits to schools and school career advisers to articulate the benefits and advantages of a career in ICT”

Of the total 27 responses (less than the 57 positive responses to Q70 and Q71), exactly 13 list a specific initiative, which corresponds well with the 15 (in number) positive responses to Q72. This broad corroboration of the Q72 results, coupled with more explicit nils in response to Q73 than explicit positive testimonies (14 vs. 13 in number) as well as even fewer (7 in number) specific current industry-based perception-raising efforts, confirms our clear impression of industry that its own efforts in improving ICT perceptions have been unsatisfactory.

ICT professionals were then asked counterparts of Q71 and Q72 pertaining to the efforts of their own “company” (which in some cases might have meant some kind of public sector enterprise), and the results are given in Table 9.

Table 9 Own company efforts at improving perceptions

Own company perception-improving efforts	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total**
Q74. My company makes efforts to improve ICT perceptions amongst the general public	4	24	31	31	11		131
Q75. These efforts by my company are successful	5	8	66	20	2		129

It’s interesting that while respondents had slightly lower awareness of the *existence* of their own organisation's efforts (42% agree; 28% disagree) than the industry's in general (43% agree; 24% agree), their estimations of their own organisation's *successfulness* were apparently higher (21% agree; 13% disagree) than those of industry (11% agree; 30% disagree).

The large neutral response to Q75 (66%), however, precludes us from concluding that there is any overall satisfaction in "own organisation" perception-raising efforts. Rather, the dominance of disagreement to Q72's proposition about the success of overall industry efforts leads us to examine closely the results of Q77, which asks for suggestions about future new industry-wide activities.

ICT professionals were next asked their own organisation-specific counterpart to Q73:

Q76 - An example of a successful effort by my company is:

Of the total 35 responses (higher than the 30 for Q73 re industry efforts in general), positive themes were reflected by 25, which could be broken down into significant categories as for industry in general (Q73 above) as follows:

A. Explicit nils: 8 responses, e.g.:

   "We have tried to forge links to schools however these have not been successful."

   "Not my company's core business"

B. The natural achievements of the ICT industry without other special effort: 13 responses, e.g.:

   "We are still noted for our failures rather than our successes eg how many successful (unreadable) this week? One failure and we are all affected."

   "Work in partnership and try to be open and honest in all business relationships"

   "Customer engagement. We focus on providing value to the customer and meeting their requirements. Technology is a secondary consideration that enables meeting of requirements."

C. Efforts with government input of some kind: 0 responses

D. Actual direct industry/professional outreach: 9 responses, e.g.:

   "Not my company but Women in Technology, WA which holds events for both women and men. We're also developing a program called techtrails designed to encourage ALL youth to consider technology careers with a focus on remote and regional areas of WA. We're working in conjunction with Scitech."

   "Arranging WIL scholarships (through the ACS Foundation)"

E. Collaboration with schools: 3 responses, e.g.:

   "We visit schools (high schools) with ICT graduates to show what ICT is about."

Possible future actions

Leaders were then asked to consider specific collaborative actions that might be undertaken in future (if not already):

Q77 - Is there something that industry could do collectively that would improve ICT perceptions amongst the general public?

Of the total 49 responses, groupings/classifications could be identified as follows.

Some reflected the classifications of earlier responses:

A. Explicit nils: 0 responses

B. The natural achievements of the ICT industry without other special effort (e.g. fewer information system failures): 7 responses, e.g.:

"Actually keep commitments. Stop using jargon."

"Stop inflicting woeful systems on so many members of the public. As a person with a strong interest in UI I'm often appalled at the poor usability of the systems in daily use at counters, clerical situations. Making people feel stupid is not a way to win friends."

C. Efforts with government input of some kind: 0 responses

D. Actual direct industry/professional outreach: 10 responses, e.g.:

"Industry showcases. We recently ran a showcase of technology use within our company for the business users. In the day we had around 1800 people go through and the feedback was very positive. This could be done on an industry level, highlighting the positive contributions of the ICT industry to the community."

"Case studies of successful ICT projects and people that have done great things in or with ICT and marketing and promotion of these to the general public. Collaborative effort between industry, academia and gov of $$ for an advertising campaign such as the CPA's have done (and I think they have done well to make accounting look fun and exciting)."

"Better management of the media. Maybe showcase examples of innovation that benefit the general public - possibly more emphasis on what is developed here and exported (there is so little support by govt. for great technology here and growing it, it's a joke)."

E. Collaboration with schools: 3 responses, e.g.:

"Provide student resources for assisting with visible non profits in the community. Most non-profit organisations have poor ICT resources. ICT schools could provide leadership and resources and in return increase ICT visibility in the community."

There were, however, a number of distinctive new kinds of response categories to this question:

A. The ICT industry needs to organise better: 3 responses, e.g.:

"Fund more promotion of ICT. We need a collective campaign."

B. ICT needs to be presented more in terms of what it can and does do for society, rather than how it does it (i.e. too technology-focused): 11 responses, e.g.:

"ICT needs to show the benefits that it brings to the community. In the end without ICT we are not going to solve medical issues, travel issues, environmental issues. ICT is the one industry that will be a part of any great move forward. We need to show this to the community."

"Start talking about it in a different language. Stop focussing on the technology and focus on the enabling qualities of it. Even among the business community anything business process and enterprise architecture gets hijacked by IT and technology considerations, instead of being about the organisation and how people do their work. It should not be about widgits, but about what the widgits can do."

"Yes - Be clear on what IT is and how it adds value to industry and society. There is no agreement on what IT actually is. Marketing will only work if we understand what we are selling. We haven't tried to define IT careers here either."

C. The ICT industry/profession needs to improve its status in society: 10 responses, e.g.:

"Continue progress towards it being seen less of a 'male geek at a computer' phenomenon through working with schools and universities to address gender disbalance. Move towards high standards as a profession (eg closer to law or accountancy) to raise standards and remove large numbers of people who enter the industry only for the money."

"The value of professional qualifications/certification needs to be recognised and seen as advantageous of preferred to employers. The profession needs to be recognised like accountants <-> CPA it is the defacto standard. This way a professional body like the ACS could effectively improve and maintain the levels of professionalism in the industry. This would help improve the image."

"Showcase the range of opportunities - IT is no longer a backroom boring repetitive role cutting code for payroll systems (which is where I started). People just do not understand the range of possibilities. 2. Promote IT as a profession - we are not an industry in our own right because we are embedded in just about every industry 3. Seek out other professionals who are fulfilling IT roles and embrace them, e.g. engineers, accountants, health professionals etc."

D. The mainstream media needs to be mobilised to portray ICT more favourably: 3 responses, e.g.:

"Where are the positive stories in mainstream media. Look what CSI did for forensics."

The results of Q73, Q76 and Q77 regarding ICT perception-improving activity are summarised in Table 10.

Table 10 Summary of perception-improving activities

Perception-improving activities	Q73 (current overall industry outreach)	Q76 (respondents' organisations' own efforts)	Q77 (suggested future ICT industry-wide activity)
	Number/total responses		
A. explicit nil	14/27	8/35	0/49
B. natural achievements of ICT industry	4/27	13/35	7/49
C. including government input	2/27	0/35	0/49
D. deliberate industry outreach	3/27	9/35	10/49
E. collaboration with schools	4/27	3/35	3/49
F. better organisation of ICT industry	NA	NA	3/49
G. better connection to social benefit	NA	NA	11/49
H. improved status for ICT industry and profession	NA	NA	10/49
I. better media portrayal	NA	NA	3/49

Table 10 allows the following deductions to be made.

- Responses to Q75 and Q76 mutually validate, in that 27 (15%) respondents agreed that their organisation's outreach efforts were successful (Q75); of 35 responses to a request for a successful example (Q76), 25 gave some kind of positive example.
- Similarly, responses to Q72 and Q73 mutually validate, in that only 15 (11%) respondents agreed that industry's current outreach efforts were successful (Q72); of 27 responses to a request for a successful example (Q75), only 13 gave some kind of positive example.
- Unsurprisingly, industrial organisations seemed relatively more aware of their own specific efforts (25 positive responses to Q76) than those of industry in general (13 positive responses to Q73).
- No particularly strong impression emerges of current overall industry perception-raising efforts (from Q72 onwards).
- Based on the strength of impressions with own-organisation efforts, future industry-wide perception-raising activity would seem to depend upon a combination of improved performance by the ICT industry with deliberate industry outreach to prospective students.
- Other activities indicated by strong support are better connection to social benefits, e.g. as a component of these industry outreach efforts, and raising the status of the ICT industry/profession.

In view that the aspect of overall improved performance of the ICT industry is beyond the scope of early action, it follows that collective promotional activities by industry to improve perceptions of ICT should be improved by including a focus on the social (including industrial and economic) benefits resulting from the application of ICT in various domains. As noted earlier, these promotional activities should involve universities and other education providers as appropriate. Status-raising activities are considered below.

Perceptions and professional status and structures

The final questions asked of industry leaders concerned their views in the broad area of status raising, as also noted by several respondents to Q77 above (response class H). Table 11 shows the response of industry professionals to the statement that marketing ICT as a profession will improve perceptions.

Table 11 Marketing of ICT as a profession to improve ICT perceptions

Marketing to improve perceptions	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total**
Q78. Marketing ICT as a profession will improve the perceptions of the ICT industry amongst the general public	2	6	20	43	29		128

Agreement (72%) relatively overwhelmed disagreement (8%). It's curious that while only 20% (10 of 49 in number) of respondents suggested specific collective action by the ICT industry in improving its status (Q77), 72% then agreed (Q78) that marketing ICT as a profession would be useful.

One potential difficulty faced in promoting professionalism in ICT has been revealed in the terms of this survey itself: the use of the term "industry" as some kind of substitute for "profession". That is, by comparison, say, with health, the span of ICT arguably corresponds not to a specific profession (such as medical specialist, general practitioner, nurse, wardsman, health administrator, etc.) but to the entire industry spanning multiple disparate professional groups. Table 12 shows the responses to the question (Q79) concerned with distinguishing between the ICT professions.

Table 12 Improving perceptions by distinguishing between ICT professions

Perceptions and ICT professions	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total**
Q79. Perceptions of ICT would be improved if there were a clear distinction between ICT occupations or careers in the ICT industry	3	9	34	35	20		130

Responses to this question (Q79, Table 12) showed one of the strongest levels of support in the "perceptions" survey: 55% agreement vs. 12% disagreement, for the proposition that discrimination among distinct professional sub-groups within the ICT industry would be beneficial.

ICT professionals were then asked to suggest what kind of professional distinctions could be made within the ICT industry.

Q80 - These distinctions could be made along the following lines:

Of the 29 responses:

A. Clearly highlighting the need for distinctions between technical, managerial and maybe other pathways: 13 responses, e.g.:

   "Management, technical, service roles"

   "Demarcate across disciplines:
   - Project/Program management
   - Business/Process Analysts
   - System Analysts
   - Architects/Designers
   - Developers/Programmers
   - Testers
   - Support"

   "There is a general perception amongst some that ICT people fix hardware. There is no perception that there is a wealth of variety in ICT occupations and that they differ vastly from each other."

   "There are clearly different 'streams': a technical one (software engineering, networks, operating systems, virtual machines, etc), a business oriented one (information systems, databases, etc), an interaction-design one (multimedia, mobile device programming, games, etc)"

B. Focusing on technical distinctions: 3 responses, e.g.:

   "Software Architecture/Software Engineering/Network Engineering/Systems Engineering/Computer Science"

C. Acknowledging in some way the need for a professional technical hierarchy of some kind: 6 responses, e.g.:

   "Three types of ICT occupations: Professional, Engineering and IT Support roles. General public only see IT support roles and little awareness of the extend [sic] of the profession"

   "Educated professional vs trained technicians"

With further regard to status raising, there was strong agreement with the suggestion that greater distinction among sub-groupings within the ICT industry would be beneficial: 55% agreed (to 12% disagreed) to the general proposition (Q79). Interestingly, twice as many responses about specifics (Q80) referred to a technical/non-technical divide (11/27 responses) as referred to hierarchies within technical areas (5/27 responses). This emphasis on the technical vs. non-technical side of the ICT industry may be attributed to the subject population of the questionnaire (ICT professionals are inevitably those whose lives become dominated by managerial issues), but unfortunately fails to shed much constructive light on how those sides might be structured. It's interesting to note that respondents failed to mention recently promoted professional structures such as the Skills Framework for the Information Age (SFIA Foundation, 2012) or the ACS Core Body of Knowledge (CBOK) (Australian Computer Society, 2008).

Complementing the general Q79 and the open-ended Q80 was the following specific question (Q81) about how a professional sub-structure in the ICT industry could be configured, anticipating the above answers advocating some kind of discrimination (hierarchical or otherwise) among different ICT professional roles.

Table 13 Distributing ICT professions across existing professions in other industries

Distributing ICT professions across other professions	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total**
Q81. ICT perceptions would be improved if professionalism in ICT was identified and distributed across existing professions such as engineering, business or the design industry	4	12	29	37	19		129

The strong support for the proposition of Q81 (56% agreed vs.16% disagreed), shown in Table 13, mirrors that of Q79 and is matched by the strong response to the opportunity to make specific suggestions in Q80.

Responses to the final question (Q82) are shown in Table 14 and have confirmed opinion (as revealed e.g. in some of the responses to Q77 and to Q78) on the need for formal structures to support perceptions of professionalism, receiving a very strong favourable response (60% agreed vs. 9% disagreed), even more so than the related Q81: the more that professional accreditation in ICT is through recognised labels, the more it will improve perceptions.

Table 14 Professional accreditation and perceptions

Professional accreditation and perceptions	**SD %**	**D %**	**N %**	**A %**	**SA %**		**Total**
Q82. Professional ICT accreditation by a professional body improves the perceptions of ICT	3	6	31	32	28		130

Responses to Q82 (Table 14) imply that a two-dimensional structure of the ICT profession needs to be maintained: one recognising professional diversity as per Q79–81, but another recognising the integrity of ICT as a whole (as per Q82 supported by Q78).

This willingness revealed in these last several questions, at least to consider adherence to established professional structures, leads to the notion that future promotion of ICT careers needs to recognise the diversity of ICT career options and, where possible, to situate them in terms of established career and professional structures.

For example: software engineering might usefully be promoted in the context of other "engineering careers"; multimedia in the context of other "design" careers; business information systems in the context of management or accounting careers; and so on. It has to be recognised, however, that this approach will require several logical prerequisites to be successful, including at least:

A. simultaneous structuring of ICT educational programs (degrees and other qualifications as appropriate) to meet the requirements of both the ICT profession and the relevant other established professions
B. development of mutual understanding between the ACS and bodies representing the relevant other established professions about the accreditation of the above programs
C. further development of mutual understanding between the ACS the other bodies about broader collaboration on joint engagement with individuals, organisations and government in their shared spaces.

Fortunately, there are some good precedents in place that bode well for the development of this ideal. In particular, the ACS and Engineers Australia have a long-established (since 2000) "Joint Board in Software Engineering" that not only has been effective in joint accreditation of software engineering degrees but also is chartered to consider broader collaboration including conferences, professional development, lobbying and at least to consider what modes of joint membership might be possible.

Does outreach make a difference?

We reiterate that the above results are based upon impressions of industry professionals and academic leaders. We can, however, at least point to some positive evidence that a cohesive industry-based outreach program has significantly improved interest in ICT programs in the last several years.

"Group X" is a tripartite (industry including public and private sector organisations as well as the Australian Computer Society, academe, government) group that has been operating in Queensland since 2007 with the broad aim of improving perceptions of ICT careers among prospective students. While academic leaders (heads of school/department or delegates) are heavily engaged in the organisation (and funding) of Group X, it is current students and industry representatives (often new graduates) that extensively conduct actual outreach/ engagement. Engagement activities include school visits and representation at higher education promotions. Representation at regional centres in addition to the metropolis is a feature of Group X's approach.

The following matrix compares changes in applications to ICT programs vs. all programs, Queensland vs. nationally, since 2007 (when Group X was founded) (Groom, 2012).

Table 15 Changes to ICT university applications since "Group X" began activities

Changes in applications 2007–2011	Queensland	National (incl. Queensland)
ICT field	+41%	+10% (approx.)
all fields (incl. ICT)	0% (approx.)	+10% (approx.)

The considerable increase in Queensland ICT applications over the period is immediately apparent. Analysis reveals that:

- even though Group X aligns appropriate parts of its work with the national ICT Careers Week (2012a), this increase can only be partly attributable to an overall national trend: 41% increase in Queensland vs. approx. 10% nationally
- neither is this increase part of any "Queensland" phenomenon; indeed, over all fields, Queensland is performing worse (approximately static) than the national norm (approx. 10% increase)
- it's indeed remarkable that whereas national ICT applications are increasing only at the rate of national applications across all fields, Queensland ICT applications are increasing at a significantly faster rate and in contradiction to a rate of increase across all fields in Queensland that are well below the national level. Indeed, without the Queensland increase in ICT, the national result is in decline.

In seeking to understand what distinguishes Group X from other national ICT promotions (National ICT Careers Week, 2012b), we offer a possibly key observation that many other (national) promotions seem to be based at universities. The potential drawbacks are that this at least risks creating the impression that the promotion is part of the "same old" university sales pitch, whereas potential students may be much more likely to be receptive to the use by Group X of employer representatives who fulfil the role of buyers of graduates. Perhaps more relevant to the perception-improving task is that these representatives (typically new graduates, sometimes current students) are best placed to communicate enthusiastically credible and positive views of ICT careers.

It follows that the basis for the evident success of "Group X" in improving perceptions of ICT careers through industry-oriented outreach in its local domain needs to be communicated to and received by other perception-raising activities and bodies across the nation.

Summary and conclusions

A considerable body of prior and more recent evidence indicates that poor perceptions of the ICT industry and profession are having a severe impact on the quality and quantity of people being attracted to ICT careers. Consequently, a range of ICT industry professionals and academic leaders were surveyed to corroborate this impression and to identify remedial promotional and outreach activities. Both groups were surveyed about the success of their current efforts and about new directions to pursue. A prior hypothesis, about possible deficiencies in the way in which professionalism in ICT is presented and structured, received a degree of corroboration, reinforced by the results of an extension to the survey of industry professionals about raising the professional profile of ICT in a number of ways. Evaluating the impact of an existing program along these lines establishes the value of coordinated industry-oriented profile raising.

Our research raises the following key issues:

- There is a lack of knowledge/understanding of how different factors actually affect ICT enrolments.
- Collaborative activities between natural competitors (for students and graduates) are effective.
- The concept of the "ICT profession" is complex, deriving at least in part from its multifaceted nature and is neither well specified, communicated to, nor understood by key stakeholders.
- Improved understanding and perception of ICT is needed in terms of social and industrial benefit rather than in academic/technical terms.

Six recommendations for action can therefore be made based on the survey findings:

1. Further research needs to be undertaken to determine how enrolment growth (in quality and quantity) in ICT is differentiated by various factors and, in particular, how this growth may be correlated with any specific kinds of outreach activity.
2. University outreach activities should be less focused on institutional promotion and more focused on raising ICT industry perceptions; and collaborative efforts with industry and other institutions should be undertaken as appropriate in pursuit of this goal.
3. More research is needed to measure the depth and precise nature of the ICT perception problem. Exactly what component(s) of the population perceives ICT badly? What do they mean by "ICT" in those negative perceptions?
4. Collective promotional activities by industry to improve perceptions of ICT should be improved by including a focus on the social (including industrial and economic) benefits resulting from the application of ICT in various domains.
5. Future promotion of ICT careers needs to recognise the diversity of ICT career options and, where possible, to situate them in terms of established career and professional structures.
6. The basis for the evident success of "Group X" in improving perceptions of ICT careers through industry-oriented outreach in its local domain needs to be communicated to and received by other perception-raising activities and bodies across the nation.

Supporting these six specific recommendations are the following three broad principles that are derived from the survey findings:

1. Industry-oriented outreach succeeds in improving perceptions, even if the precise reasons for this result remain to be determined.
2. Collaboration does, however, seem to be a key ingredient of success, between

different sectors (industry, academe, government) and between otherwise competing organisations (for students or for graduates).
3. Social as well as technical issues are essential in perceptions of ICT, namely those of relevance and status.

It’s interesting to observe that overseas activities that parallel the actual and projected local work reported here don’t seem to adhere to these principles; for example, Purdue University (2011) exemplifies a university-based schools outreach program with various components targeted at a broad range of students, parents and school teachers; and Carnegie Mellon University exemplifies a program focused on attracting increased female participation in ICT education (as noted in the Introduction to this report).

As a result, it is concluded that Australian-based initiatives in response to the findings of this report have the opportunity to set an example of global impact and benefit.

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CHAPTER 2: Attrition from ICT

Authors: Madeleine Roberts and Tanya McGill

Background

The use of information and communication technology (ICT) now underpins the vast majority of work and business life in the developed world, and this trend is also increasing in the developing world (ITU, 2010). There is, however, a shortage of ICT professionals in most developed countries (Gras-Velazquez et al., 2009; Lewis et al., 2007). In Australia, for example, the Australian Computer Society (ACS) identified a shortfall of 28,488 ICT staff for 2008 and projected a massive increase on this over the following decade (ACS, 2008). More recently it was reported that there were 30,000 ICT positions unfilled in Germany (Telecompaper, 2010), and e-skills UK (2011) has predicted that over half a million new ICT professionals will be needed in the next five years. One factor contributing to this shortfall is attrition from ICT courses.

This chapter aims to identify factors contributing to attrition in ICT. It first explores national attrition rates then describes the results of a survey of students who have discontinued their ICT study and explores the reasons they identify for leaving their ICT courses. It then makes recommendations to institutions based on these reasons.

ICT courses have been identified as having exceptionally high attrition rates across the developed world. In an Australian study, Marks (2007) identified information technology as having the largest attrition rate of identified fields of study with approximately one-third of students leaving. Similarly, Bailey and Borooah's (2007) UK study found a 28% attrition rate for ICT and in comparison, science had 15% and humanities and languages 16%.

Numerous studies have been undertaken to establish the reasons for attrition in tertiary education in a number of countries. Many of these have focused on only one reason at a time, such as financial aid (Stater, 2009), the effect of boredom (Mann and Robinson, 2009), or the choices made by students with dependent children (Marandet and Wainwright, 2009). Others have attempted to cover a spectrum of reasons. Hovdhaugen (2009), for example, focused on student background characteristics, as well as their goals and commitments once enrolled at university, to determine the causes of both withdrawal from, and transfer between, university courses. The study found that pre-entry attributes (gender, age, social background and prior academic achievement) could explain withdrawal more effectively than the educational goal or the motivation of the student, while these largely explained the reasons for transfer. The work of Bennett (2003) and Bailey and Borooah (2007) has also highlighted the role of personal characteristics in attrition, and both studies confirmed the importance of financial hardship. Early models such as those proposed by Tinto (1975) and Bean (1980) have proved useful in understanding attrition and have been extended by various authors to better predict and understand the phenomenon (e.g. Beekhoven et al., 2002; Braxton et al., 2000; Cabrera et al., 1993), though none have succeeded in finding a set of definitive reasons, causes or answers.

In addition to studies focusing on attrition across a range of disciplines, there have been a number of studies focusing on attrition in ICT degrees. Whilst ICT faces many of the same issues as other disciplines, factors such as the low numbers of female students enrolling, and reports of higher female attrition rates (Barker et al., 2009), differentiate it. There is some evidence that these are linked, as an increase in the proportion of females has been shown to reduce attrition (Cohoon, 2001). Previous research has shown that while female ICT students do not appear to differ from male students in terms of their academic ability to understand the material, they may lack confidence in their ability to do so (Beyer et al., 2003; Cohoon, 2007), and they may also have had less previous ICT experience (Cohoon and Aspray, 2006).

Other studies specific to attrition in ICT have explored factors such as technical ability, computing resilience (Lewis et al., 2008), prior experience in programming and use of collaborative learning experiences in the classroom (Barker et al., 2009). Prior experience in programming was found to be an important predictor of intention to continue in computer science, however, technical ability appeared to be less important than soft skills (Lewis et al., 2008). Weng, Cheong and Cheong (2010) developed an information systems student retention model based on the models of Tinto (1975) and Bean (1980) and found the three most important factors in determining information systems students' continuance were self-efficacy, goal commitment and academic integration.

The outcomes of these many studies suggest that attrition is influenced by both the individual characteristics of students and the educational environment. Some factors apply across many disciplines, and some are more discipline specific. While some factors, such as student ability and financial pressures, are beyond the control of the institution, others, such as collaborative learning experiences in the classroom and the amount of contact students have with faculty members, can be influenced by universities.

National attrition rates for ICT courses

In addition to publishing annual summary statistics, the Higher Education Statistics Unit of the Department of Education, Employment and Workplace Relations can supply specific datasets on request. The following section is based on data obtained from a specific request. It relates to student data for the Field of Education Information Technology (FoE02) for the period 2001–2008 and represents the proportion of students in a particular year who neither graduate nor continue studying in an ICT course at the same institution in the following year.

Table 16 shows attrition rate as a percentage of commencing students in all ICT qualifications at Australian universities between 2001 and 2008. Between 16% and 19% of all ICT students dropped out of their ICT qualification each year, and overall female attrition rates were relatively consistent with male rates of attrition (see Figure 6). Thus, it appears that although female enrolment rates are much lower than those of male students, once female students commit to their studies they are not more likely to leave them than are male students.

Table 16 Overall attrition rates from all ICT qualifications at Australian universities by gender, 2001–2008 (DEEWR requested data)

	2001	2002	2003	2004	2005	2006	2007	2008
Total	17.5	17.7	17.1	16.5	16.9	17.7	18.0	16.7
Males	17.6	17.9	17.2	16.5	17.1	17.9	18.6	16.7
Females	17.3	17.1	16.7	16.8	16.1	16.9	15.6	16.9

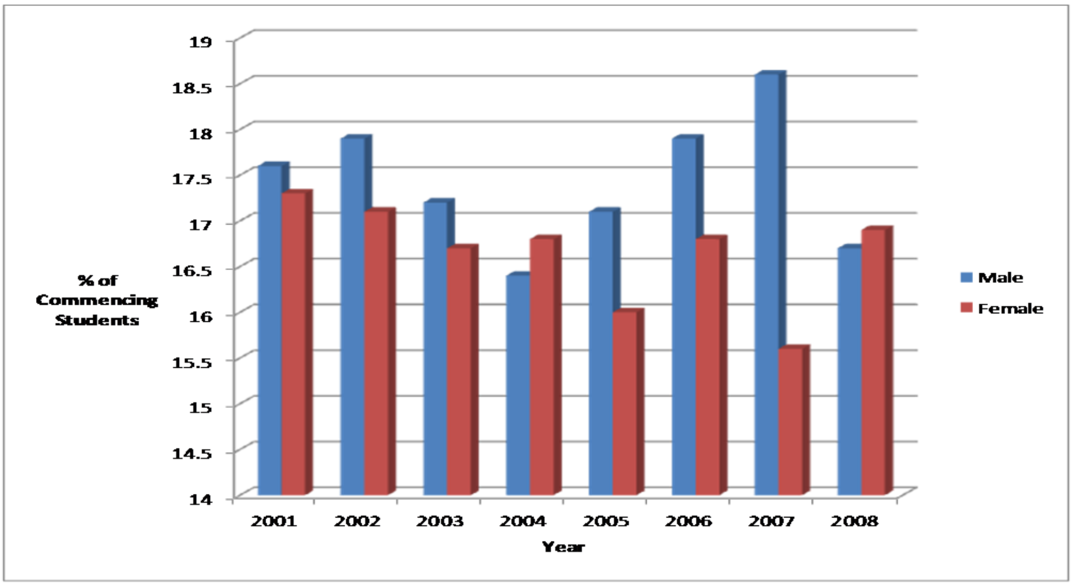

Figure 6 ICT attrition rates for males and females as percentages of commencing students (DEEWR requested data)

Table 17 provides attrition rates by Australian state. The exception to the relative consistency of average attrition across the states is the Northern Territory with extremely high attrition rates of between 30% and 40% each year. These attrition rates are consistent with those of other disciplines in the Northern Territory (DEEWR, 2010), thus are a function of the transient population and higher proportion of Indigenous students in the Northern Territory, not specific issues related to ICT.

Table 17 Attrition rates (as percentages of commencing students) from all ICT qualifications at Australian universities by state, 2001–2008 (DEEWR 2010)

State	2001	2002	2003	2004	2005	2006	2007	2008
New South Wales	17.5	17.4	18.9	16.6	14.8	16.8	16.1	13.2
Victoria	17.2	15.8	14.6	15.1	15.9	17.0	17.5	16.3
Queensland	15.9	19.4	17.8	17.2	20.2	19.8	22.3	19.8
Western Australia	19.1	20	20.5	18.5	22.9	18.4	19.2	20.4
South Australia	22.6	19.9	20.1	17.9	13.2	16.5	19.3	18.3
Tasmania	14.6	17.9	9.6	17.8	6.9	15.2	11.7	19.3
Northern Territory	39.4	31.0	36.1	31.4	35.0	40.0	34.3	32.7
Australian Capital Territory	16.5	14.8	14.6	16.8	15.9	20.2	13.8	16.6
Multi-state (ACU)	22.7	20.3	25.3	22.7	26.2	20.8	16.2	21.0

There are several groupings of Australian universities that have been formed to support collaboration and provide increased lobbying power. The four main groupings currently active are:

1. Group of Eight (Go8) – University of Sydney, University of New South Wales, Monash University, University of Melbourne, University of Queensland, University of Western Australia, University of Adelaide, Australian National University
2. Innovative Research Universities (IRU) – University of Newcastle, La Trobe University, James Cook University, Griffith University, Murdoch University, Flinders University, Charles Darwin University
3. Australian Technology Network (ATN) – University of Technology Sydney, RMIT University, Queensland University of Technology, Curtin University of Technology, University of South Australia
4. Regional Universities Network – University of New England, University of Ballarat, Central Queensland University, University of Southern Queensland, University of the Sunshine Coast, Southern Cross University.

Some variations in attrition are apparent across these groupings (Table 18), with the Group of Eight universities showing a consistently lower rate of attrition that is commensurate with the higher entry scores required for ICT qualifications at these institutions. Attrition at the Australian Technology Network universities also appears to be lower than that of the Innovative Research Universities and the Regional Universities Network.

Table 18 Institutional groupings of attrition rates from ICT (as percentages of commencing students), 2001–2008

	2001	2002	2003	2004	2005	2006	2007	2008
Group of Eight	11.5	12.5	13.0	13.0	11.8	12.9	13.3	12.1
Innovative Research Universities	19.1	21.3	21.5	21.2	19.9	17.2	19.9	19.6
Australian Technology Network of Universities	19.2	16.8	15.2	17.0	16.9	18.7	16.5	15.1
Regional Universities Network	19.7	23.3	22.2	14.9	20.7	22.0	25.9	20.8

A full listing of the attrition rates of all universities for 2001–2008 is provided in Appendix 1.

Survey

To further explore the reasons for the attrition reported in the previous section, an online survey was conducted to determine what factors in a student's personal life, or in their experience of attending university, influenced their decision to abandon their study of ICT.

Method

The four project partner universities (each from a different state) were involved in the study. To identify those students who were early leavers from their ICT degrees or from the universities themselves, the Registrars at the four universities identified students who had transferred from an ICT degree to an unrelated degree at the university, or who had left the university altogether, between 2005 and mid-2010. These 2868 students were then sent an email or letter requesting their participation in an online survey (designed by the project team). The questionnaire took approximately 15 minutes to complete. Completion of the questionnaire was voluntary and all responses were anonymous.

The online survey was created in SurveyMonkey and consisted of three main types of questions. Participants were asked questions that captured demographic and background information such as age, gender, marital status, ethnicity, whether they were a domestic or international student, their parents' gross annual income and the type of ICT degree in which they had been enrolled. There were also questions about their enrolment and early participation in the course. These included original enrolment status, whether they had enrolled late, and whether they had participated in orientation programs and other activities organised by the university and faculty. The rest of the survey questions were designed to explore the reasons why participants had withdrawn from their ICT course. These questions were presented in four sections. The first section contained questions to determine whether their main reason for leaving their degree was due to personal reasons, whether it related to something about the course, or whether it was a combination of these. The second section contained questions covering experiences of the university itself (see Table 19 – University Experience Reasons – for a list of these items). The third section included items about their course including items relating to academic preparedness, the way the course was taught and run, and aspects of the teaching and learning environment (see Table 20 – Course Experience Reasons – for the items). The fourth section asked about life experiences such as chance events, health, finances, travel, accommodation and work (see Table 21 – Life Experience Reasons – for the items). The items in the second, third and fourth sections were presented as negative statements summarising possible reasons for attrition (e.g. "I couldn't get help when I needed it"), and respondents were asked to rate their agreement with each statement on a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree". These groups of questions were designed to cover the range of events, experiences and outcomes that may have led each respondent to make the decision to leave their ICT degree.

Participants

A total of 154 ex-ICT students (18.8% females and 81.2% males) completed the survey. The relatively small proportion of female respondents is consistent with the numbers of women studying ICT at the universities involved (DEEWR, 2011) and with the literature on the notably low female participation in ICT education at a tertiary level in Western countries (Cory et al., 2006; Craig et al., 2007; Lewis et al., 2007; Ogan et al., 2006; Siann and Callaghan, 2001). The majority of the participants had studied full time (74%) and were domestic students (92.7%). The low proportion of participating international students (7.3%) reflects the difficulty in maintaining contact details for international students once they leave the country. Participants ranged in age from predominantly school leavers (41.5%) to a small proportion (1.3%) who were between 46 and 55 when they commenced their studies. It was the first attempt at university study for 75.2% of the students, and the degree they were studying was their first choice for 76.6% of respondents.

The majority of the participants had attended orientation activities (72.3%), and 32.4% had attended functions organised by the university and/or school. It was interesting to note that many of the students who had not attended functions indicated that either none were organised or that they were not aware of any. Only one participant had missed the start of the course.

Reasons for attrition

The literature has identified many factors that may be associated with attrition. When participants were asked if their main reason for leaving their degree was due to personal reasons, reasons associated with the course itself, or both, the majority of respondents indicated that both personal and course issues had influenced their decision (55.2%). For example:

> *"Two Reasons. A) Dad died. B) Course wasnt what i expected when i enrolled."* Male, 24, CompSci.

For 26% of participants the main reason was personal. The following quote is from a student who had financial issues:

> *"I had to work more to pay rent/bills which negatively impacted my study. Centrelink allowances are too low to live on and (in my case at least) were cut off if I elected to do part time study."* Male, 21, CompSci.

For 18.8% of participants the main reason was course related. The following quote illustrates the frustration that led to one student withdrawing for course-related reasons:

> *"The course content material was paced relatively quickly, and i wasnt able to pick up the programming languages fast enough, i lost interest in the course as the programming languages changed frequently and would have to start back at 'square one' almost every time the language would change."* Male, 19, CompSci/GamesTech.

Table 19 presents the responses to reasons for attrition that relate to the university environment. The most frequent response was that there were too many distractions preventing them from concentrating on their studies (40.5% agreed or strongly agreed). Other notable reasons also included the challenge of organising a timetable with no clashes (27.6% agreement) and getting help when needed (26.7% agreement). The difficulties some students experienced in obtaining help are illustrated by the following quote:

> *"….specifically asked admin staff, or teaching staff for help and was turned away on every occasion, or told to look at a website, neither of which provided the slightest bit of help…"* Male, 18, IT.

The issue of least concern was the possible security risk associated with attending evening classes (4% agreement). Although security concerns have often been mentioned in the literature as a reason for attrition (Marginson et al., 2010), the vast majority of ICT students and participants in the online survey were male and domestic, and perhaps because of this have not been so influenced by this issue.

Table 19 Responses to reasons for attrition associated with the university environment

University Experience Reasons	Total Num.	SD %	D %	N %	A %	SA %
There were too many distractions preventing me from concentrating on my studies	153	13.7	26.1	19.6	32.7	7.8
Organising a suitable timetable, with no clashes, was challenging	152	20.4	34.9	17.1	18.4	9.2
I couldn't get help when I needed it	150	19.3	37.3	16.7	18.0	8.7
The University staff were not friendly	151	25.2	35.8	21.9	11.9	5.3
The University facilities were not adequate	152	23.7	43.4	18.4	10.5	3.9
There were no opportunities to socialise	151	19.9	39.7	27.2	9.3	4.0
Attending evening classes posed a security risk	152	38.8	38.2	19.1	3.3	0.7

The most frequent response to the reasons relating to the course experience (Table 20) was that classes were boring (42.4% agreement). Many also found the pace of teaching too fast (32.2% agreement). As one of the participants put it:

> *"It was uninteresting and not exciting. I felt like I was just memorising information, not using critical thinking, not *really* learning."* Male, 19, IT.

Table 20 Responses to reasons for attrition associated with the course experience

Course Experience Reasons	Total Num.	SD %	D %	N %	A %	SA %
Teaching						
The classes were boring	151	9.9	27.8	19.9	25.8	16.6
The pace of teaching was too fast	152	17.1	33.6	17.1	20.4	11.8
The teachers didn't explain the exercises	151	13.9	38.4	19.2	19.9	8.6
I wasn't encouraged to do well by the teachers	151	15.2	34.4	27.8	16.6	6.0
The teaching methods were harsh and confrontational	152	20.4	43.4	24.3	10.5	1.3
The teachers were not prepared	152	18.4	51.3	20.4	5.9	3.9
The teachers' knowledge was out of date	152	15.1	44.1	25.0	11.8	3.9
Course						
The course didn't have a workplace focus	151	9.9	27.2	25.8	25.8	11.3
The course lacked practical applications	151	12.6	39.1	17.2	19.9	11.3
The course didn't have a business focus	152	14.5	26.3	28.3	21.7	9.2
The course was too theoretical	152	13.8	34.9	22.4	22.4	6.6
The course was poorly structured	149	12.8	34.9	25.5	15.4	11.4
There were too many assignments	147	13.6	36.7	27.9	18.4	3.4
The focus was on individual activities rather than groups	149	18.1	32.2	30.2	13.4	6.0
The course was too mathematical	151	15.9	46.4	19.2	12.6	6.0
Teaching and learning environment						
Academic environment did not suit my learning style	152	13.2	32.9	18.4	23.7	11.8
I didn't feel I fitted in or belonged	147	18.4	27.9	17.7	24.5	11.6
The teaching environment was not welcoming	152	15.1	38.2	21.1	17.1	8.6
I was in the minority in my classes	146	24.7	32.2	17.8	16.4	8.9
The course was too competitive	151	17.9	40.4	28.5	11.9	1.3
Preparedness and other student issues						
The course didn't meet my expectations	148	8.8	20.9	16.9	30.4	23.0
I didn't enjoy attending classes	146	12.3	18.5	19.9	32.9	16.4
I didn't understand the concepts	152	17.1	33.6	15.8	24.3	9.2
My results were not as high as I expected	149	12.1	29.5	28.9	22.1	7.4
I didn’t make friends with classmates	145	15.2	33.8	24.1	17.9	9.0
I didn’t understand the meaning of the terms used in the course	149	18.8	40.3	18.1	20.1	2.7
I didn't have the expected background knowledge	148	23.6	35.1	16.2	15.5	9.5
I felt it was unacceptable to be smart	147	36.7	44.2	14.3	4.8	0.0

In a recent Australian survey of over 30,000 students, ICT students were found to have the lowest levels of academic challenge, higher order thinking and enriching educational experiences of all disciplines considered (ACER, 2010). The results of the current study reflect a sense that much ICT teaching may be boring because of its focus on transferring content knowledge at a rapid rate rather than making use of constructivist approaches; this is contributing to attrition.

Consistent with perceptions that ICT teaching can be boring, other frequent course experience reasons were: the balance between application and theory; lack of workplace focus (37.1% agreement); lack of practical applications (31.2% agreement); and lack of business focus (20.9% agreement). Courses were also seen as too theoretical (29.0% agreement). ICT courses in Australia have the lowest proportion of students doing internships (ACER, 2010), and a study by Koppi et al. (2010) noted that ICT graduates in the workplace have recommended that students receive more industry-related learning. Weng et al. (2010) also called for an increased focus on solving business problems. The following quote from a participant reflects a common sentiment among students:

> *"I lost interest in IT through the university's conception of what IT is. It was presented as highly technical, highly mathematical and very individualized. In reality, IT has close links with business, work in teams and programming is a small portion of what IT is about."* Male, 17, IT.

Issues associated with the teaching and learning environment were also considered important: some felt that the teaching environment did not suit their learning style (35.5%) or was not welcoming (25.7%), and 36.1% felt that they did not belong. Barker et al.'s (2009) study of predictors of intention to persist in computer science found that when students perceive the workload as being too heavy they are less likely to pursue the major. While this influenced some students (21.8%), it was not the major issue.

Participants also noted reasons such as the course not meeting their expectations (53.4% agreement) and not enjoying classes (49.3% agreement). These sentiments are relatively general and could be associated with a variety of other more specific reasons discussed in this section.

Some students felt that they did not understand the concepts (33.5%) or terms used in the course (22.8%) and believed that they did not have the expected background knowledge (26.9%). This perception is illustrated by the following quote:

> *"I didn't have the expected background knowledge; the courses were definitely geared towards those with more pre-existing knowledge,"* Female, 18, IT.

Having the expected background for ICT studies has been identified in previous research as an important predictor of attrition (Barker et al., 2009). This issue is explored further below in relation to different types of students.

The social aspect of study also received attention with 26.9% of participants agreeing that they didn't make friends with classmates. For example:

> *"During the tutorials there was no chance or encouragement to socialise with other*

students." Male, 17, Games Software Design.

This was also identified by Barker et al. (2009), who found that levels of student-to-student interaction were perceived as "unfavourable" by the computer science students in their study, and they recommended that faculty focus on incorporating activities that support interaction. This issue can be addressed in both the nature of the course and in the teaching approaches used.

The responses to possible reasons for attrition that relate to the lives of the students are shown in Table 21. Many participants felt that they had picked the wrong degree (43.7% agreement). This sentiment implies a lack of interest and engagement with the degree content but could also be associated with a variety of other more specific reasons that are discussed in this section.

Financial pressures are of concern to students in all disciplines and are a major predictor of attrition (Bennett, 2003; Cabrera et al., 1993). ICT students are no different in this respect. The cost of university education influenced many of the participants; over one-third of students (37.3%) considered it too expensive, and 19.8% agreed or strongly agreed that they couldn't get financial aid. Conflicts with work commitments were also a common issue: 36.4% agreed that they experienced conflict with work commitments, and 33.4% noted that their study timetable did not fit with their work commitments. Various aspects of travel to university were also found to be problematic for many: distance was an issue for 24.9% and transport availability for 23.5%. Factors such as these make it difficult for students to fully engage with their studies and are likely to work in combination with other issues to precipitate attrition, as illustrated by the following quote:

> *"Finances were a big issue; Public transport from the southern highlands was almost nonexistant, thus I had to drive - petrol was costing me greatly. To make the money to get to uni, I had to spend all my 'spare' time working, which of course meant I had no time for uni. Stress of both money and failing classes compounded, making both problems even worse."* Male, 18, IT.

Table 21 Responses to reasons associated with students and their lives

Life Experience Reasons	**Total Num.**	**SD %**	**D %**	**N %**	**A %**	**SA %**
I picked the wrong degree	144	18.1	17.4	20.8	20.8	22.9
Attending university was too expensive	142	23.9	21.8	16.9	21.1	16.6
There was conflict with my work commitments	143	26.6	23.1	14.0	21.0	15.4
My timetable didn't fit with my work commitments	144	22.2	25.0	19.4	17.4	16.0
Travelling to University was/is difficult because of distance	145	31.7	25.5	17.9	15.2	9.7
Travelling to University was/is difficult because of transport	145	30.3	29.0	17.2	14.5	9.0
I couldn't get financial aid	141	32.6	25.5	22.0	9.2	10.6

My timetable didn't fit with the transport timetable	143	30.8	29.4	25.2	9.8	4.9
My family didn't help me to study at home	144	37.5	25.7	23.6	9.7	3.5
Living at home was too difficult	145	33.1	31.0	26.9	6.2	2.8
I became very ill or was involved in a serious accident	145	47.6	24.8	19.3	4.8	3.4
Studying at University wasn't as important as socialising with my friends	144	34.0	37.5	20.8	6.3	1.4
Living away from home was too difficult	144	31.9	26.4	33.3	2.8	5.6
A family member died or was very ill or had a serious accident	144	50.7	25.0	17.4	4.2	2.8
I lost my job	143	48.3	25.2	21.0	3.5	2.1
I missed my family	144	34.7	32.6	27.8	3.5	1.4
I or my partner got pregnant.	144	52.1	20.1	23.6	2.8	1.4
Living in student accommodation was too difficult	142	26.8	21.1	47.9	3.5	0.7

Few ex-students indicated that they had been affected by serious illness (8.2%), death or illness in the family (7.0%), loss of their job (5.6%) or pregnancy of themselves or their partner (4.2%).

The results above demonstrate the wide range of issues that can contribute to student attrition. Figure 7 summarises the dominant reasons, that is, those that received 25% or higher agreement from the female participants.

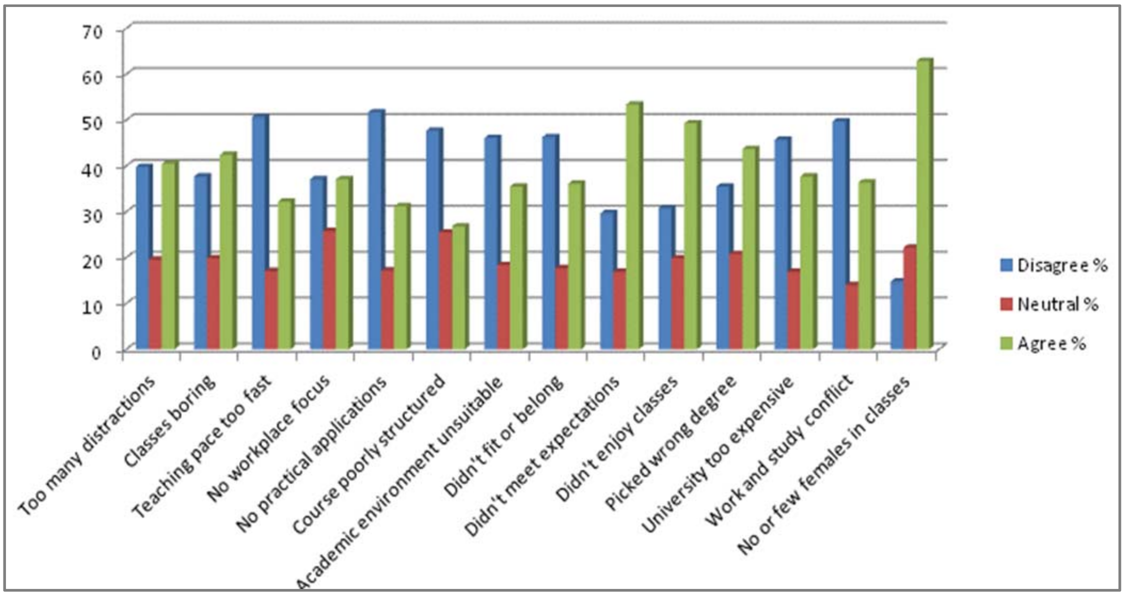

Figure 7 Dominant reasons for females leaving ICT courses

It appears that individual students rarely withdraw from their studies for just one reason. Personal issues and university- and course-related issues combine to put pressure on students who may respond by ceasing their studies. In some cases, ex-students felt they had made the decision willingly, but in others they were very conscious of the lack of support received, as illustrated by the following quotes:

> *"I found the attitude of the faculties, the structure of courses and resistance to reasonable student requests very deflating and negative."* Male, 21, Comp Eng.

> *"Was not provided with enough information about how I should have acted when I got very sick, and even though I handed in withdrawal forms, was treated unfairly when it took staff 3 months after constant hassling by me to get information, and in result still getting charged and not withdrawn from my subjects."* Male, 18, IS.

Do different types of students have different reasons for leaving their ICT course?

Various student characteristics have been proposed to influence attrition; these include gender, age and enrolment status (Barker et al., 2009; Long et al., 2006). Nonparametric Mann-Whitney U tests were used to determine whether these factors had a significant influence on students' reasons for leaving their ICT course. These tests were used as an alternative to independent samples t-tests to ensure that violations of the assumptions did not impact on the interpretation of the results. A significance level of $p < 0.05$ was established. Tables 23 to 25 provide the mean agreement ratings for each sub-group for those reasons where there was a significant difference.

Gender differences

The first demographic factor considered was gender. Summary attrition data for the four universities involved in the study (DEEWR, 2011) suggested that female students, once enrolled, were not more likely to withdraw from their course than male students. Their reasons for withdrawal may, however, differ, and this is explored below.

Several possible reasons for attrition relating specifically to gender issues were included in the survey. The levels of agreement of the 29 female participants are reported in Table 22. Overall, gender issues did not appear to be relatively important to the female respondents. Whilst the gender imbalance was certainly noted (62.9% agreement), sexist behaviour from male staff or students was not rated highly as an issue in terms of their withdrawal from the course. For example, only one female participant agreed that male students or staff spoke in a sexist manner or that male students did not let them participate. Some female participants (18.5%) felt that male staff did not encourage them to participate, and 27.6% believed that the course content was male oriented. The levels of agreement with these issues were, however, not significantly different from those of the male ex-students ($U=1405.5$, $Z=-1.16$, $p=0.259$; $U=1466.0$, $Z=-1.55$, $p=0.120$). The general sentiment is encapsulated by the following comments:

> *"As a female, I guess it was easier to quit because it 'just wasn't my thing'. It had nothing to do with anyone in particular, just that most of the course were males."* Female, 17, IT.

"Just because I'm a female doesn't mean anything. Most of my friends are guys so I don't mind being one of the only girls." Female, 18, Network Design.

"As a female it was quite daunting being a minority in the class but the male students and teachers were in no way deliberately sexist." Female, 17, IT.

Table 22 Female participant responses to gender-specific reasons for leaving an ICT course

Gender Specific Reasons	Total Num.	SD %	D %	N %	A %	SA %
There were no or few females in the classes	27	11.1	3.7	22.2	48.1	14.8
The course content was male oriented	29	20.7	24.1	27.6	20.7	6.9
Students acted or spoke in a sexist manner	28	28.6	32.1	32.1	3.6	3.6
Male students wouldn't let me participate	27	25.9	40.7	29.6	3.7	0.0
Male staff didn't encourage me to participate	27	25.9	33.3	22.2	18.5	0.0
Male staff acted or spoke in a sexist manner	27	33.3	37.0	25.9	0.0	3.7

Gender was found to have a significant influence on students' agreement with several of the other possible reasons for leaving their ICT course, as shown in Table 23. Males were significantly more likely to believe that there were too many distractions preventing them from concentrating on their studies (U=1316.0, Z=-2.32, p=0.020). Females, on the other hand, were more likely to believe that they didn't have the expected background knowledge for the course (U=1240.0, Z=-2.23, p=0.026), didn't understand the concepts (U=995.5, Z=-3.63, p<0.001), or didn't understand the meaning of terms used in the course (U=1243.0, Z=-2.29, p=0.022). Previous research has suggested that female students have no less ability to undertake ICT courses than male students (Beyer et al., 2003), however, it has been found that female ICT students lack confidence in their ability to achieve their educational goals (Beyer et al., 2003; Cohoon, 2007). The findings of this study are consistent with this previous research. Lack of confidence in ability to undertake study in a discipline that is perceived to be challenging is thought to contribute to low enrolment rates of females (Gras-Velazquez et al., 2009; Manis et al., 1989). It also appears to contribute to female attrition, preventing female students from accessing the benefits that can flow from an ICT career. Actions that increase confidence should be pursued. These might include mentoring (Cohoon, 2001) and early exposure to work integrated learning.

Female ex-students were also more likely to say that their results were not as high as they had expected (U=1244.5, Z=-2.26, p=0.024) and that they felt they had picked the wrong degree (U=1189.5, Z=-2.04, p=0.041). Previous research has shown that female students who leave ICT degrees tend to have higher grades than male students who do not leave (Strenta et al., 1994), yet they are more sensitive to perceptions that their grades are lower than those they received in high school (Jagacinski et al., 1988). Differential attrition of female students in this way is a major loss to the ICT profession, but it is not purely a gender issue, as Strenta et al. (1994) found in other disciplines, such as science and engineering, where persistence was the same and grades were the same.

Given that there is a common perception that women are more likely than males to take on caring roles that ensure the functioning of families, it might have been expected that female ex-students would have shown stronger agreement with reasons relating to life issues. Unexpectedly, there were no significant differences in responses to most of the life issues: female students were not more likely to be affected by issues such as pregnancy or dealing with family illness.

Table 23 Reasons for attrition with significantly different levels of agreement between females and males

Reasons	Females		Males		
	Mean	Std. dev.	Mean	Std. dev.	Sign.
There were too many distractions preventing me from concentrating on my studies	2.48	1.06	3.06	1.22	0.020
I didn't understand the concepts	3.54	1.17	2.57	1.21	<0.001
I didn't have the expected background knowledge	3.00	1.30	2.41	1.24	0.026
I didn’t understand the meaning of the terms used in the course	2.96	1.29	2.36	1.02	0.022
My results were not as high as I expected	3.29	1.15	2.73	1.10	0.024
I was in the minority in my classes	3.04	1.26	2.41	1.25	0.018
I picked the wrong degree	3.63	1.36	3.02	1.41	0.041

Full time versus part time study

The majority of previous research has focused on students who were studying full time (e.g. Braxton et al. (2000); Christie et al. (2004); Crisp et al. (2009); Harrison (2006); Price et al. (1992); Stratton et al. (2008)). However, many students study part time in order to be able meet their work or family commitments, and previous research has shown that part time students are more likely to withdraw from their studies (Bean and Metzner, 1985; Long et al., 2006). It might be expected that part time students face greater pressures, so differences in their reasons for ceasing to study are of interest.

As shown in Table 24, participants who had been full time students differed significantly from those who had been part time in their levels of agreement with many of the reasons for attrition. In all except two cases, students who had been full time had stronger levels of agreement. This included all differences relating to perceptions of the university environment and the course and how it was taught, and all but two of the reasons associated with the lives of the students. For example, full time students were significantly more likely to believe that they had picked the wrong degree (U=1200.5, Z=-3.89, p<0.001), that classes were boring (U=1441.5, Z=-3.24, p=0.001), and that they did not have sufficient background knowledge (U=1684.5, Z=-2.12, p=0.034) or understand the concepts (U=1520.0, Z=-3.11, p=0.002). This finding is surprising. Traditionally, part time students have been perceived as facing significant pressures associated with juggling the competing demands of work, family and study; whereas full time students have been viewed as having more freedom to devote their time and attention to their studies. This is perhaps no longer the case. Analysis of the hours worked by the participants who were full time students before they withdrew showed that 59.4% were working over 10 hours per week, and 27.7%

were working over 20 hours per week. This suggests that in some respects full time students may be under greater pressure than part time students and that this has led to an increased sensitivity to a range of issues that affect their satisfaction with their studies and predispose them to attrition.

The two issues with which students who had been part time were more likely to agree related to conflicts between their studies and their work commitments. This is consistent with Long et al.'s (2006) findings and summarised by the following quote:

> *"Financial struggle. I was unable to support my family while attending University Full Time. I tried going part time but this was still too hard. I tried external, however working full time and then trying to study all became too stressful."* Male, 25, CS.

Table 24 Reasons for attrition with significantly different levels of agreement between participants who were full time and those that were part time

Reasons	**Full time**		**Part time**		
	Mean	**Std. dev.**	**Mean**	**Std. dev.**	**Sign.**
University environment					
Academic environment did not suit my learning style	3.07	1.18	2.35	1.31	0.001
I couldn't get help when I needed it	2.75	1.23	2.15	1.14	0.008
The university staff were not friendly	2.51	1.17	1.92	0.91	0.006
Course/teaching					
The pace of teaching was too fast	2.96	1.28	2.21	1.15	0.001
The classes were boring	3.31	1.22	2.54	1.23	0.001
The teachers didn't explain the exercises	2.85	1.20	2.31	1.06	0.018
The course was too competitive	2.50	0.99	2.05	0.78	0.013
The course was too theoretical	2.93	1.10	2.17	1.11	<0.001
I didn't understand the concepts	2.94	1.25	2.23	1.12	0.002
The course was too mathematical	2.65	1.12	1.95	0.78	<0.001
I didn't have the expected background knowledge	2.66	1.30	2.15	1.12	0.034
The course was poorly structured	2.94	1.18	2.33	1.14	0.003
The course didn't meet my expectations	3.53	1.25	2.98	1.31	0.021
I didn't understand the meaning of the terms used in the course	2.62	1.10	2.08	0.97	0.006
There were too many assignments	2.76	1.07	2.21	0.86	0.005
I didn't feel I fitted in or belonged	3.00	1.31	2.38	1.19	0.011
I didn't enjoy attending classes	3.47	1.20	2.58	1.24	<0.001
Life					
I picked the wrong degree	3.41	1.40	2.38	1.18	<0.001
My timetable didn't fit with my work commitments	2.61	1.28	3.31	1.56	0.012
There was conflict with my work commitments	2.56	1.30	3.28	1.67	0.015
My timetable didn't fit with the transport timetable	2.42	1.20	1.92	0.93	0.033
Studying at University wasn't as important as socialising with my friends	2.15	0.99	1.72	0.82	0.016

Age differences

There is some evidence that, in general, older students are more likely to cease their study (Department of Education Science and Training, 2004). Whether this is the case for ICT students, and if so why, was explored here. Table 25 lists the reasons for attrition where there were significant differences in agreement between participants who were 20 or younger when they enrolled and those who were 21 or older. Again the findings were surprising, as for all but four of the proposed reasons for attrition, where differences were significant, the younger group showed higher levels of agreement. This included all differences relating to University Experience Reasons and Course Experience Reasons and all but three of the Life Experience Reasons. Three of the reasons with which the older students showed higher levels of agreement were pregnancy of themselves or their partner (U=1964.0, Z=-2.74, p=0.006), loss of their job (U=2090.5, Z=-2.02, p=0.043), and death or serious illness in the family (U=3234.5, Z=-2.79, p=0.005). These are serious life events that are often linked to stage of life, so the differences are what might be expected. The older students also agreed more that university was too expensive (U=1991.5, Z=-2.20, p=0.028). Older students are less likely to receive parental support and more likely to be supporting others and incurring large expenses such as home mortgages; hence, this difference is not surprising. The higher levels of agreement by younger students with many course-related issues such as classes being boring (U=1622.5, Z=-4.68, p<0.001), the pace of teaching being too fast (U=2279.5, Z=-2.30, p=0.022), and the course having too many assignments (U=2111.0, Z=-2.38, p=0.017) perhaps suggests that older students had made a more considered choice when starting their ICT course and that, whilst life issues influenced their decisions, they were less susceptible to other issues.

Table 25 Reasons for attrition with significantly different levels of agreement between participants who were 20 or younger when they enrolled and those who were 21 or older

Reasons	20 or under Mean	Std dev.	21 or over Mean	Std dev.	Sign.
Course/teaching					
Academic environment did not suit my learning style	3.08	1.16	2.68	1.32	0.038
The pace of teaching was too fast	3.00	1.13	2.51	1.22	0.022
The classes were boring	3.58	1.16	2.62	1.19	<0.001
The teachers didn't explain the exercises	2.95	1.19	2.44	1.14	0.010
The course was too competitive	2.54	0.98	2.22	0.92	0.040
The course was too theoretical	2.96	1.33	2.49	1.13	0.011
I didn't understand the concepts	3.15	1.28	2.32	1.09	<0.001
The course was too mathematical	2.66	1.12	2.26	1.02	0.015
The course didn’t have a business focus	3.05	1.27	2.64	1.07	0.034
I didn't have the expected background knowledge	2.78	1.37	2.26	1.11	0.023
The course didn't meet my expectations	3.65	1.23	3.11	1.29	0.010
I didn’t understand the meaning of the terms used in the course	2.71	1.16	2.24	0.98	0.015
There were too many assignments	2.82	1.08	2.41	0.96	0.017
My results were not as high as I expected	3.04	1.13	2.62	1.09	0.040

I didn't feel I fitted in or belonged	3.10	1.34	2.57	1.22	0.016
I didn't enjoy attending classes	3.83	1.05	2.64	1.20	<0.000
Life					
I or my partner got pregnant	1.58	0.84	2.04	1.07	0.006
There was conflict with my work commitments	2.44	1.30	3.09	1.51	0.009
I lost my job	1.69	0.93	2.03	1.06	0.043
A family member died or was very ill or had a serious accident	1.62	0.95	2.06	1.08	0.005
Attending university was too expensive	2.58	1.43	3.10	1.37	0.028
I picked the wrong degree	3.77	1.30	2.48	1.24	<0.000

Summary and conclusions

Student attrition is an issue of serious concern to universities around the world. It is of particular concern to the field of ICT because of the shortfall of ICT professionals (ACS, 2008). This survey of ex-students attempted to further understand the causes of attrition from ICT courses by exploring the reasons students from four Australian universities gave for leaving their ICT courses. It has shown there are many factors that can contribute to the attrition of ICT students, and for many students it is a combination of issues that leads to their withdrawal. Some of these issues are beyond the control of universities, but many could be mitigated by universities taking appropriate action.

Only a relatively small number of ex-students had experienced serious life events (such as death or serious injury in the family, pregnancy, or loss of their employment) that necessitated their withdrawal. It was much more common for the participants to cite reasons associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. A theme in issues associated with the university environment was the difficulty in obtaining help when required. The transition from school to university is a challenging one, and providing greater levels of support during the initial enrolment process, and when students need to make changes to their enrolment to accommodate other changes in their lives, would address a number of the factors that students have indicated influenced their decision to withdraw. In particular, issues relating to financial pressures, and the attendant conflicts with other commitments that arise when students need to support themselves, require a sympathetic ear and help with strategies to manage the challenges of scheduling study around work commitments and managing transportation issues. These issues are particularly important for students who are older and/or studying part time.

The major course-related issues that contributed to withdrawal were related to the style of teaching and to the focus of the ICT course. Many ex-students had found their classes boring, yet they also noted that the pace of teaching was often too fast and exercises were not explained well. These sentiments have also been expressed by students who continue with their ICT course, resulting in ICT courses being ranked as having the lowest levels of enriching educational experiences and higher order thinking of all courses considered in a survey of over 30,000 students (ACER, 2010). The way in which ICT is taught clearly requires urgent consideration. Recommendations from the ICT education literature include increasing the use of small group class activities (Barker et al., 2009; Powell, 2008). Small group activities provide students with opportunities to undertake more active learning, addressing the boredom issue (Schweitzer and Brown, 2007), but also to increase levels of interaction with other students and faculty. Increasing this interaction reduces the likelihood of students feeling disconnected from the teaching and learning environment and makes it easier for them to ask for support when they need it.

In addition to the style of teaching, the balance between application and theory was also of concern. Courses were seen to lack a workplace or business focus and to lack practical application. This finding is not just applicable to students who withdraw; students who have successfully completed their course and obtained work in the ICT industry have also called for more industry-related learning (Koppi et al., 2010). Increased use of case-based teaching can tie ICT content to application, enabling students to understand the context in which their knowledge will be applied (Mukherjee, 2000; Weng et al., 2010). Better integration of practical and workplace knowledge and skills can also be achieved though providing forms of work integrated learning (e.g. industry-related projects or work placements). Team-based projects that address problems or opportunities provided by companies, government departments or community organisations enable students to gain professional skills while ensuring that curriculum is aligned with industry needs. Work placements (or internships) are another way to provide students with valuable experience and to strengthen their sense of the relevance of their ICT course. Addressing the perceived lack of workplace focus will lead to committed students who can see where their ICT degree is taking them, possibly providing a greater incentive to work through issues that might be making students consider withdrawing.

A perception that they did not have the expected background knowledge influenced some students' decisions about withdrawal, and previous ICT experience has been found to be an important predictor of attrition (Barker et al., 2009). This issue can be addressed successfully by implementing alternate pathways so that those students without a strong background take an alternative initial unit in their first year that provides the opportunity to develop the skills and confidence to be successful. This approach has been shown to be particularly valuable in addressing the attrition of female students, as they are more likely to believe that they do not have the necessary background (Powell, 2008). Other strategies that have had success in improving female student retention include ensuring a gender balance in faculty and providing mentoring (Cohoon, 2001).

CHAPTER 3: Perceptions of a gender-inclusive ICT curriculum held by Australian ICT academic staff

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Background

Researchers in the major industrialised nations have found that ICT has a male-dominated culture (Beyer et al., 2003; Boivie, 2010; Bury, 2011; Clayton et al., 2009; Cohoon, 2002; Frieze, 2005; Grundy, 1996; Guerrier et al., 2009; Lewis et al., 2007; Margolis and Fisher, 2002; Perry and Greber, 1990; Vilé and Ellen, 2008), and the lack of inclusiveness is an issue as it is in the related Engineering discipline (Mills et al., 2010). Lewis et al. (2006) reported that the proportion of women in many ICT courses in Australia is less than 15%, and Figure 8 shows recent data sourced from the Department of Education, Employment and Workplace Relations website as an indication of the small proportion of females enrolling in IT Bachelor degrees in Australia over the last decade.

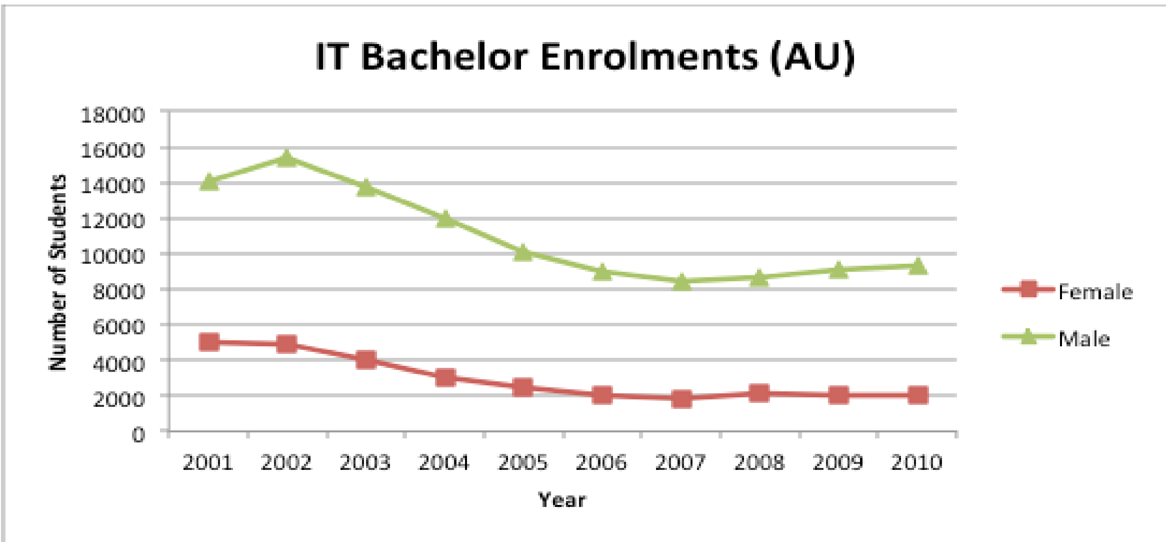

Figure 8 IT Bachelor enrolments in Australia by gender

Few enrolments in ICT is one factor contributing to the drop in the proportion of females in, and entering, the ICT workforce. Australian Women in Information Technology (OzWIT, 2006) reported that 15% of ICT workers were female and that the trend in the employment of female ICT workers is downwards, with similar numbers and trends in Europe (Valenduc and Vendramin, 2005).

While there are many contributing factors to the gender imbalance in ICT participation, one that appears to have attracted minimal attention is the design and composition of the ICT curriculum. Many of the remedies devised to address the gender imbalance in ICT have been centred on attracting more females to the courses such as: “ChicTech” and “Games4Girls” at the University of Illinois (http://cs.illinois.edu/outreach); the Women’s Technology Program at MIT (http://wtp.mit.edu); and the National Center for Women and Technology established with funding from the National Science Foundation (http://ncwit.org) in the US, and: Digital Divas (http://digitaldivasclub.org); Go Girl, Go for IT (http://www.gogirl.org.au); and Females in Information Technology and Telecommunications (www.fitt.org.au) in Australia.

There are, however, no data available on the success of these programs in attracting young women to the available courses, and neither is there any investigation of whether the content of these courses is inclusive of female students. At the theoretical level, there have been attempts to address this (Heemskerk et al., 2005; Lewis et al., 2006; Mills et al., 2010), however, at the practical level, there are few success stories such as that achieved by the School of Computer Science at Carnegie Mellon University in the US (Blum and Cortina, 2007; Frieze and Blum, 2002; Margolis and Fisher, 2002). It is not uncommon for authors to identify the ICT curriculum as one that is biased towards male familiarities and interests (Lewis et al., 2007; Mills et al., 2008), but widespread consciousness or concerted effort to remedy this bias is lacking in ICT.

It may be that few women enrol in ICT because of the perceived masculine stereotype (Cory et al., 2006), which might be reinforced by high school teacher behaviour (Dee, 2007) and compounded by societal attitudes and influences imposed on boys and girls during their development (Dingel, 2006). Perhaps as a result of these influences, anxiety and lack of confidence in using computers is more prevalent among women than men (Volman and van Eck, 2001), even amongst experienced users (Beyer et al., 2003; Broos, 2005).

It has been suggested that a gender-inclusive ICT curriculum is one that is inclusive of social and human concerns and portrays technology in that context without lessening the content (Koppi et al., 2010). ICT curricula that are focused on technology-centred topics have been found to be biased towards male students (Lewis et al., 2007; Lewis et al., 2006; Miliszewska and Moore, 2010). Mills et al. (2010) note that there are several aspects to a gender-inclusive curriculum including respecting every student as an individual and enabling them to reach their potential; recognising and accommodating differences in interests, experiences and circumstances of all students; and adjusting the curriculum in response to feedback. As Cukier et al. (2002) point out, to obtain balanced outcomes in a masculine culture, it is necessary to adopt a gender-inclusive approach.

Although the authors of this report recognise that the curriculum influences are complex, it has been necessary to focus on the perceptions of a gender-inclusive curriculum amongst Australian ICT academic staff because such perceptions influence how individuals collectively respond.

Methods

The main aim of this research was to obtain an understanding of the representative view held by Australian ICT academic staff about a gender-inclusive curriculum. This was achieved through two means: a survey of senior ICT academics that influence curriculum developments; and deliberations on gender issues at an academic forum. A secondary aim was to ascertain the view from industry as to gender balance in the workplace and consequences for university preparation of students for the workplace. A survey of ICT industry professionals achieved this aim.

Survey groups

The first targeted group was the heads of ICT units at all Australian universities who were members of the Australian Council of Deans of ICT (ACDICT). Following a series of approaches to elicit responses from this group, a total of 22 completed surveys were received from 18 universities (a few ICT heads had distributed the survey to other ICT heads internally).

The second academic group to complete the same survey was the Associate Deans for Learning and Teaching (or their equivalent) in ICT at a forum of 35 attendees representing 25 universities, and 24 completed surveys were received. In addition to the completed surveys, discussions on gender issues at the forum were also used to inform the project. The total of 46 completed surveys from the two groups and forum deliberations of 35 ICT academic staff are considered as representative of Australian ICT academia concerning a gender-inclusive ICT curriculum.

The third group comprised industry professionals: ACS members and Industry Advisory Board members for ICT at the four partner institutions. A combination of paper-based and online surveys were used to survey Advisory Board members, and 65 responses were received. A request on the ACS homepage and an emailed branch newsletter to complete an online survey designed by the project team were used to survey ACS members in the workplace; 67 responses were received, making a total of 132 responses from ICT industry professionals. However, this total number varies slightly for each question because not all respondents answered every question.

Survey analysis

The surveys designed by the project team consisted of a series of questions to be rated on a 5-point Likert scale. In addition, a number of open-ended questions were presented to allow free text responses. These free text entries were read several times to enable the coding and categorisation of responses, which were then counted to enable quantitative comparisons. The work of Boyatzis (1998) and Bogdan and Bicklen (2002) informed this qualitative data analysis method.

Workshop data

Participants were organised into small groups to discuss gender issues in ICT and invited to focus on the possible reasons for the lack of women in ICT and on the nature of a gender-inclusive ICT curriculum. Discussions were summarised on paper by each group, collected and later compiled by the facilitator. Plenary discussions were summarised and typed for the whole group to see on screen and edit at the time. Written discussion summaries were analysed.

Findings from academic surveys and forum discussions

Enrolment trends of women in ICT

Approximately half of the survey respondents noted that undergraduate enrolments of women are steady, and one-third noted that the number of female enrolments was falling. Only five respondents indicated that the number of female undergraduate enrolments was increasing at their university. Seventy-six per cent of survey respondents noted that they were trying to increase the enrolments of women in ICT, and only 18% of respondents noted that these strategies were effective.

Strategies to increase female enrolments in ICT

Responses to the open-ended survey statement: “Our strategy for increasing the enrolment of women in ICT is:” indicated that most of the strategies being used were apparently not effectively contributing to increased enrolments of females. It seems that similar strategies at a range of universities have been used repeatedly over the years. Craig (2010) recently suggested that strategies intended to attract females into ICT must be more formally structured and stringently assessed.

The survey data revealed that the main practices in targeting female students from years 9–12 are: (1) female ICT staff or students visiting schools as role models or ambassadors; (2) inviting female students to participate in various ICT activities at universities, such as engineering or programming workshops; and (3) female-specific events, for example, “Go Girl, Go For IT”, supported by Victorian ICT for Women (2010) held bi-annually at Deakin University since 2006. This event, which also includes invitations to careers advisers and teachers, has been attended by over 2000 people and is, apparently, a successful activity in improving female perceptions of a career in ICT (Lang et al., 2010).

Other strategies to attract more women into ICT that were mentioned by survey respondents included scholarships for females enrolling in ICT and to include females in the marketing of ICT. Notwithstanding the success of marketing events or inducements, survey respondents noted that females in high school still have negative experiences with ICT which probably significantly contribute to the overall low enrolment rate of females in ICT higher education. Not one respondent mentioned whether or not the high school curriculum is gender inclusive and the impact this may have on female experiences.

When asked what further strategies could be used by universities to increase female enrolments in ICT, responses included emphasising social and business dimensions; changing the media representation of women and men; changing the geek perception of ICT; working further with females in high schools; emphasising employment opportunities; and improving perceptions of the ICT profession generally. Some respondents mentioned working with high school teachers and ensuring that relevant enabling subjects are taught. No one mentioned the desirability of a gender-inclusive curriculum *per se*, although the benefits of a more inclusive curriculum to cater for different interests were mentioned:

> *“More inclusive curriculum – not necessarily gender but generally more inclusive of different interest areas and motivations to enter the workforce.”*

When asked what other organisations could do to entice more women into ICT, it was noted the ACS (Australian Computer Society) professional body was largely ineffective in this regard and that the federal government should be more forthcoming with financial incentives to encourage more students into ICT and in helping to drive cultural change through government policies. High schools were identified as the primary focus for changing the perceptions of ICT, and it was noted that female professionals in industry should be more involved in school visits, as well as the industry engaging in more marketing and promotional activities in general. Revising the high school ICT curriculum was seen as essential, and suggestions included less focus on technology; promoting the value of mathematics; emphasising the communication and “soft skills” aspects of ICT; and having gender-inclusive projects.

Workshop discussions

The issues concerning a gender-inclusive curriculum were discussed by three groups of six before the plenary session (35 attendees). Two of the three groups comprised men and women, and their group summaries identified the perception that females were concerned with human issues and that they needed to see the benefits of ICT to the community on a broad range of fronts such as health, education and the environment. The all-male group was unable to speculate on what a gender-inclusive curriculum would look like.

The groups reported that cultural differences resulted in a greater proportion of female students in international cohorts than domestic students. The Australian ICT culture was described as male-centred (e.g. advertisements portraying men in the profession; lack of female role models; and a perception of being unsuitable as a female career), geeky, and technology-centred rather than outcome focused. High schools were thought to be promoting this culture, providing a narrow curriculum that focused on technology tools and lacked creativity and diversity and failed to present the wide-ranging functions and roles of ICT. High school teachers and careers advisers were thought to have a limited understanding of ICT and its potential. Apart from gender issues, the high school ICT curriculum was considered to lack inclusivity in terms of content, scope and application, and probably contributed to domestic students deciding, early in their high school education (before year 10), against a career in ICT.

The plenary session reinforced the notion that women need to know “why” and have people and community concerns about how ICT can solve people’s problems; women have concerns about how technology can build a better world. It was noted that business ICT degrees have a greater proportion of women than technology-focused degrees. It was also concluded that the ICT curriculum problem starts in high school.

Theory and practice of a gender-inclusive ICT curriculum

The survey data given in Table 26 (n = 46) revealed that 62% of respondents were unsure of what a gender-inclusive ICT curriculum would really look like – indicating that the majority of ICT academic staff is unclear about the nature of a gender-inclusive curriculum. It seems there is also uncertainty as to the effect of a gender-inclusive curriculum in that only 24% of respondents agreed with the statement that there is a link between having a gender-inclusive curriculum and the low proportion of women studying ICT, while 41% disagreed. A minority (28%) agreed that they make an effort to have an explicitly gender-inclusive curriculum. While Margolis and Fisher (2002) have noted that, on the whole, women have a different perspective of computer science (a part of ICT) to males, a small proportion (24%) of respondents agreed that an ICT curriculum that appeals to women would be different to one that appeals to men. However, the majority of respondents (89%) agreed that they would welcome informed guidelines on the practical implementation of a gender-inclusive ICT curriculum.

Table 26 Compiled responses to survey statements about a gender-inclusive curriculum

Statements regarding an ICT curriculum	**SD**	**D**	**N**	**A**	**SA**
We are unsure of what a gender-inclusive ICT curriculum would really look like	2	9	6	21	7
An ICT curriculum that appeals to women would be different to one that appeals to men	6	15	13	10	1
We make an effort to have an ICT curriculum that is explicitly gender inclusive	1	20	10	8	4
There is a link between having a gender-inclusive curriculum and the low proportion of women studying ICT	3	14	14	10	0
We would welcome informed guidelines on the practical implementation of a gender-inclusive ICT curriculum	1	0	4	25	15

Questions about the features of the ICT curriculum that would appeal to females and males were used to further explore the awareness amongst Australian ICT academics of different perspectives in ICT interests between females and males.

Perceptions of an ICT curriculum that would appeal to females

Table 27 shows categorised responses to the free text question about the features of an ICT curriculum that appeal to females. Thirty-five per cent of respondents either left this field blank or stated that they didn’t know. A little over half of the respondents gave some indication of what appealed to females in the ICT curriculum. Of the total, 30% of respondents noted that what appealed to women was the “people” side of ICT, using words such as “people”, “social”, “community”, “collaborative”, “society” and “humanity”. This is consistent with the conclusions of Courtney, Timms and Anderson (2006) and Craig, Fisher and Lang (2007) that females are particularly interested in the people part of the profession and the application of ICT; for example, as one respondent noted:

> *"The application of curriculum should be gender sensitive not the curriculum. It is important to show that the curriculum does what female students are interested in. It includes providing welfare, health, community support and similar."*

Eleven per cent of respondents noted that communication (interpersonal rather than technology) appeals to females. Differences in communication between males and females have been reported many times (Monaghan and Goodman 2006; Still 2006; Wood 2005) and are therefore likely to be relevant. A total of 11% of respondents also noted that creativity and problem solving, especially in a global or big-picture context (implying people interests), would appeal to females.

It is relevant to note that only one respondent mentioned technology itself as appealing to women, and there was no mention of laboratory work being of interest.

Table 27 Categories of responses to the survey question of features of the ICT curriculum that appeal to females

Category of responses regarding curriculum aspects appealing to females	**Number (n = 46)**	**%**
Blank	12	26
Don't know	4	9
No difference	2	4
Unsafe/unwilling to generalise	3	7
Soft/softer skills	2	4
People/social/community/society/humanity/collaborative	14	30
Communication	5	11
Creative/problem solving	5	11
Technology	1	2

Perceptions of an ICT curriculum that would appeal to males

Table 28 shows categorised responses to the free text question about the features of an ICT curriculum that appeal to males. Fifty per cent of responses mentioned some aspect of technology with the words "hardware", "networking", "programming", "games", "competitions", "technology" and "shooting". Only one person noted that not all men like playing with technology.

Various other aspects of the curriculum that appealed to males were mentioned, such as laboratory work, solo efforts, creativity, problem solving, design, building and project management. There was no mention of males having an interest in people or the application of technology to social issues. The view that males in ICT tend to be more interested in the technology than social and human concerns has been reported elsewhere (Lewis et al., 2007; Lewis et al., 2006; Moore et al., 2005).

Table 28 Categories of responses to the survey question of features of the ICT curriculum that appeal to males

Category of responses regarding curriculum aspects appealing to males	Number (n = 46)	%
Blank	13	28
Don't know	3	7
Difficult/unsafe to generalise	3	7
Hardware, networking, programming, games, competitions, technology, shooting, play	23	50

Measures to ensure a gender-inclusive curriculum

Table 29 shows the categories and responses to the open-ended survey question about the measures taken to ensure a gender-inclusive ICT curriculum.

Thirty-nine per cent of respondents either left this blank or indicated that they didn't know or were unsure. Twenty per cent commented their curriculum was not gender inclusive or that they had done nothing to make it so. A few noted that "soft skills" such as communication and teamwork had been increased and that male-centred examples and stereotypes were avoided. A few also noted that technology was presented as part of a systems or society or people perspective. A couple of people considered that allowing students to select their own projects was part of being gender inclusive. One person also mentioned the use of female role models.

Table 29 Categories of responses to the survey question of the measures taken to ensure a gender-inclusive curriculum

Measures taken to ensure a gender-inclusive ICT curriculum	Number (n = 46)	%
Blank	14	30
Don't know/unsure	4	9
Done nothing or non-existent	9	20
Increased soft skills such as teamwork, communication	3	7
Avoiding stereotypes and male-centred examples	3	7
Technology as part of the system/society/people perspective	3	7
Project choice	2	4

Findings from the survey of industry professionals

Gender in the ICT industry

Table 30 shows the results of the four gender issues to which industry professionals were asked to respond.

Table 30 Gender statements asked of industry professionals

Gender issues (% responses)	SD	D	N	A	SA		Total
ICT is generally male oriented with a masculine culture	5	18	21	43	14		132
My workplace is male dominated with a masculine culture	7	18	28	41	5		131
Female perspectives and approaches to ICT issues and challenges are valuable	0	2	11	39	49		132
In my workplace, female perspectives and approaches to ICT issues and challenges are actively sought	2	12	34	31	21		131

Fifty-seven per cent of the ICT professionals agreed that ICT is generally male oriented with a masculine culture (23% disagreed), and 47% agreed that their workplace is male dominated with a masculine culture (25% disagreed). There was overwhelming agreement that female perspectives and approaches to ICT issues and challenges are valuable (89%), and 52% agreed that female perspectives and approaches to ICT issues and challenges were actively sought in their workplace (14% disagreed).

While females are in the minority in the ICT industry, the respondents do not indicate that there is a strong masculine culture. However, the survey did not allow respondents to identify their gender, so we can only assume that the majority of respondents were masculine in keeping with the majority of males in the ICT workplace. Given that reasonable assumption, it seems that males do not consider themselves as portraying a masculine culture and that they value female perspectives and approaches.

There were 45 answers to the request for a written response which was worded as follows: "Regarding gender issues, any suggestions for universities in preparing students for the workplace?" It was generally acknowledged that the ICT workplace was male dominated, and several indicated their belief that schools (secondary and primary) are the root cause of the attitude held by students that ICT is for boys. Employers noted that while they needed and would like to appoint more females, a small proportion of responses to ICT job advertisements were received from female applicants, for example:

> *"This doesn't answer the question but attracting females to ICT and software development in particular is key so that industry has some females to employ. Less than 10% of our job applicants are female."*

Some respondents noted the gender differences in communication styles and that students needed to have good interpersonal and communication skills (commonly thought of and described as "soft") in a male-dominated environment. Only one person mentioned that the university ICT curriculum should be more gender inclusive and better balanced with consideration given to female approaches to work and life such as social and collaborative patterns:

> *"I think there are two issues here. I think the curriculum and course structures are just as male-biased as the workplace they end up in. I think universities should re-think what they offer students and how they focus their courses and take into consideration how women approach work/life. Web Technologies, for instance, instead of 'programming'. Web Technologies allows for content related to social networks and connectivity. Collaboration is much more a female trait and that should be much more incorporated to keep the courses attractive to females (and hopefully change the work place culture over time)."*

It was also noted that sexism in the workplace is often subtle and so integrated into everyday life that it was hardly recognised, and that it is usually the women who have to deal with the issues to develop and maintain self-confidence.

Discussion

Enrolment strategies in relation to a gender-inclusive curriculum

As discussed by forum attendees, it is broadly recognised that the ICT culture from high schools through to industry is male dominated and that the proportion of females studying ICT is small (Craig et al., 2007; Lang et al., 2010; Lasen, 2010; Lewis et al., 2006; McLachlan et al., 2010; Miliszewska and Moore, 2010; Young, 2003). Results from the survey of Australian ICT academics have shown that the higher education ICT curriculum is largely reflective of that culture and that a gender-inclusive curriculum does not appear to be well understood or established.

It may be postulated that the culture and the curriculum are related, mutually reinforcing and perpetuating. However, only 24% of survey respondents agreed with the statement that there is a link between having a gender-inclusive curriculum and the low proportion of women studying ICT. Given the widespread nature of the culture, it is not surprising that strategies to increase female participation in ICT higher education over the years have not changed much and have largely been unsuccessful.

The survey revealed a range of intervention strategies employed by universities in an attempt to encourage more females into ICT, including using female ambassadors and female-only events at universities. A likely reason for the persistence and lack of success of these intervention strategies is that the evaluation conducted is not formal or rigorous (Craig et al., 2011).

Other suggested strategies included more effective ACS activities (unspecified) or greater federal government financial incentives and policies to bring about cultural change. However, if the curriculum remains male centred, the culture is unlikely to change and enrolment strategies will continue to be largely ineffective fringe activities in regard to increasing the proportion of female enrolments. Present approaches may be effective in maintaining the small numbers of female enrolments. Alternatively, this may be evidence that there is a core of female students who will persist under any circumstances.

Gender-inclusive ICT curriculum perceptions

The majority of survey respondents agreed that they were unsure about what a gender-inclusive ICT curriculum would really look like, yet a relatively large proportion identified the features of an ICT curriculum that appeal to males and females that are consistent with other published findings. About 40% of survey respondents noted that females tend to be more interested in the people side of the discipline and the skills required to benefit society and humanity at large – a view that is supported by the literature (e.g. Bissell et al. (2002); Margolis and Fisher (2002); Tillberg and Cohoon (2005); Courtney et al. (2006); and Craig et al. (2007)). Approximately 50% of survey respondents also noted that males tend to be more interested in the technology rather than human concerns, which is a view also supported by the literature (e.g. Moore, Griffiths and Richardson (2005); Lewis et al. (2006); and Lewis et al. (2007)). Workshop attendees also expressed similar views.

It seems that the perceptions of differences in male and female approaches to ICT are recognised to an extent: almost half of the surveyed ICT academic staff is aware of gender differences and interests in the discipline, yet a much smaller proportion indicated that any practical measures addressing these issues were in place. There appears to be a considerable gap between what is known (or at least suspected) and practised. This is supported by the fact that 89% of survey respondents expressed the desire for informed guidelines on the practical implementation of a gender-inclusive ICT curriculum.

These findings are not meant to imply that different female and male approaches to ICT are as a result of exclusively masculine or feminine characteristics; rather that there is a tendency broadly related to gender resulting from societal influences which dictate what is feminine and what is masculine (Dingel, 2006; Jaworski and Coupland, 1999; Seymour and Hewitt, 1997). Undoubtedly, there are women interested in the technology *per se* and men interested in the social application.

If the ICT academic curriculum designers are also affected by these societal influences which dictate gender, and are only partly aware of them (as suggested from these survey results), then gender stereotypes are being reinforced and contributing to the lack of gender inclusivity in the teaching of ICT.

The issue of a gender-inclusive curriculum is not confined to ICT. Engineering (a related discipline) is also beginning to address these issues (Mills et al., 2010). A significant factor in making the curriculum more gender inclusive is concerned with emphasising the *context* of the technology so that all students may readily perceive its relevance to improving society (Koppi et al., 2010). Other curriculum aspects such as student experiences, forms of assessment, learning and teaching methods and the learning environment are also part of gender-inclusive considerations (Mills et al., 2010). The deliberate implementation of gender-inclusive practices has been shown to make significant differences in attracting and benefiting all students (Margolis and Fisher, 2002). However, changing the curriculum locally depends on many factors, such as individuals, politics and fashion; and academic merit and curricula practised elsewhere are not necessarily major concerns at the local level (Gruba et al., 2004).

One survey respondent noted that the emphasis should not be on gender differences, rather on inclusivity:

> *"Not very sure that we should be focussing on gender differences – there is such variability in what attracts students. A broadly inclusive curriculum that includes activities such as business studies, social benefit, multimedia and media design, soft skills, etc will attract a broader range of students, including females."*

Gender in the ICT workplace

The survey of ICT professionals in the workplace confirmed the gender imbalance and also showed that industry workers recognised that males and females generally have different interests, perspectives and approaches as shown by the literature cited in this report. Few survey respondents specifically responded to the question about giving suggestions to universities in preparing students for the workplace. Suggestions included awareness-raising amongst students of gender and equity issues; actively encouraging females to enter ICT; developing good communication and negotiation skills and dealing with conflict; ensuring academics do not promote gender bias; and showing how ICT contributes to social improvements. Incorporating these aspects into the curriculum would make it more inclusive and be beneficial to all students.

Conclusion and recommendations

There appears to be an appreciation amongst a significant proportion of ICT academics in Australia that there are different gender perspectives and interests in ICT. However, this awareness has not necessarily translated into a gender-inclusive curriculum at most institutions. Perhaps because of the uncertainty of the nature of a gender-inclusive curriculum, the desire for informed guidelines on developing such a curriculum has been strongly expressed.

Probably the single most useful recommendation that can be made from this investigation is that guidelines for a gender-inclusive ICT curriculum should be developed.

While the gender of survey participants was not identified, forum attendees were predominantly male, and given the gender balance amongst ICT academics, it is likely that the survey results reflect a male perspective. Nevertheless, the strong desire (89% of survey respondents) for informed guidelines suggests that most ICT academics would welcome them.

Research has shown that a comprehensive approach to curriculum design needs to be adopted to make it more inclusive, and that emphasis should be more on inclusivity rather than on gender alone (Mills et al., 2010). Notwithstanding the rapid change of technology, or perhaps because of it, comprehensive curriculum revision is likely to be a protracted process because of innate conservatism and the slow pace of curriculum change in the ICT sector (Gruba et al., 2004).

Most universities make a special effort to attract more female students into ICT even though the prevailing culture is male dominated, the majority of academic staff is male and the curriculum is apparently largely biased towards programs more appealing to males. However, significant increased enrolments of females can only be expected to occur if they perceive an unbiased culture at all levels.

Even though there is inertia to curriculum change in the sector, given the general awareness of gender differences and apparent desire for change amongst ICT academics, it would appear that the current paradigm might be close to a tipping point. The availability of informed guidelines for the development and implementation of a gender-inclusive ICT curriculum may facilitate the change required.

Suggestions made by ICT professionals in industry about how to prepare students for the workplace confirm that gender issues need to be addressed in the curriculum and that all students would benefit by doing so. This would subsequently help bring about culture changes in the workplace and promote a more balanced perception of gender in the ICT professions amongst the general public.

CHAPTER 4: The teaching-research-industry-learning nexus in ICT education

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Background

Koppi and Naghdy (2009) introduced the concept of the teaching-research-industry-learning (TRIL) nexus in ICT education in their report for an Australian Learning and Teaching Council (ALTC) Discipline Scoping Study. They found that both ICT graduates and employers felt that graduates were not well prepared for industry, and that both ICT academics and industry wanted closer ties. Their report highlighted that in addition to the well-documented relationships between teaching and research, the importance of bringing industry into the mix needed to be explored. The possible relationships between the components of the TRIL nexus are summarised in Figure 9.

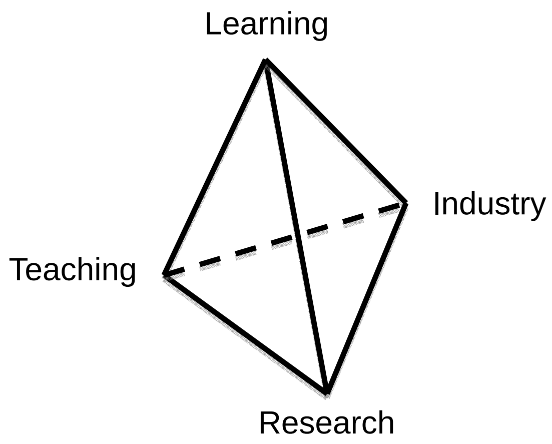

Figure 9 The TRIL nexus depicted as a 3D tetrahedron to show the possible connections

Many ICT academics consulted in the Discipline Scoping Study (Koppi and Naghdy, 2009) considered the notion of the TRIL nexus important, yet found it hard to articulate what the implications might be. Koppi and Naghdy argued that greater understanding of the concept was needed and proposed that strengthening of the TRIL nexus would lead to curriculum improvements. This project area aimed to improve understanding of the TRIL nexus and to investigate how the interrelationships can benefit teaching, research in academia and industry, student learning and curriculum development. This was achieved via an exhaustive review of both the general and ICT-specific relevant literature followed by surveys of both ICT academic leaders and industry. The findings from each are discussed below, followed by recommendations for achieving the benefits associated with strengthening the TRIL nexus.

Literature review

The term "teaching-research nexus" has been used in a wide variety of ways in the literature, with several researchers developing categorisations to describe different forms of the nexus. These include students doing research; teachers doing research; teachers and students doing research together; and research being embedded in the curriculum (Trowler and Wareham, 2007). The most widely discussed categorisation is Healey's (2005) categorisation that identifies students as audience or participants, and the emphasis on research as content or process. Figure 10 shows the four categories of approaches.

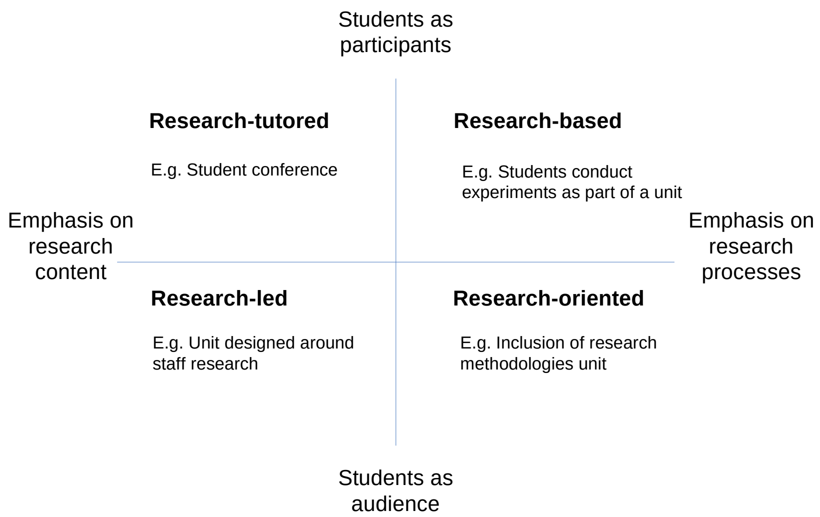

Figure 10 Students in the teaching-research nexus (Healey, 2005)

Despite the lack of quantitative evidence in the literature to support the importance of the relationship between research and teaching (Hattie and Marsh, 1996), the overwhelming consensus of opinion (e.g. Jenkins et al. (2003); Healey et al. (2010)) is that strong benefits can flow from strengthening the relationship.

There has been less formal conceptualisation of the relationships in the ICT discipline, although attempts to formally classify ICT teaching approaches (White and Irons, 2007; 2009) have been undertaken. In addition to these, a wide range of examples of practices to improve the integration of research processes and knowledge into teaching have been described in the ICT education literature (e.g. individual research-led courses, where academics' research is used to drive curriculum development (Hannon et al., 2005; Thomas and Mancy, 2004) and research-based courses where students learn research processes (Clarke, 1998)). Reed et al. (2000) and Strazdins (2007) describe comprehensive research-based and research-oriented efforts to introduce a research culture throughout an entire undergraduate computer science curriculum.

However, there have also been some concerns published about the appropriateness of the approaches for all students and the attendant difficulties for staff. Strazdins (2007) notes that a research-based ICT education may not be suitable for all students, especially those of lower ability and at lower undergraduate levels. Strazdins (2007) also comments on the view of some academics that it can be hard and time consuming to establish research-based assignments and to get students working in groups on them. This is particularly the case when classes are large and teaching loads are high. Despite these concerns, the consensus of published ICT academics who have attempted various forms of integration of research into their teaching and their students' learning appears to be that, if applied well, the potential benefits in terms of higher quality pedagogical outcomes and enhanced student and academic experience are considerable.

The increase in authentic learning experiences in Australian universities' (Patrick et al., 2008) and peak bodies' desire for closer links with academia in regard to the development of graduate capabilities (Healy, 2009) indicate that the nexus between universities and industry is becoming increasingly important. However, while key strengths of learning through workplace experiences have been identified (Billett, 2001), little has been written about student involvement in research with industry.

ICT graduates, academics and industry have all expressed their support for greater industry involvement (Koppi and Naghdy, 2009), and there are a number of examples in the literature of attempts to improve linkages. These examples include incorporation of real-world projects into courses (Bruhn and Camp, 2004; Schilling and Klamma, 2010; Zilora, 2004) and the use of work placement programs (Carpenter, 2003; Wallace, 2007). Other reported approaches include the use of industry advisory boards for curriculum development (Catanio, 2005) and provision of short courses to industry (Morasca, 2006). The latter author reports that offering short courses to industry provides benefits not only to industry personnel who take the courses but to the teachers who can gain good insights into current practices and future trends. The incorporation of industry certifications into degree structures has also been discussed (McGill and Dixon, 2005), with students perceiving potential benefits relating to real-world experience and employability, while teachers are more involved with industry partners than might otherwise be the case, as they must usually also be certified. Finally, ICT academics can be encouraged to undertake consultancy- and industry-based research. These activities can enable organisations to have access to the knowledge and expertise in universities, provide practical experience to staff, and make teaching and research more relevant to current industrial needs (Oyebisi and Ilori, 1996).

Although there has been little formal evaluation of the impacts of ICT industry connections on teaching, learning and research, it appears that the establishment and maintenance of industry links is associated with positive outcomes for students, academics and industry. In effect, greater involvement of industry in education can bring the four components of TRIL together by enabling the development of industry-relevant curricula; providing more work integrated learning and authentic learning experiences for students, which would improve their employability; and providing more research opportunities for students and academic staff and industry.

Methods

To further explore perceptions of the nature and value of the TRIL nexus in ICT education, separate surveys of ICT academic leaders and industry ICT professionals were carried out.

The academic leader of ICT in each of the 38 Australian universities belonging to the Australian Council of Deans of ICT (ACDICT) was contacted to participate in a survey designed by the project team. Ultimately, 22 responses were received from 18 universities (a few universities provided responses from different ICT areas, thus representing a 47% university response rate), and these are taken as providing a representative view of the nature and value of the TRIL nexus in ICT education from the perspective of those leading the discipline and guiding the development and teaching of ICT academic offerings in Australia.

The industry professionals surveyed consisted of ACS members and Industry Advisory Board members for ICT at the four partner institutions. A combination of paper-based and online surveys (designed by the project team) were used to survey Advisory Board members, and a total of 68 responses were received from them. A request on the homepage and an emailed branch newsletter asked ACS members in the workplace to complete an online survey (designed by the project team); a total of 114 responses were received from ACS members, making a total of 182 responses from ICT industry professionals. However, the total number of responses to specific questions relating to the TRIL component of the surveys differed throughout the survey, and the numbers of responses to specific questions are given in the relevant tables.

Findings from ICT academic leaders

The survey items relevant to the TRIL nexus were designed to clarify the outcomes associated with the TRIL nexus and to investigate what more Australian universities believe they could be doing to exploit synergies associated with the TRIL nexus in ICT education. There were eight items that related to benefits associated with the industry component of the TRIL nexus (see Table 31 for a list of the items) and seven items that presented outcomes associated with the research component of the TRIL nexus (see Table 32 for a list of the items). Respondents were asked to rate their agreement with each of these statements on a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”.

Two Likert scale items to capture perceptions of synergies were also included:

- “Universities should be doing more to take advantage of synergies between industry, research and teaching and learning”
- “There is a synergy between teaching, research, industry and learning”.

An open-ended question that asked, “What more should universities be doing to take advantage of synergies between industry, research and teaching and learning?”, was also included.

Overall, the ICT academic leaders believed that there is a synergy between teaching, research, industry and learning. Eighty-six per cent agreed or strongly agreed, and no respondents disagreed with the notion that there is a synergy between teaching, research, industry and learning. Further results of the survey are given below.

Industry component of the TRIL nexus

Table 31 presents the responses relating to the industry component of the TRIL nexus. The vast majority of participants felt that their school needed more connections with industry (77%) and that research in their school would be improved by making more connections with industry (86%).

Respondents believed that student learning benefits both directly from associations with industry and indirectly via staff connections. Direct student connections with industry include activities such as work placements and industry-related projects, and obtaining industry certifications. Twenty of the ICT academic leaders (91%) agreed that their students' learning is helped by these kinds of connections with industry, and none disagreed. They also believed that industry connections formed by academic staff were important for student learning. These connections can include provision of courses to industry, the establishment and use of industry advisory boards, and consultancy and/or industry-based research activity. Eighteen ICT academic leaders (82%) agreed that these kinds of connections with industry help student learning, and none disagreed.

The nature of potential improvements in learning associated with industry connections was further explored in several questions. The vast majority of ICT academic leaders believed that involving students with industry in various ways increases their awareness of the problems and issues faced in the industry (95% agreement) and stimulates their interest and enthusiasm (91% agreement). The majority of participants (73%) also agreed that involving students with industry increases their understanding of subjects.

Table 31 Benefits associated with the industry component of the TRIL nexus given as counts

	SD	D	N	A	SA	Total
The school should have more connection with industry	1	2	1	11	6	21
The research in this school would be better if we had more connection with industry	1	1	1	13	6	22
Industry connections formed by academic staff help student learning	0	0	4	9	9	22
Learning by our students is helped by their connections with industry	0	0	2	12	8	22
Students would learn better if they had more connection with industry	0	2	3	11	6	22
Involving students with industry increases their awareness of the problems and issues faced in the industry	0	0	1	12	9	22
Involving students with industry increases their understanding of subjects	1	2	3	10	6	22
Involving students with industry stimulates their interest and enthusiasm	0	1	1	13	7	22

Research component of the TRIL nexus

The majority of the ICT academic leaders who participated in this study concurred with the benefits identified in the literature but were mindful of the potential for very research-oriented staff to perhaps disengage from student learning concerns. Sixty-four per cent of participants agreed that discipline-based research in their school leads to better student learning, and only 5% disagreed. This lack of complete consensus about the benefits may result from concerns about research detracting from teaching and learning. This is discussed further below.

As shown in Table 32, the perceived positive impacts on learning associated with involvement in research include increased understanding of subjects; improvements in research skills; and increases in interest and enthusiasm. The vast majority (86%) of the ICT academic leaders agreed that involving students in research increases their understanding of subjects. Ninety-one per cent agreed that involving students in research stimulates their interest and enthusiasm, and 95% agreed that it improves their research skills.

Participants in this study were divided over whether academic staff who are focused on research may be less interested in teaching and learning, and whether this may have a negative impact on student learning. Forty per cent agreed and 45% disagreed that academic staff who are focused on discipline-based research are less inclined to be interested in learning and teaching. Twenty-seven per cent agreed that the emphasis on research by academic staff involved in discipline-based research may have a negative impact on student learning, and 59% disagreed with this statement. This seems to indicate that, in general, over-involvement in research is not perceived as a serious problem for student learning: the positive aspects identified appear to outweigh the concerns.

Table 32 Outcomes associated with the research component of the TRIL nexus given as counts

	SD	D	N	A	SA	Total
Discipline-based research in the school leads to better student learning	0	1	7	9	5	22
Involving students in research increases their understanding of subjects	0	1	2	11	8	22
Involving students in research stimulates their interest and enthusiasm	0	0	2	10	10	22
Involving students in research improves their research skills	0	0	1	7	14	22
The lack of academic staff involved in discipline-based research in the school has had a negative impact on student learning	1	4	10	0	4	19
Academic staff who are focused on discipline-based research are less inclined to be interested in learning and teaching	5	5	3	6	3	22
The emphasis on research by academic staff involved in discipline-based research may have a negative impact on student learning	7	6	3	4	2	22

What more should universities be doing to take advantage of synergies between industry, research and teaching and learning?

The majority of ICT academic leaders (82%) believed that universities should be doing more to take advantage of synergies between industry, research and teaching and learning. Participants were asked to elaborate on this and describe what they felt universities should be doing to take further advantage of synergies between industry, research and teaching and learning. It was interesting to note that almost all suggestions related to the industry component of the TRIL nexus.

The predominant theme of the recommendations was that universities should provide more support for making connections with industry (6 comments). The nature of the support proposed varied between participants with all the following mentioned: resources (unspecified); money; administrative support; small grants; and sabbaticals. Typical comments included:

> *"Actively seek connections with industry. Provide administrative support to staff making such connections."*
>
> *"Small grants and sabbaticals for industry engagement"*
>
> *"Provide more resources at grassroots for such activities. That is the key."*

Two participants recommended that universities should more actively help industry, presumably believing that this support would lead to reciprocal benefits for teaching, learning and research in universities in the future:

> *"Being proactive in the nurturing/incubation of ICT companies in regional areas"*
>
> *"Engaging with industries, identify problems that they are trying to solve. Help them think about different ways of solving problems."*

The final suggestion on approaches to increasing connections with industry was that peak ICT academic bodies should encourage industry to support university initiatives to increase engagement with industry:

> *"Make sure that the ACDICT convinces Industry to help."*

Only one participant made a suggestion that related to the research component of the TRIL nexus. This recommended that students should obtain practical experience with applied research, thus embracing both the research and industry aspects of the TRIL nexus:

> *"Undergraduate students in my opinion should take at least 1 unit which is research based working in teams for Academia and Industry researchers in a 3 year UG degree. This should not be in the 3rd year but probably in the second (early)."*

It is interesting that despite strong recognition of the benefits of integration of both research and industry activities and connections into ICT teaching and learning, the ICT academic leaders were more cognisant of the need to strengthen the industry component of the TRIL nexus than they were of the need to strengthen the research component. This may reflect the fact that research is (and has always been) an integral part of academic life, and that academics have already taken steps to enable the learning undertaken by their students to benefit from it. The connections with industry are, however, less well embedded in universities. Whilst there have been some published examples of successful strengthening of these links, ICT academic leaders clearly believe that more is required.

Findings from ICT industry professionals

As discussed above, the survey of ICT academic leaders found that universities were very positive about the value of associations with industry. The survey of industry explored these relationships from the perspective of those working in industry and found that, in general, those working in industry perceive connections between universities and industry as valuable. Of the 182 responses, 91.8% agreed that connections between universities and industry are very valuable.

Table 33 shows the potential involvement of industry in learning and teaching in a number of areas from the perspective of ICT industry professionals. In terms of input into what is taught in ICT degrees, the participants believed that industry involvement is important: 89% agreed that universities should have industry representation on committees that review and/or design the curriculum; and 83.4% believed that universities should seek indirect input into the curriculum through industry bodies (e.g. AIIA) or from government agencies/reports. The nature of this input was also considered. Respondents were most likely to believe that industry should provide advice relating to high level themes or focus of courses (88% agreement). They also wished for input into the syllabus of individual subjects (66% agreement), but less than half (45%) believed that industry should provide advice relating to the structure of degrees. Not surprisingly, only 25% felt that industry should advise on teaching methods.

Table 33 Potential involvement of industry in teaching and learning

	SD	D	N	A	SA	Total
Universities should have industry representation on committees that review and/or design the curriculum	3	4	13	78	83	181
Universities should seek indirect input into the curriculum through industry bodies (e.g. AIIA) or from government agencies/reports	5	8	17	95	56	181
Industry should provide advice relating to high level themes or focus of courses	1	4	14	83	53	155
Industry should provide advice relating to the structures of degrees	6	24	56	52	18	156
Industry should provide advice relating to the syllabus of individual subjects/units (including topics and skills)	7	19	28	76	27	157
Industry should provide advice relating to the teaching methods used	21	52	46	21	18	158

In addition to connections related to teaching and learning, respondents were asked about connections relating to research and obtaining expertise from universities. Table 34 provides information about the other kinds of interactions with universities that the respondents believe would be valuable for their own organisation. Short courses provided by universities appear to be the most desired form of interaction, with 68% of respondents agreeing that short courses would be useful to their organisation. The value to university ICT staff of offering short courses has also been noted in the literature (Morasca, 2006). Not only do they allow industry to receive training in emerging areas, but they allow academics to maintain contacts and to gain insights into current practices. The following comments indicate the kinds of courses desired:

> *"Short refresher courses on current methodologies"*
>
> *"Courses specifically using industry tools - including both short courses and academic programs"*
>
> *"Organise short courses at a reasonable cost that count towards ongoing professional development."*

Research relationships were also seen as useful, with 48% of industry participants agreeing that research relationships with universities are very useful to their organisation and 41% wishing for more research relationships. Consultancies by university ICT academics were seen as the least useful form of interaction with universities (40% agreement). This lack of interest from industry is perhaps because of the financial implications.

Table 34 Potential involvement of industry in non-teaching and -learning connections with universities

	SD	D	N	A	SA	Total
Research relationships with universities or university staff are very useful to my organisation	4	12	52	38	24	130
My organisation would like to have more research relationships with university staff	4	8	65	41	13	131
Consultancies by university ICT academics would be very useful to my organisation	5	13	61	40	12	131
Short courses provided by universities would be very useful to my organisation	4	11	27	71	18	131

Industry respondents were asked specifically about whether their organisation currently encourages engagement with universities. Table 35 summarises their responses. The most encouraged activity was hosting internship or work placement students (66%), and a number of participants called for even further support of this activity:

> *"Provide more intern spaces."*
>
> *"Providing guaranteed work placements to students"*

Provision of guest speakers was also well supported (62.3% agreement). The following quotes illustrate this sentiment:

> *"…More Industry Guest Lectures as part of Course. - Potential to have 1 Guest Industry lecture Per Subject as Compulsory"*
>
> *"Have up to 2 lectures in each unit be given by external industry."*
>
> *"Become more involved in taking guest lectures on various subjects (for example on the topics of agile project management and specific development technologies)."*

Participation on university committees also appeared to be strongly encouraged (60%), and there was substantial support for hosting site visits (44%) and provision of case studies or project ideas (44%). The activity that participants felt was least encouraged by their particular organisation was research linkages (38% agreement). Participants were also asked if there were other forms of engagement encouraged by their organisation. The only additional connection mentioned was direct communication with lecturers in order to provide an industry perspective on assignments.

Table 35 Support of respondents' organisations for interaction with universities

My organisation encourages engagement with universities such as:	**SD**	**D**	**N**	**A**	**SA**	**Total**
participation on university committees	6	14	36	57	27	140
provision of case studies or project ideas	6	19	54	50	10	139
hosting site visits	6	22	50	52	9	139
provision of guest speakers	3	12	37	65	21	138
hosting internship or work placement students	7	10	30	64	27	138
research linkages	8	18	60	41	12	139

In addition to the generally positive responses received about the value of and support for different kinds of connections with universities, a number of comments critical of universities and their interactions with industry were received. These included the following:

> *"Because universities nowadays interact very little with industry (try getting a university lecturer to give a presentation to an industry SIG - impossible!), industry tends to not want to have anything to do with universities."*
>
> *"We have tried many times, the universities are only interested on their arrogant terms."*
>
> *"My general feeling is that universities are completely out of touch with industry. The ACS-W program is a great example of this. It's run by academics and provides no real benefit to the many women working in the ICT industry. Another example is the recent IEEE-WISE international conference held in Perth. By any standard, it was an unmitigated disaster. I think the blame goes squarely on the shoulders of the academic approach with absolutely no effort in marketing or to attract*

attendees from industry."

"Honestly, I think the universities aren't interested in what industry is doing. There's an arrogant and ignorant view about what goes on off the campus."

Whilst only apparent in a small number of responses, this perception of universities as uninterested and inaccessible signals a potential barrier to realising the synergies associated with the TRIL nexus.

Industry participants were also asked what more they believed that universities could do to strengthen connections with industry and what more they believed that their organisation or industry could do. The responses to these open-ended questions were content analysed and the themes that emerged are listed in Table 36.

Table 36 Themes in industry participants' suggestions for strengthening connections with industry

What more universities could do	What more industry could do
Create more opportunities for interaction with academics (13)	Become more involved in teaching and research supervision (12)
Market more to industry (7)	Create more opportunities for interaction (8)
Facilitate more student contact (6)	Communicate needs to universities (2)
Actively seek problems and unsatisfied needs from industry and help address them (7)	Provide research funding (2)
Be less "academic" and more "real world" (3)	Work with professional bodies (2)
Work more with industry associations and professional bodies (5)	Provide technology to universities (1)
Have liaison roles (3)	
View industry as a partner not a just a source of funds (3)	
Focus on a key set of organisations and align with them (1)	
Offer industry certifications (1)	

The most frequently provided suggestions for what universities could do to strengthen connections with industry related to increasing opportunities for contact and interaction with both academic staff (13 suggestions) and students (6 suggestions). There appeared to be a strong desire from industry to be provided with situations that would allow them to develop ongoing relationships. The following comments illustrated this:

"Offer to host industry user groups on university facilities and encourage staff to become involved in these user groups. This would increase networking potential with industry, could give the staff an opportunity to learn from presentations given by industry at these events, and staff could present at these events as well."

"Maintain communications with past students."

"Have industry events held at universities for the Industry plus students."

Some respondents believed that creating liaison roles was an important way to achieve improved interactions (3 comments):

> *"Employ specialised people to act as Industry Liaison people who have good experience and can act as a bridge between industry and the Uni. Not academics who have not been in industry for years and lost touch with reality."*
>
> *"Perhaps assign student (or staff) liaisons to potential industry partners to engage the industry partner in further activities with the university and develop the relationship."*

Respondents also recognised that creating these opportunities was not solely the role of universities, with eight respondents suggesting that industry should also create more opportunities for interaction:

> *"Encourage staff to maintain contact with the organisations they studied with."*
>
> *"Promote more post-graduate learning among staff."*
>
> *"Bring researchers to workplace for discussion."*

Some respondents considered that universities should market more to industry (7 suggestions), perhaps considering that their organisations were not fully aware of the benefits that could be realised; for example:

> *"Market more to industry. Possibly use success stories from previous engagements as proof statements of the value and benefit to industry."*
>
> *"I think that Universities need to be more proactive in advertising what they can do for organizations. This would include road shows that highlight what the universities do, industry nights and other contact events."*

Several themes related to the perceptions universities may appear to hold about industry and the need for universities to better understand where industry is coming from. Three respondents urged universities to be less "academic" and more "real world"; for example:

> *"Educate all University staff (particularly senior research staff) to understand industry's 'reason for being' and in particular the drivers that link technology opportunities to commercial outcomes."*
>
> *"Actually do industry research rather than call their pet project 'industry related'."*
>
> *"Have ARC linkage be judged by industry not academics."*

This sentiment was also associated with advice to view industry as a partner and not just a source of funds (3 responses), and to actively seek problems and unsatisfied needs from industry and help address them (7 responses):

> *"Stop looking at commercial organisations primarily as an opportunity to get funds."*

“Put some effort into it. See industry as a customer not a source of funding. Most if not all approaches from universities are because they want something: money (e.g. research funding, student scholarships etc), ideas (project or research topics), or provide assistance to students (advice on projects, placements etc). I've not seen any examples of universities working closely with a company to understand their 'issues’ and then suggesting projects, work etc that would assist both.”

“Actively seek from organizations their problems and unsatisfied needs (e.g. difficulty in credibly estimating software intensive projects) and support organizations to address the issues (research/consultancy/centers of expertise when significant enough (e.g. The UniSouthCal CSSE in USA)).”

Some respondents also recognised that industry should communicate its needs to universities (2 comments) and be prepared to provide research funding (2 comments).

Several comments recommending that universities become more involved with these groups (5 comments) and that industry also do so (2 comments) acknowledged the value of industry associations (e.g. AIIA) and professional bodies (e.g. the ACS) in helping to form and sustain connections.

Single respondents offered suggestions including focusing on a key set of organisations and aligning with them rather than trying to liaise more broadly; and offering industry certifications. Forming partnerships with industry to offer certifications has been reported in the literature as being successful (McGill and Dixon, 2005).

Respondents were also asked to consider what more industry could do to increase interactions with universities. In addition to the suggestions spanning both university and industry action that have been discussed above, the most common theme of these responses related to becoming involved in teaching and research supervision (12 responses). Many respondents recognised the benefits of this kind of interaction and were keen for their organisation to be more involved:

“Provide supervisors or assistant supervisors for theses topics.”

“Become more involved in taking guest lectures on various subjects (for example on the topics of agile project management and specific development technologies).”

“Be involved with defining/mentoring final year projects.”

“Have interns from 3rd/4th years come and do work on a project.”

“Nominating employees to give talks at various class teachings in their area of expertise”

“Providing guaranteed work placements to students”

One respondent also noted that industry could support universities by providing infrastructure such as technology. This is consistent with the recommendation that universities offer industry certifications, as these programs are often facilitated by support from organisations such as Microsoft and Cisco Systems.

Comparison of the results from the ICT academic leader and industry surveys

The results of the two surveys undertaken as part of the TRIL nexus project area highlight the consensus around the benefits for ICT of strong connections between universities and industry. Table 37 summarises the key results from the two studies and highlights the consensus that was apparent. Both ICT academic leaders and those working in industry recognise and value the existing connections between universities and industry. They recognise that industry can contribute to teaching, learning and research, and that both academic staff and students can contribute to industry. Both ICT academic leaders and those working in industry desire stronger connections, and both groups have made recommendations to help achieve this.

Table 37 Comparison of survey results

University respondents	Industry respondents
Believe connections between universities and industry are valuable	Believe connections between universities and industry are valuable
Believe university research would be stronger if there were more connections with industry	Want more research relationships with universities
Believe student learning would be improved if there were more connections with industry	Industry wants to be more involved in teaching and learning including: 1. Curriculum design – both degree and subject design 2. Provision of WIL placements 3. Provision of guest lecturers 4. Provision of case studies and project ideas
Believe student learning would be improved if students have more involvement with research	Industry wants to increase research linkages including provision of supervisors for theses
More connections with industry are desired. The recommendations for taking advantage of TRIL synergies all include increasing connections with industry. Increased support from universities for this is the common thread	More connections with universities are desired. Key recommendations include: 1. More opportunities for interaction should be created 2. Universities should actively seek problems and unsatisfied needs from industry and address them 3. Industry staff should become more involved in teaching and research supervision 4. Universities should market more to industry

It is interesting that the recommendations from ICT academic leaders primarily focused on strengthening industry connections. Thus, despite strong recognition of the benefits of integration of both research and industry activities, and connections into ICT teaching and learning, they were more cognisant of the need to strengthen the industry component of the TRIL nexus than they were of the need to strengthen the research component. This may reflect the fact that research is (and has always been) an integral part of academic life, and that academics have already taken steps to enable the learning undertaken by their students to benefit from it. For example, the ICT education literature abounds with examples of successful attempts to integrate various kinds of research experiences into the curriculum. The connections with industry are, however, less well embedded in universities. Whilst there have been some published examples of successful strengthening of these links, ICT academic leaders clearly believe that more is required, and the industry representatives agree with them.

Conclusion and recommendations

This project area sought to improve understanding of the TRIL nexus and to investigate how the associated interrelationships can benefit teaching, research in academia and industry, student learning and curriculum development. A review of both the general and ICT-specific relevant literature provided the basis for understanding the varied ways in which the connections can be forged. The opinions of ICT academic leaders and those working in industry were also explored. The kinds of connections that were described in the literature are shown in Figure 11. As can be seen, there are numerous possible connections between these components, and it can be argued that the greater the connections, the richer the potential learning experience. The survey of ICT academic leaders indicated that a substantial number of these connections are emphasised in Australian universities.

As illustrated in Figure 11, the student is a learner whether taught by a university-based teacher or industry-based teacher (or both), and the student may or may not be exposed to, or involved in, discipline-based research. That research may be basic research and relate more to academia or be applied research and relate more to industry. The student may learn about the ICT business through exposure to industry as well as learn about research and be part of the research bridge between industry and academia. Whether or not the student is involved in research, the learning experience can be enhanced by the connection between academia and industry. The majority of initiatives described in the literature represent piecemeal attempts to further integrate research or industry into the curriculum. Whist these attempts are laudable, and the authors generally report success, it seems likely that the achievement of maximum benefits associated with strengthening the TRIL nexus are more likely when a “whole degree” approach is taken. The initiatives at the Australian National University that involved redesign of several degrees (Strazdins, 2007) provide an exemplar of this approach. This kind of initiative should be extended to also include the industry aspects of the TRIL nexus.

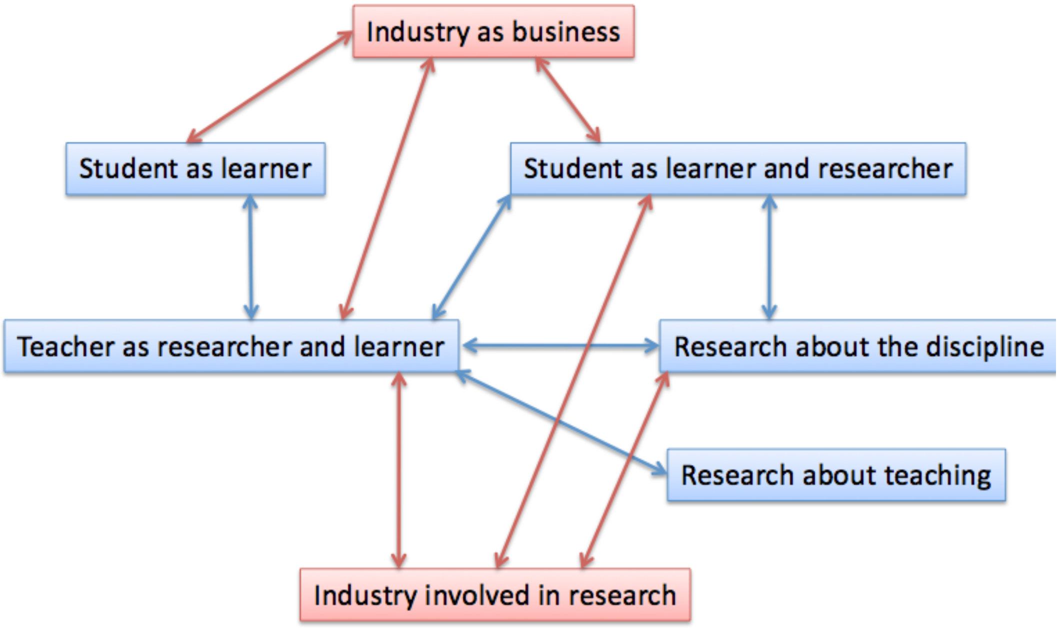

Figure 11 Connections between the TRIL components

Figure 11 shows that the academic teacher has the greatest number of connections, being involved in teaching and research and therefore also being a learner (learning being a product of research). Teaching may be about the discipline only (without including research) or include discipline research whereby student learning is about the discipline and research. The teacher may also undertake research into teaching, the outcome of which should promote student learning. Teachers have been the drivers behind most of the successful initiatives discussed in the literature, and they will most likely continue to be so. Sharing of information on initiatives and their evaluations is central to continued success. Papers such as those of Bruhn (2004) and Strazdins (2007) that provide an excellent discussion of the issues involved in successfully organising initiatives contribute to this. The results of the survey of Australian ICT academic leaders show that they greatly value the role that research plays in enriching student learning in various ways. These ways include improving students' understanding of subjects and stimulating their interest and enthusiasm. The ICT academic leaders are, however, conscious that some academic staff may focus on their own research to the detriment of their teaching, but in general believe that the positive aspects outweigh the concerns.

Industry is shown in Figure 11 to contribute to the learning of the student and teacher from both the industry and research perspectives, although the research is likely to be more applied and commercially focused. Industry itself also learns from teachers, students and discipline-based research. The student projects described by Thomas and Mancy (2004) provide an excellent example of the multi-directional nature of these relationships, with student projects not only benefiting students but having clear benefits to research, as the products were used in research later. The results of the survey of ICT academic leaders reinforce the importance of these connections. ICT academic leaders strongly believe that there are important benefits to students and staff from strengthening the industry component of the TRIL nexus. The industry participants in the study mirrored this sentiment. They were keen to strengthen research and teaching and learning linkages.

Thus, as shown in Figure 11, the connections between academia and industry identified from the literature review, and supported by the results of the surveys, reinforce learning and research in many and various ways and can provide a wide range of benefits to the people and organisations involved.

A number of the papers considered in this study have made recommendations to help others undertake initiatives to strengthen aspects of the TRIL nexus. The ICT academic leaders and industry representatives who participated in this project also made recommendations towards achieving the benefits associated with the connections illustrated in Figure 11. The following lists draw from these sets of recommendations and the analysis undertaken as part of the project and are designed to provide guidance to those seeking to achieve the benefits associated with strengthening the TRIL nexus:

1. Faculties need to formulate strategies to ensure that integration of the research and industry aspects of the TRIL nexus occurs across curricula. Sector-wide recommendations such as that of Universities Australia (2008) to include internships in all degrees, or at least work experience of some kind, need to be embraced.
2. The research and industry aspects of the TRIL should not be considered in isolation. Redesign efforts should attempt to integrate both, but a balance appropriate to the university and its stakeholders needs to be achieved. For example, research-intensive universities may favour a stronger research focus, whereas universities with a more applied focus and stronger links to local industry may shift the balance toward industry.
3. Universities should market more to industry as many organisations are not fully aware of the benefits that could be realised.
4. Industry advisory boards should play a strong role in supporting attempts to strengthen the TRIL nexus. Their value includes curriculum and content advice, provision of guest lectures, and support in obtaining student projects and sites for internships. They can also facilitate the initial connections needed for other linkages.
5. Having appropriate staff expertise is essential to the success of attempts to strengthen the TRIL nexus (Thomas and Mancy, 2004). Different academics will possess different degrees of research strength and different levels of interest and connection with industry. This needs to be taken into account and built upon.
6. To determine the most effective ways to strengthen the TRIL nexus, more sharing of innovative practices and their evaluations is needed. Seminars, conferences and scholarly papers all provide useful venues for this.
7. Sabbatical leave is currently a valuable tool for allowing staff to dedicate time to research activities. Extending this to allow academic staff to undertake consultancy or work in relevant enterprises will strengthen their ability to provide appropriate industry exposure to students (Oyebisi and Ilori, 1996).
8. Universities should actively invite industry to be more involved in teaching and research supervision; there is an unmet desire for them to participate in teaching and learning.
9. More opportunities for interaction between industry and students and academic staff should be created. Both formal and informal occasions are of value in providing situations that allow the initiation and development of ongoing relationships.

10. Universities should actively seek problems and unsatisfied needs from industry and help address them. To do this, universities need to better understand where industry is coming from.
11. Industry associations and professional bodies can play a valuable role in helping to form and sustain connections. Participation should be encouraged and opportunities to work together through these organisations should be embraced.
12. Where possible, consider each degree as a whole and redesign the degree, not just individual courses in isolation. To be truly successful, initiatives should reach across the curriculum.
13. Build up from inquiry/problem-based approaches and teaching of research-related skills in earlier courses (Reed, et al., 2000; Strazdins, 2007). Research-based approaches can then be incorporated in the more advanced courses.
14. Many of the research-based, research-oriented and industry-focused initiatives require students to demonstrate strong teamwork skills. Active attention to this is important; therefore, teachers must proactively address teamwork skills (Zilora, 2004).
15. To maintain positive links with organisations that supply student projects, faculty must ensure that promises made to customers are met. This requires that faculty responsibilities are clearly defined and workload issues are addressed (James, 2005).
16. Many of the approaches to strengthening the TRIL nexus described in the literature are labour intensive. Workload issues need to be addressed early to ensure success (Bruhn and Camp, 2004; James, 2005).

CHAPTER 5: Improving professional practice in ICT degrees

Author: Chris Pilgrim

Background

Many Australian universities have a strong history of engagement with the ICT industry regarding the design and implementation of degree programs. There are many examples of best practice including engagement with professional society accreditations, the implementation of work integrated learning programs, and other innovations such as industry-linked final year projects. Authentic engagement with industry has the potential to bring significant benefits to all stakeholders including students, the university and the industry in general.

Despite the many examples of good practices and the significant potential benefits that come from these engagements, the ICT Scoping Study (Koppi and Naghdy, 2009) found that ICT graduates and ICT employers identified common deficiencies in the workplace readiness of new graduates, particularly regarding the development of essential generic skills such as interpersonal and professional communications, business awareness and problem-solving abilities.

The Scoping Study report indicated that both new graduates and employers believed that these deficiencies could be largely addressed by appropriate workplace experience resulting in the following recommendations:

Recommendation 5

> The Australian Council of Deans of ICT (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.

This chapter aims to clarify the issues of concern that were raised in the ICT Scoping Study in the context of existing research regarding curriculum design and work integrated learning (WIL). In particular, it specifically addresses the two recommendations with the goal of improving the ICT curriculum and the overall learning experiences of students, with the aim of enhancing the professional practice capabilities of graduates.

The chapter initially presents an overview of issues relating to industry involvement in the design of university curriculum and WIL. It then describes the results of surveys of university leaders in learning and teaching in ICT and of industry representatives that provide a representative set of views of the issues. The chapter concludes with a set of recommendations.

Industry involvement in the university curriculum

The ICT Scoping Study accurately described the tensions that currently exist between universities and industry regarding the design of curriculum for ICT degree programs. Many universities have focused on the development of the foundations that will enable graduates to acquire ICT skills relevant for their work with the aim of developing a graduate with lifelong learning skills. This approach is contrary to the "application driven outcome-based curriculum" (Shoikova and Dwishev, 2004) in which there is a focus on training in the contemporary tools and techniques used in the corporate and industry environments. The ICT Scoping Study has indicated that an approach to curriculum and learning that focuses on fundamentals rather than training has resulted in a situation where employers believe that "universities are not interested in meeting industry requirements", and, subsequently, universities conclude that industry is "remote from and sceptical about university education".

The ACS ICT Profession Body of Knowledge (Gregor et al., 2008) makes the following observations regarding this tension:

1. "*There is a lack of a common understanding of the ICT profession. Amongst the general public, there is low recognition regarding what constitutes the ICT profession. There are even very fragmented views amongst the different parts of the profession."*
2. *"Different groups of stakeholders tend to look only from their own point of view and not the viewpoint of the ICT profession as a whole. For example, some employers want to just look at 'what type of graduates they want' and hand over the problem to universities to produce 'work ready' graduates."*
3. *"Some program designers focus on using curricula that matches their traditional disciplinary field, rather than looking at whether their programs lead to graduates who possess the skills and knowledge required for professional practice."*

The ACS Body of Knowledge (ACS BOK) document calls for a "common vision" that can be shared by all stakeholders including industry, government, educators, academic disciplinary bodies, the community, students and professional standards bodies. The ACS BOK encourages a partnership between universities and industry whereby curriculum designers in universities should determine what is required of professionals in the workforce when designing programs, and industry should be involved in program design through advisory committees.

The approach to curriculum design recommended by the ACS BOK is an appropriate mixture of top-down and bottom-up considerations. The top-down focus should ensure that designers consider the roles that their graduates will undertake after graduation, with an emphasis on the development of a professional who should be able to work across the boundaries of traditional disciplines. This is balanced with a bottom-up consideration of ensuring that underlying knowledge, principles and theories are covered rather than the "extreme position where programs are designed to address short-lived market trends or skills gaps".

One of the most encouraging aspects to the ACS BOK document is the development of schema that categorises ICT roles into "Technology Building, Technology Resources, Service Management and Outcomes Management". This development will aid in the partnership approach to curriculum design by establishing a common vocabulary and understanding between the stakeholders.

The Australian Government's development of a new Higher Education Quality and Regulatory Framework also has implications for the relationship between industry and universities regarding curriculum design and graduate outcomes. The key feature of the new framework is the establishment of the Tertiary Education Quality and Standards Agency (TEQSA). TEQSA will be given the responsibility to develop measures for learning and teaching outcomes and will regulate the sector against these agreed standards. The approach will involve "discipline communities" who will "own" and take responsibility for implementing academic standards. The proposed process will also require institutions to "demonstrate that their graduates have the capabilities that are required for successful engagement in today's complex world" (DEEWR, 2009).

In AUQA's May 2009 discussion paper on "Setting and Monitoring Academic Standards for Australian Higher Education", the concept of "Quality" is discussed in terms of "fitness for purpose". This paper raises the question of whether graduates of universities are "'good enough' to work effectively in the professional areas for which they have been educated" (AUQA, 2009). This discussion paper describes academic achievement standards in the context of how much, intellectually and professionally, students have learned or acquired by the time they complete their higher education courses, rather than simple graduate employment outcomes. However, the paper proposes that "national statements of desired academic achievement" be developed to formally define academic standards and that these should be developed in consultation with "national disciplinary communities" that include "the professions, industries and business communities that employ graduates" (AUQA, 2009).

An important related issue that was raised in the ICT Scoping Study regarding industry connections and influences on the curriculum relates to how a "focus on generic attributes may enhance the development of industry-ready graduates and their employability" (Koppi and Naghdy, 2009). Generic attributes are "the skills, personal attributes and values which should be acquired by all graduates regardless of their discipline or field of study" (Higher Education Council (Australia), 1992, p. 20). Such attributes or qualities include "critical thinking, intellectual curiosity, problem-solving, logical and independent thought, communication and information management skills, intellectual rigour, creativity and imagination, ethical practice, integrity and tolerance" (Bath et al., 2004). The positive benefits of embedding graduate attributes in curriculum and assessment are commonly acknowledged with a considerable body of literature reporting the practical outcomes of graduate attribute initiatives (Barrie et al., 2008); however, the reality is that there exists a significant mismatch between what the graduates in the workplace considered important abilities for their work and how they perceived universities had prepared them for those abilities (Koppi and Naghdy, 2009).

The challenge of how to coherently and effectively embed the development of generic graduate attributes into the curriculum will remain an issue for universities into the future. However, the key issue that the ICT Scoping Study identified was the challenge of "achieving a balance between developing generic attributes and teaching business skills that help prepare graduates for industry". The tension between the development of generic graduate attributes and specific task-related work skills was highlighted in the recent National Graduate Attributes Project (GAP, 2008). The GAP was a scoping project funded in 2007–08 by the Australian Learning and Teaching Council which investigated institutional strategies and institutional policy issues related to embedding and assessing graduate attributes. The GAP highlighted the range of different perspectives that can be taken regarding graduate attributes (GAP, 2008). One perspective has a focus on graduate attributes as employment skills that are required for recruitment and/or the skills needed to succeed in a job. An alternative perspective aligns graduate attributes with requirements of professional society accreditation processes; for example, the Seoul Accord (2011) has established a set of graduate attributes expected of students entering the ICT profession. A final perspective is based on a view that universities should regard graduate attributes more holistically by taking a broader view of graduates' future lives beyond their future work activities; that is:

> *"Graduate Attributes proponents would argue that universities should be about educating graduates who have the sorts of flexible ways of thinking and being, which will allow them to thrive in today's unpredictable, changing and pluralistic world. An important part of a graduate's world is the world of work, and work is also likely to be the main way in which graduates can shape society. However, work is not all there is to life and universities should equip graduates for life. So while work might be seen as possibly the most important context for the graduate to thrive in, it is not the only one".* (Barrie, 2008)

Work integrated learning

The recent ALTC National Scoping Study for Work Integrated Learning (WIL) (Patrick et al., 2009) reported on the broad and growing picture of WIL across Australia and ways of improving student learning experiences in relation to WIL. The project regarded WIL as an umbrella term that included a "range of approaches and strategies that integrate theory with the practice of work within a purposefully designed curriculum".

The number of programs that provide students in various professional fields with practical experience in the workplace have proliferated in recent times (Bates et al., 2007). This increase in interest in WIL has seen the development and adoption of a range of models of WIL extending from the traditional work experience placement to new virtual or simulated WIL experiences. In his speech to the World Association for Cooperative Education Asia Pacific Conference (O'Connor, 2008), the Hon Brendan O'Connor, representing the Minister for Education, recognised that WIL now comes in many different forms including "research, internships, studying abroad, student teaching, clinical rotations, community service or volunteer work, industry attachments or placements, sandwich programs, and professional work placements". These models of WIL may be classified on a continuum from the traditional external, industry-based WIL experiences such as work experience placements and internships, to internal, university-based experiences such as project work, case studies and experiential learning opportunities. As the demand for WIL increases, alternative models are likely to be developed and refined in order to offer students a range of options for gaining workplace experience that suits different student motivations and capabilities and different university resourcing models and priorities.

The benefits of WIL to students are widely acknowledged. Bates et al. (2007) state that WIL provides students with an opportunity to test the theoretical knowledge learnt at university and to put it into action in the complex and pressurised environment of the real professional world. In a survey of three Australian universities, Smith et al. (2008) found that all lecturers surveyed identified industry-based learning as the single best feature of their degrees, primarily because it realised the alignment of their programs to industry, and included the following supportive statement from one of the survey participants: "The experience provided a quantum step towards realistic practice and it gave students an understanding of that practice and confidence that they could meet its requirements". Other more recent surveys found that ICT graduates in the workplace strongly believe that there needs to be some form of WIL to address both what was missing from their courses and what needed improvement, and that ICT employers believe that students need more work placements to gain industry experience (Koppi and Naghdy, 2009).

The federal government also acknowledges the value of WIL with O'Connor (2008) noting the "immeasurable" value of integrating real work experience into academic programs, including recognised benefits to students: "By integrating practice and theory, students develop those important 'softer' skills greatly valued by employers, such as team work, self-management and initiative"; and other stakeholders: "Students are able to make an immediate and meaningful contribution to increasing productivity and prosperity—for industries, businesses and the nation as a whole."

O'Connor's recognition of the role of other stakeholders in the WIL process is critical to the further development and adoption of WIL. The ALTC National Scoping Study identified a broad range of stakeholders involved in providing or benefiting from WIL experiences, including students, university academic and professional staff, employers, professional associations and government (Patrick et al., 2009). Employers benefit from participation in WIL through recruitment opportunities; universities benefit through improved student learning, engagement and retention (Patrick et al., 2009); and the government and the wider community benefit through the development of a graduate workforce who can make an "immediate and meaningful contribution to increasing productivity and prosperity" (O'Connor, 2008).

The ALTC WIL Scoping Study (Patrick et al., 2009) also recommended an integrated stakeholder approach to the planning and implementation of WIL that would be based on "formalised relationships and a common understanding of the associated responsibilities and level of commitment required" where there are "clear agreements and the recognition of needs as well as mutual benefit and costs". Smith et al. (2008) link the quality of any WIL program to a "dynamic interplay of stakeholder needs" (such as academic disciplines and departments contributing to the curriculum, the expectations of industry and professional associations, and the students).

O'Connor (2008) also mentioned the "critical" requirement for a stakeholder approach in his speech but extends this to the notion of a "genuine partnership" between students, employers and education providers for effective collaborative education programs.

The partnership concept is also suggested by Orrell (2004) who noted that partnerships are a distinguishing feature of any effective work placement programs. In addition, Orrell indicates that the continuing success of WIL programs also requires identification and attainment of explicit benefits for each partner, and "if the benefit fails for any party, the partnership ceases to be effective". Orrell comments on the research of Harvey et al. (1997) who found that the motivations of host organisations ranged from those who had a "value-added" ethos in which the placement is evaluated on tangible, short-term returns for the organisation, to the "stakeholder" ethos which emphasises learning with a long-term view seeking benefits for all parties. The stakeholder approach need not preclude tangible task-related outcomes for the organisation but would also provide the student with a more holistic learning experience with intentional learning outcomes.

Bates et al. (2007) discussed the WIL partnership model by examining the respective responsibilities of each partner. They suggested that WIL is a three-way partnership between the student, workplace and educational institution with specific responsibilities for each partner. The student must take responsibility for their own learning during a placement; the university has the responsibility for ensuring the WIL curriculum provides students with learning opportunities, including a requirement for reflective learning; the academic supervisor has responsibility for mentoring, support and feedback; and the workplace organisation has the responsibility for providing a relevant and suitable project for the student to focus on and a suitable induction process for introducing students to the specific workplace.

Universities Australia (2008) proposed a National Internship Scheme to further enhance the employment skills of university students and graduates. The scheme called for a broad collaboration between universities, the government and employers noting that "graduate employability concerns should not and cannot be matters for university action alone". The aim of the National Internship Scheme was to build on the experience in place in many organisations and universities by providing for many more Australian university students to undertake structured WIL during their studies. Feedback from the initial discussion paper suggested general support for a comprehensive "package" approach to WIL opportunities, rather than a reliance on just one component. The key elements of the package included encouraging industry and universities to partner the scheme to improve the extent and content of industry internships; the government leading by example by offering internships within its own departments and agencies; industry accepting its responsibility for its role in WIL partnerships with universities; some element of public subsidy for wage supplementation and/or tax relief; and having the scheme developed as part of a wider skills agenda.

The federal government is now demanding more accountability for the quality of all higher education courses and through TEQSA are likely to adopt an outcomes approach to assessing quality of university degree programs. This may require universities to develop curriculum statements that formalise learning outcomes, and possibly formal statements of assessment methodologies. These requirements would have particular implications for WIL programs that have traditionally had relatively flexible approaches to learning outcomes, assessment and the roles of the participants (Bates et al., 2007). For universities to be permitted to charge a student contribution amount or tuition fee for a student who is undertaking work experience in industry (WEI), the university must provide “direction” to the student’s learning and performance in regards to work undertaken outside the university. The Administration Guidelines (Australian Government, 2012) specify that work is not WEI unless all of the following are features of the WEI program:

1. Ongoing and regular input and contact with the student
2. Oversight and direction of work occurring during its performance
3. Definition and management of the implementation of educational content and objectives of the unit
4. Definition and management of assessment of student learning and performance during the student placement
5. Definition and management of the standard of learning and performance to be achieved by the student during the student placement.

Given these requirements and the necessity of the management of partnership relationships, WIL should be intentional, organised and real-world rather than opportunistic or contrived. WIL requires a formal educational structure that defines the roles of the student, the teacher/supervisor, the curriculum emphasis and teaching methodologies (Calway and Murphy, 2006). Unfortunately, the experience in many universities/degree programs is contrary to such recommendations, with the Hon Brendan O’Connor citing the Department of Education, Employment and Workplace Relations survey of final year university engineering students in Australia in 2007, which found that nearly 70% of respondents stated they had to organise their work experience themselves (O’Connor, 2008).

In addition to the key issues of managing different stakeholder motivations and expectations, and the requirement to ensure that WIL is an integral part of the curriculum with quality supervision and appropriate task allocation, the ALTC National Scoping Study for Work Integrated Learning (Patrick et al., 2008) identified three further key challenges for WIL that are also valid for ICT disciplines:

1. Ensuring equity and access – not all students have easy or equal access to WIL experiences, with access dependent on university/degree program priorities
2. Improving communication and coordination – essential to the enhancement of a stakeholder approach
3. Adequately resourcing WIL – a requirement for practical mechanisms to ensure movement beyond advocacy to successful implementation.

Methods

To investigate the current WIL rationale, practices and representative views regarding industry involvement in the curriculum, two surveys were conducted. The first survey involved managers and educational leaders of ICT teaching units within Australian universities. The second survey obtained representative views and current practices from industry.

Survey 1 – University practices and views

The aim of the first survey was to obtain an understanding of the representative views and practices of WIL in ICT in Australian universities. The first targeted group was the Heads of ICT organisational units at the Australian universities who were members of the Australian Council of Deans of ICT. A series of four approaches was used in order to obtain their participation in the data-gathering exercise: a paper-based survey was mailed to each university representative on the Council; a fortnight later an emailed survey was sent to the same people; a telephone follow-up was undertaken two weeks later; and finally they were sent an invitation to complete the survey online. As a result of these efforts, a total of 22 completed surveys were received from 18 universities (a few ICT heads had distributed the survey to other ICT heads internally).

The second group to complete the same survey was the Associate Deans for Learning and Teaching (or their equivalent) in ICT at a forum of 36 attendees representing 25 universities, and 30 completed surveys were received. One workshop session at the forum was dedicated to a range of WIL issues, and the recorded discussions were also used to inform the project. The total of 52 completed surveys and forum deliberations are considered as representative of WIL views and practices amongst Australian ICT academia.

The survey consisted of a number of questions rated on a 5-point Likert scale, where a tick was sufficient to indicate the response, and an option to provide further comments. Entries to survey tick boxes were compiled to provide quantitative data.

Participants at the forum were broken into six small groups to facilitate workshop discussions on a broad range of WIL issues in ICT. Their deliberations were summarised on paper by each group, collected and later compiled. Plenary discussions were summarised and typed for the whole group to see on screen and edited at the time to ensure that the views were representative.

Survey 2 – Industry practices and views

The aim of the second survey was to gather representative views and practices from industry regarding industry participation in the curriculum and WIL. Surveys were distributed to members of the industry advisory boards and other industry partners at four Australian universities, as well as to industry members of the Australian Computer Society (ACS). The survey was distributed online (SurveyMonkey) with some paper versions going to the university advisory committee members.

A total of 182 responses were received comprising 68 responses from industry advisory boards/partners (36 online and 32 paper) and 114 responses from industry members of the ACS.

The survey consisted of two main types of questions. Participants were asked questions that captured demographic and background information such as job title, gender, type of industry and state. The rest of the survey contained questions that were designed to explore the respondents' views on WIL and industry contribution to the curriculum. The questions included a check box response rated on a 5-point Likert scale, where a tick was sufficient to indicate the response, and an option to provide further comments. Entries to survey tick boxes were compiled to provide quantitative data.

Findings

Industry involvement in university curriculum

Table 38 shows the responses concerning current practices regarding industry involvement in the curriculum within Australian ICT faculties, schools or departments. Responses ranged from Strongly Disagree (SD) to Strongly Agree (SA) with the proportion (%) of entries per box and were ranked according to the strength of agreement (A + SA) with the given statements.

Table 38 University practices regarding industry involvement in the curriculum

University practices regarding industry involvement	SD %	D %	N %	A %	SA %
Seeks industry input into curriculum design	0	2	8	46	44
Has policies that require industry input into curriculum design	0	4	12	46	38

According to the academic staff that completed the survey, the majority of universities have practices that provide opportunities for industry contribution to the curriculum. However, the previous Scoping Study found that the majority of ICT graduates in industry who were asked about their curriculum and workplace preparation stated that industry involvement in the curriculum was an area in need of improvement (Koppi and Naghdy, 2009).

Table 39 presents the results from the survey of 182 industry representatives. The results indicate that industry values the connections with universities with a preference for some form of direct involvement rather than working through an industry body. This is consistent with the Scoping Study (Koppi and Naghdy, 2009) that found that ICT employers desired greater input to the curriculum.

Table 39 Industry views regarding involvement in the curriculum

Industry involvement in the curriculum	Total Num.	SD %	D %	N %	A %	SA %
Industry input						
Connections between universities and industry are very valuable	182	2.2	1.1	4.9	31.9	59.9
Universities should have industry representation on committees that review and/or design the curriculum	181	1.7	2.2	7.2	43.1	45.9
Universities should seek indirect input to the curriculum through industry bodies (e.g. AIIA) or from government agencies/reports	181	2.8	4.4	9.4	52.5	30.9
Industry should be involved in curriculum by:						
Advising university curriculum developers	181	0.6	2.2	12.2	53.6	31.5
Working directly with university curriculum developers	182	1.1	6.6	23.6	42.9	25.8
Endorsing/approving curriculum decisions	180	2.2	17.8	27.8	37.2	15.0
Industry should be involved in curriculum design at:						
Degree formulation stage (i.e. focus, themes, etc.)	157	1.3	2.5	14.6	56.7	24.8
Program accreditation stage (formal approval/endorsement)	158	1.9	7.6	27.2	47.5	15.8
Program implementation stage (assisting with delivery, etc.)	158	2.5	8.9	29.7	41.8	17.1
Times when degree programs have a major change	157	0.6	3.8	11.5	58.6	25.5
Annual review stage	157	1.9	4.5	26.1	48.4	19.1
Every 5 years as part of a review or reaccreditation	157	1.9	2.5	15.3	51.6	28.7
Industry should provide advice relating to:						
High level themes or focus of courses	155	0.6	2.6	9.0	53.5	34.2
The structures of degrees	156	3.8	15.4	35.9	33.3	11.5
The syllabus of individual subjects/units (including topics and skills)	157	4.5	12.1	17.8	48.4	17.2
The teaching methods used	158	13.3	32.9	29.1	13.3	11.4
Industry perceptions of universities						
Universities welcome advice regarding curriculum	134	6.7	7.5	32.1	37.3	16.4
Universities act on the advice regarding curriculum provided by industry	133	6.0	15.0	39.1	30.1	9.8
Universities provide feedback on how they have responded to advice	132	6.8	18.9	38.6	25.0	10.6

There were some very positive comments from the industry respondents, such as,

> *"I think it is important to have a strong relationship between the university and industry to help develop the right skills and build a strong pipeline of candidates to join the workforce - especially with undergraduate degrees."*

Other comments observed that it is difficult to gain representative industry views given the breadth of the ICT industry:

"Substantive effective industry consultation/input would not be easy, particularly as 'industry' is very varied and has wide and contradictory needs."

"Industry is far too vague a term. All work-places have their own needs within their work-force, in other words every different company will have their own axe to grind and will give different information on what universities should be teaching."

The results suggest that industry would like to be involved at all stages in curriculum design, approval and to some degree implementation. The results indicate that industry believes that their major contribution should be at the degree formulation level with their role being focused on provision of high level themes or foci of courses, with further involvement when there are major course changes or at a review/reaccreditation stage. Most of the respondents indicated that they should not be involved in provision of advice regarding teaching methods.

The respondents appeared to recognise the role of universities in having ownership of curriculum with comments such as:

"*It is not the place of industry to approve university curricula, but working with universities in an advisory role would be very valuable in my view."*

In general, there is support for the wider educative mission of university education:

"There has to be a right balance for curriculum decisions between the needs of the industry (which may be too focused on 'applied' and 'practical experience') and a solid academic grounding providing students with skills beyond the immediate industry needs."

"Industry involvement in curriculum development (ie assuming this is to ensure industry-focussed content is relevant/accurate etc) should be balanced with curriculum areas that are more exclusively theoretical. ie don't make all content industry advised & approved!"

Despite this, some respondents had strong views regarding the need for universities to teach current skills that are required by industry:

"The key is to ensure that current trends and relevant skills are covered in the curriculum. The challenge becomes that the process is not agile enough and more often than not that curriculum can't be changed in a timely manner for skills to be taught and then for the students to take this to industry."

The survey identified one concern regarding the perceptions of how industry believes that universities respond to their advice. The results indicated that, in general, industry believes that universities welcome advice from industry regarding curriculum, however, a large proportion of respondents appeared to suggest that universities do not necessarily act or provide feedback on the advice.

Work integrated learning

Value of WIL

Table 40 shows local practices within ICT schools or departments based on the survey of university managers and teaching and learning leaders. Responses range from Strongly Disagree (SD) to Strongly Agree (SA) with the proportion (%) of entries per box and are ranked according to the strength of agreement (A + SA) with the given statements.

Table 40 University views on value and costs of WIL

University views on value and costs of WIL	SD %	D %	N %	A %	SA %
WIL Value					
Actively encourages students to undertake a placement	0	10	18	37	35
Regards WIL as a key feature of the ICT degrees	0	15	22	42	21
Actively manages IBL or internship placements	2	24	12	38	24
WIL Resourcing					
Believes that industry should financially support WIL programs	2	8	31	37	22
Finds IBL or internship placements for students	6	23	18	30	23
Has academic staff who support WIL activities	0	30	22	32	16
Has an induction program for students entering placements	4	26	24	30	16
Provides a high level of resourcing for WIL	8	38	24	22	8

The findings from the survey of university leaders in ICT suggest that the majority of universities regard WIL as a key feature of ICT degrees and actively encourage students to undertake a placement. A little over half of the universities actively find and manage placements and believe that industry should support the management of such programs. About half of school or department academic staff provide support for industry engagement with WIL, although less than half provide support for students with an induction program.

The representatives from the forum unanimously agreed that from a university perspective, WIL is beneficial in developing certain “professional attributes” in students with many universities regarding WIL and industry-based learning (IBL) as key features of their degrees. There were some concerns raised during the forum regarding the need for some “hard evidence” of the value of WIL in the context of student outcomes beyond the direct employment benefits, and also that such employment benefits should not necessarily be seen as the primary goal of university education.

From an industry perspective, there appears a strong consensus that traditional forms of WIL such as IBL placements and internships are highly desirable and effective in developing the employability attributes of graduates (Table 41). Industry appears to regard WIL primarily as a graduate recruitment strategy, however, there is strong support for the view that WIL is a service to the ICT industry. Industry appears to have mixed views regarding government support or subsidies for WIL.

Table 41 Industry views on benefits and costs of WIL to industry

Industry view on benefits and costs of WIL to industry	Total Num.	SD %	D %	N %	A %	SA %
WIL Benefits						
Graduate recruitment	139	0.0	3.6	12.9	53.2	30.2
Service to the community	137	1.5	10.9	43.1	38.0	6.6
Service to the ICT industry	138	2.2	8.0	25.4	51.4	13.0
Cost-effective labour for projects	138	11.8	27.9	27.9	27.2	5.1
WIL Costs						
Industry should pay students during placements	113	3.5	4.4	27.4	41.6	23.0
The government should support/subsidise payments for students in placements	117	5.1	6.0	34.2	34.2	20.5

Comments from the industry respondents were generally supportive of WIL experiences:

> *"Involvement in graduate programs may not be cost-effective but they can build staff loyalty, improve industry recognition by potential recruits and encourage / improve the quality of IT graduates that would assist them in not for graduate intake, later when graduates transition to other roles. It lifts the game overall."*

However, there were some respondents who raised concerns regarding the level of investment required by industry in engaging with a university WIL program:

> *"It will always be a very simple equation for any employer and that is cost related. How productive is someone going to be in how short a time."*

> *"WIL style tasks tend not to be cost effective as it usually requires senior staff to oversee and assist the students working on the project, particularly if the project requires business knowledge."*

Table 42 indicates the representative views of industry regarding the value of WIL experiences when recruiting graduates. These results indicate strong support for WIL experiences involving actual workplace experience rather than those where industry has involvement in an internal program such as projects or guest speakers.

Table 42 Industry views regarding value of WIL when recruiting

Industry view value of WIL when recruiting	Total Num.	SD %	D %	N %	A %	SA %
The student has worked in an industry placement for 3 to 12 months	148	2.0	6.8	10.1	42.6	38.5
The student has worked on a project that has been set by industry during their studies	148	0.7	8.1	29.1	47.3	14.9
The student has experienced a simulated workplace environment within a university	148	6.1	33.1	34.5	19.6	6.8
The student has been exposed to curriculum that has direct industry links including industry guest speakers	148	1.4	12.2	29.7	45.9	10.8

Models of WIL

The significant benefits of WIL have incentivised universities to develop and implement a range of models of WIL extending from the traditional work experience placement or internship programs to innovative virtual or simulated WIL experiences. The range of models has also been acknowledged by the government with O'Connor (2008) noting that WIL comes in many different forms including "research, internships, studying abroad, student teaching, clinical rotations, community service or volunteer work, industry attachments or placements, sandwich programs, and professional work placements". Boud and Symes (2000) regard all models of WIL, including those that occur in a workplace, in the community, within the university, and real or simulated, as valid "as long as the experience is authentic, relevant and meaningfully assessed and evaluated" (Boud and Symes, 2000).

Table 43 University WIL opportunities available to students

12-month paid industry placement	16
6-month paid industry placement	17
Industry-linked final year project	43
Unpaid internships	23
Industry relevant curricula	44
Virtual or simulated work experience	22

Table 43 shows the tick-box results from the 52 respondents regarding the kinds of WIL opportunities available to students at their institution. Respondents may have ticked more than one box. Most respondents indicated that their curricula are industry relevant and that the final year project is somehow linked to industry.

Virtual or simulated work experiences seem to be a common practice. Forum attendees were overwhelmingly in support of WIL models that provided authentic work experience for students. In particular, the forum participants discussed alternative opportunities for students unable to attend a workplace (such as by means of a placement). For those students, a virtual or simulated experience was regarded as a valid option. A similar number of respondents also indicated unpaid internships; paid industry placements were the least available to students; and there was little difference between the frequencies of 6- or 12-month placements.

Survey respondents also had the opportunity to specify other options available to students or comment on the tick-box options, and these included:

- funded placements through WIL scholarships
- placements vary from a few weeks to about three months, and may be part time, e.g. 2.5 days/week or a flexible 100 hours during the course
- paid internships in research organisations
- guest teaching by industry professionals
- assignments requiring interviews and interaction with ICT professionals in industry
- industry certified courses (e.g. CISCO).

The range of WIL opportunities appears broad from a national perspective, but the options at the local level will depend upon the university location (metropolitan or rural), local context, staff approaches and resource availability. The forum participants agreed that a range of models was required to provide the flexibility to accommodate the diversity of student capabilities, motivations and interests as well as different university resourcing models and priorities.

The industry representatives were surveyed on their views of the authenticity of the various models of WIL (Table 44). The results confirmed strong support for models of WIL that involved actual workplace experience such as internships, industry-based learning and work experience placements. The industry survey suggested that industry-linked projects set as part of university studies, such as final year capstone projects, were still generally regarded as "authentic", however, not as much as a workplace experience.

Table 44 Industry views regarding authenticity of WIL models

Industry view on authenticity of WIL models	Total Num.	SD %	D %	N %	A %	SA %
Students working in an industry placement for 3 to 12 months	148	0.7	2.7	12.8	45.9	37.8
Students working on a project that has been set by industry during their studies	147	0.7	8.8	29.3	46.3	15.0
A simulated workplace environment within a university	147	5.4	46.3	29.3	12.9	6.1
Curriculum that has direct industry links and is taught with industry guest speakers	146	2.1	19.9	27.4	36.3	14.4

The results indicate that a majority of industry respondents believe that simulated or virtual WIL experiences that are conducted within a university are not authentic. They do, however, have a higher regard for the authenticity of models of WIL that involve actual industry representatives, such as guest speakers. Perhaps this is an indication of a lack of confidence in university academics to provide students with an understanding of professional ICT work.

Some of the comments from the industry respondents confirm the finding that there is a strong preference in industry for the traditional work placement rather than other forms of learning experiences that provide students with a professional experience:

> *"There is no substitute for actual experience in the work place."*
>
> *"Practical industry placement gives the student an experience which he/she would not get in any other way."*
>
> *"Authentic is the key word for me here and a 'simulated' environment is not authentic or real."*
> *"Generally speaking, despite universities' best efforts, universities cannot recreate a true industry environment. No matter how deadline driven teams are, assessors have to limit interaction between teams and teaching staff to prevent accusations of collusion or assistance. Similarly, real world systems are often vague and indistinct and require at least some business knowledge, making precise evaluation difficult."*

These results and comments are consistent with the results in Table 42 that indicate that employers have a much lower regard for WIL experiences that do not involve a workplace experience when recruiting graduates.

Compulsory WIL

The issue of compulsory WIL was raised at the university forum, with participants unanimously rejecting any proposal for work placements to become a compulsory component of IT degrees. The key concerns raised during the workshop related to equity and access to placements, as well as issues relating to student diversity and personal life preferences.

The equity and access issues raised during the forum included the visa limitations that are imposed on international students that generally precluded them from participating in full time paid work, including industry-based learning, and that many regional and rural universities and/or university campuses would have difficulty in sourcing appropriate industry placements within their immediate location. The ALTC National Scoping Study for Work Integrated Learning (Patrick et al., 2008) also identified the issue of ensuring equity and access, noting that not all students have easy or equal access to WIL experiences with access dependent on university and/or degree program priorities. These two factors present a significant barrier to the implementation of a mandatory work experience requirement for IT degrees, with any solution requiring a substantial package of government and industry funding and support to ensure that no student or university is disadvantaged.

The issues relating to student diversity and interests that were raised during the forum involve a broader range of challenges for any compulsory work placement initiatives. The first of these issues related to generational change, in particular the different attitudes and values that Generation Y students bring to all aspects of life, including education. Students born in the 1980s and 1990s are now known as the Gen Y students. These Gen Y students are the current age cohort targeted for university workplace learning experiences such as IBL and internships. It has been reported that the certain behavioural attributes that characterise Generation Y include their cynicism towards what they are told by older generations and their rejection of the things that their parents took for granted including lifelong relationships, continual employment and home ownership (Nimon, 2007). Generation Y students also display different approaches to learning with a desire for “immediacy” (Nimon, 2007) and a strong preference for flexibility of learning options, including modes that meet their individual preferences and needs. In addition, Generation Y students value learning that occurs outside the classroom and seek to have this recognised (Skene et al., 2007).

Several participants at the university forum stated that the majority of their undergraduate students have significant part time work obligations. This view is supported by research that found that half of all Gen Ys in full time study also have paid jobs compared to the late 1980s when around two-thirds of full time students devoted all their attention to their studies and did not undertake paid work (AMP.NATSEM, 2007). The forum participants indicated that Gen Y students value part time work as it funds their technology lifestyle requirements within the flexible work-life balance that Gen Y desire. Many students may therefore be reluctant to give up their part time work for a work placement or internship as they may not be able to resume their part time positions afterwards. It was also suggested that some are reluctant to reduce flexibility in their lifestyles by committing to a full time work placement.

The forum participants also suggested that students may be acquiring the desired soft skills and the professional attributes through their part time work, hence are achieving some of the learning outcomes of a work placement or internship. It was suggested that some form of formal credentialisation of the part time work might be considered in order to recognise the value that this work brings.

The final issue that was raised at the university forum in relation to the issue of compulsory work placements related to the diversity of the student cohort, particularly the academic and personal capabilities of students and their immediate suitability for a traditional work placement. The forum participants indicated that many universities have eligibility criteria for work placements or internships that require a certain level of academic achievement (e.g. a Credit average). In addition, many universities require the students to undergo a vetting process that may include an interview to ensure that the student has the required interpersonal and communication skills demanded by employers. These criteria are applied to provide some assurance that the placement or internship will be successful from the perspectives of all stakeholders and are based on many years of experience in the cases of some universities. The participants suggested that the relationship with industry partners who hosted work placements may be put at risk if universities were compelled to involve “pass-level” students. Such students might place an unreasonable burden on the industry partners who would need to introduce additional support and supervisory procedures to manage students who may not yet have developed the capability to work without direct supervision and support.

Success measures of WIL placements

Table 45 shows the proportional responses (%) of academic staff to the statement: "The success of an Industry-Based Learning or internship placement is judged when the student:"

Table 45 University views on success measures of placements

Success measures of placements	SD %	D %	N %	A %	SA %
Has improved understanding of professional responsibility	0	2	8	45	45
Gained a variety of work perspectives	0	4	7	62	27
Has completed work tasks as required	0	2	9	72	17
Has gained new technical skills and competencies	0	6	36	47	11
Did not disrupt normal company operations	7	15	37	30	11
Is now employable	7	22	34	26	11
Added value to the company's profitability	0	38	40	22	0

The results suggest that academics believe that a successful WIL experience provides students with an improved understanding of professional responsibility and the variety of work perspectives. Completion of work tasks is a strongly desired outcome, but these are not necessarily related to gaining new technical skills and competencies because the proportion of responses to these two outcomes is different. On balance, not disrupting normal company operations is seen as a success, but adding financial gain to the company is generally not.

Additional comments made by university survey respondents in respect to success measures include the attainment of analytical skills, better interpersonal skills, more realistic views about the workplace and work politics, and improved self-organisation. In addition to not disrupting company operations, it was noted that the students should not harm university-industry relations.

The results of the university survey may be contrasted with the industry survey question regarding their views on the attributes or skills that WIL should develop in students (Table 46). Whilst there is alignment regarding the value of the development of professionalism and workplace skills, there appears to be a stronger priority for employability outcomes from WIL programs.

Table 46 Industry views on attributes or skills that WIL should develop in students

Industry views on attributes or skills that WIL should develop in students	Total Num.	SD %	D %	N %	A %	SA %
Technical skills (e.g. a new programming language)	134	3.0	15.7	26.9	41.0	13.4
Interpersonal skills (e.g. communication, teamwork, etc.)	134	0.0	0.7	2.2	37.3	59.7
Workplace skills (e.g. professionalism, realistic expectations, etc.)	134	0.0	0.7	2.2	33.6	63.4
Project management, planning and problem solving	135	0.7	3.0	11.1	55.6	29.6
Ensuring the student is immediately productive when employed	135	3.7	11.9	34.8	28.1	21.5

The participants from the university forum agreed that WIL is beneficial in developing certain "professional attributes" in students. Although development of these attributes might improve students' employment prospects, some forum participants agreed that the value of WIL extended beyond employment benefits and that employment outcomes should not necessarily be seen as the primary goal of university education. These differences in priorities between universities' priorities in teaching theory and practice along with lifelong learning skills and industry's priorities of employment outcomes and relevant work skills has resulted in some employers believing that "universities are not interested in meeting industry requirements" (Koppi and Naghdy, 2009). This tension is not new or limited to the Australian ICT context, with Shoikova & Dwishev (2004) commenting on the academic goal to develop rounded graduates with lifelong learning skills in contrast to industry priorities of graduates who are trained in the contemporary tools and techniques used in current corporate and industry environments.

Several respondents commented on this tension between academia and industry regarding placements, and these have been summarised in Table 47.

Table 47 Tensions between industry and academia over placements

Industry	Academia
Work ready	Academia ready
High-level communication skills	Balance between communication skills and expression of knowledge
Profit-making environment	Knowledge-making environment
Want high-performing students	Have students with a wide range of abilities
Time for effective student contribution	Time away from formal teaching
Variable demand for students	Constant requirement for places
Expect universities to provide resources	Would like more industry contribution

Discussion

The results of the university survey and forum discussions indicate that there is a range of rationale and practices for WIL in Australian universities. Universities recognise the educational and employment benefits of WIL and generally regard WIL as a key feature of ICT programs. Resourcing for WIL varies across the sector, possibly influencing a variety of models of WIL that extend from the traditional work experience placement to new virtual or simulated WIL experiences. Universities appear to advocate for more flexibility in WIL models to meet the diversity of student capabilities and interests, including international students and those students with significant part time jobs. Universities also indicated that appropriate models of WIL are required to suit different university resourcing models and priorities.

The results indicate that the most prevalent WIL models were the “Industry-Linked Final Year Project” and “Industry Relevant Curricula”. These models may be classified as “internal” using a continuum from the traditional “external”, industry-based WIL experiences – such as work experience placements and internships – to “internal”, university-based experiences – such as project work, case studies and experiential learning opportunities. Fewer universities provided traditional 6-month or 12-month paid industry-based learning placements.

The use of industry-linked final year projects as the key method of providing a WIL experience in ICT degrees is endorsed by the Australian Computer Society in their Accreditation Guidelines (ACS, 2009) that state that programs must “include a capstone unit in the final year to allow an assessment of the program objectives”. The guidelines contain a Policy on Capstone Units that states dual objectives for capstone units including integration of the skills and knowledge developed throughout the program, and providing a structured learning experience to facilitate a smooth transition to professional practice or further study in the discipline. The ACS policy does not provide details of the types of learning experiences that would be appropriate to achieve these objectives, apart from a statement regarding the need for “authentic learning experiences in relation to its intended professional outcomes”.

The issue of the authenticity of learning experiences is central to the success of WIL programs; however, agreement on what makes a WIL experience authentic appears to be split between academic and industry views. Whilst universities support the development of virtual or simulated models, particularly for those universities where direct experiences are difficult to achieve, the results of the industry survey indicate some different views. The survey results suggest that industry values models of WIL that involve direct experience within a workplace environment in terms of authenticity and as a consideration when recruiting graduates. There is a lesser preference for industry-linked projects and the use of industry guest speakers. There is significantly less support for university-based simulated workplace environments with comments such as “a ‘simulated’ environment is not authentic or real”.

The results of the university survey indicate that universities believe that a successful WIL experience provides students with an improved understanding of professional responsibility and the attainment of generic skills. The industry survey also identified these attributes as extremely valuable outcomes of WIL. Industry also indicated strong support for WIL having the objectives of developing students’ technical skills and ensuring that the student is immediately productive when employed. The forum discussions raised concerns from universities regarding industry priority for universities to produce work-ready graduates possibly at the expense of a more holistic education with a focus on lifelong learning. This issue was described as an "expectations gap" in the ALTC WIL Project (Patrick et al., 2008), which recommended a "stakeholder integrated approach to the planning and conduct of WIL based on formalised, sustainable relationships and a common understanding of the procedures and commitment required by all those involved".

An approach to develop a shared understanding regarding the authenticity of the range of learning experiences for WIL is required in order to achieve industry acceptance and recognition of innovative internal and virtual models of WIL. This approach also needs to address the balance that is needed between employability skills and lifelong learning.

The movement towards outcomes-based education in engineering education may provide a way forward to achieving a common understanding of the value of the full spectrum of WIL models. This approach involves an increased focus on educational outcomes rather than teaching methods and is now endorsed by universities and industry in international course accreditation processes for engineering and many other disciplines. The approach is based on the demonstrated student attainment of stated graduate attributes with the focus on outcomes rather than process. This approach encourages diversity and innovation in delivery and has brought significant benefits to engineering education (Palmer and Ferguson, 2009). The outcomes-based approach generally requires a linking of course and unit level learning objectives with graduate outcomes. The use of taxonomies such as Bloom (1956) is commonly used in computer science education to describe learning outcomes and links to assessment (Lister, 2000).

The findings from the surveys and forum discussions indicate that there is lack of a shared understanding between universities and industry regarding the learning objectives for WIL programs.

The development of clear learning objectives with the support of all stakeholders including universities, industry, professional bodies, industry associations and particularly students will provide the basis for the development of a range of WIL models. Models should include external forms where students go out to industry (e.g. industry placements, internships, field visits and community projects) as well as internal models where industry comes to students (e.g. guest speakers, case studies, industry-linked projects and simulated experiences). The authenticity of each form of WIL should be evaluated according to the achievement of the agreed learning objectives, rather than just relying on personal opinion. Industry acceptance of the value of innovative learning experiences to provide students with the necessary understanding of aspects of professional practice will benefit all stakeholders.

This approach is similar to the current Engineering Australia accreditation requirements for professional engineering degrees (EA, 2008) that require "a minimum of 12 weeks of experience in an engineering-practice environment (or a satisfactory alternative)". The EA requirements state that there is "no real substitute for first-hand experience in an engineering-practice environment, outside the educational institution", however, the requirements also state that "however, it is recognised that this may not always be possible", that is, engineering students do not have to undertake 12 weeks of actual industry experience in an external organisation in order to complete their degree but can achieve this requirement through alternative means. Valid learning experiences for professional practice include traditional placements as well as the "use of guest presenters, industry visits and inspections, an industry based final year project". The EA requirements go on to indicate that: "The requirement for accreditation is that programs incorporate a mix of the above elements, and others - perhaps offering a variety of opportunities to different students - to a total that can reasonably be seen as equivalent to at least 12 weeks of full time exposure to professional practice in terms of the learning outcomes provided."

This liberal interpretation of professional practice permits universities to provide a set of university-based learning experiences to achieve the "12-week experience" requirement of EA accreditation. The professional practice requirement could be spread out over the duration of the degree program, including providing a context to engage first year students as well as a professional preparation for final year students. The key requirement is that the experiences are authentic and can be documented to demonstrate targeted graduate capabilities set for the program.

Using the EA experience as an example, consideration should be given in the current revision of the Australian Computer Society Course Accreditation Guidelines to incorporate detailed guidelines for professional practice, including stated learning objectives that have been endorsed by industry and other stakeholders. Whilst the 12-week requirement appears to work well in the context of engineering, it is accepted that a similar requirement might not map well to the ICT disciplines. However, there would be wide ranging benefits in implementing a similar professional practice requirement for ICT degrees where the requirement is visible, significant and readily understood by the prospective and current students, teachers, parents, industry, government and the community in general, and provides scope for universities to innovate in the design of learning experiences and approaches.

Recommendations

The study confirmed that all stakeholders including universities, government, industry and students acknowledge the benefits of WIL. The study revealed strong academic support for students being exposed to professional practice through a variety of WIL models. The study found that industry does not regard internal models of WIL, such as simulated workplaces, as authentic. Authenticity is the critical success factor in WIL. There are also opposing views regarding the objectives of WIL in relation to immediate employability outcomes or lifelong learning.

It is recommended that all stakeholders collaborate on the implementation of an outcomes-based approach to WIL, including the development of clear learning objectives for WIL experiences. Agreement on such learning objectives may provide the basis for mutual recognition of the authenticity of innovative models of WIL, such as virtual and simulated experiences, and will ensure the balance between employability skills and lifelong learning.

CHAPTER 6: Conclusions

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Conclusions across the five areas

Each project area has drawn its own conclusions; this section is concerned with identifying links and commonalities between the areas and drawing them together with appropriate themes.

Relevance

A common learning and teaching issue can be identified as one of relevance. ICT studies by students (at all levels) are not always perceived as having relevance to their current learning activities or to their lives or careers. Repeatedly involving students in activities that relate to the application of theory to impact, and the benefits of ICT to industry and society in general, can mitigate this perceived lack of relevance. Practically, this means greater engagement between academia and industry, particularly at the learning and teaching interface.

This academia and industry engagement to demonstrate relevance is central to providing ICT students with professional practice experience in learning activities that may take place physically in industry (e.g. placement) or in universities where students work on projects with clearly perceived value to industry and society. Such projects may be within a range of contexts such as the environment, energy, health, finance and business. Students being bored, leaving ICT or expressing dissatisfaction with their ICT studies upon graduating commonly report the lack of actual or perceived relevance to industry and society a reason for the dissatisfaction. A possible by-product of a strong engagement between academia and industry is the professional image of ICT that will be created. This has an impact on the attractiveness of ICT to school leavers and their retention in the various ICT programs.

The perception of the relevance of ICT to improving society and humanity seems particularly important to females, who make up the minority of tertiary students and industry workers. The Australian academic community has largely recognised this, but in most cases this has not been translated into an inclusive curriculum with optimal support structures.

Thus, effective integration of all forms of WIL (including the full range of internal (university) and external (industry) options, and as practised in industry such as with appropriate teamwork) that is perceived as being relevant to students will have an impact on attrition, satisfaction, engagement, perceptions, gender balance and the teaching-industry-learning nexus. Incorporating the research (discipline or educational) being carried out by academics into this mix would demonstrate research relevance and further enhance the experience of students and other stakeholders. This will also encourage the employment of research-driven innovation in the Australian ICT industry. The percentage of research degree holders employed in Australian ICT industry needs to improve.

Collaboration

Each of the five project areas has found that collaboration is an essential and effective process to achieving desired outcomes. Support structures for students who are at risk of leaving ICT involve collaboration – not only between students, academics and administrators but also with industry – to help make courses more relevant and focused on practical outcomes (even if highly theoretical) that provide engagement opportunities for students. These broad collaborative approaches also lead to improved understanding and perception of ICT in terms of benefits to society and industry, rather than focusing on academic or technical issues in isolation.

Collaboration between academia, industry and government is essential to raising the profile of ICT as well as demystifying the variety of ICT professions. Unless collaboration leads to consistent and common language to describe the ICT professions (and that common living language still seems to be lacking), general perceptions of what ICT is, what ICT professionals do and the benefits ICT provides to all areas of life will continue to be unclear and fail to draw the kinds of students required, including a balanced proportion of males and females.

As noted above, collaboration between industry and universities is necessary to provide relevant professional practice experiences for students. Furthermore, this collaboration requires that each stakeholder group appreciate the perspective of the other; progress will be constrained if, for example, industry holds fast to the belief that students cannot obtain professional practice experience unless they spend time in industry. Academia and industry need to collaborate effectively to ensure the desired learning outcomes are achieved, rather than focusing on any particular preconceived process or processes.

Collaboration between stakeholders is also essential to achieve the affordances given by the TRIL nexus. The scope of the collaboration in this context is very broad in that the whole of the curriculum must synergistically incorporate each component from the outset. Such a transparent approach would provide relevance to students by demonstrating collaboration between industry and academics in research and teaching, as well as the benefits of the resulting outcomes. Collaboration amongst the stakeholders will also lead to the image of an integrated professional practice that spans the continuum of theory, analysis, design, implementation, deployment and maintenance. This is important for the image and perception of ICT amongst students and the public.

These conclusions are incorporated into the Recommendations given in the Executive Summary.

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Appendix 1

Table 48 Australian university attrition rates from ICT as percentages of commencing degrees (DEEWR, 2010*)

State/Institution - Attrition rates	Attrition rate							
	2001	2002	2003	2004	2005	2006	2007	2008
New South Wales								
Charles Sturt University	21.4	26.9	23	22.8	21.7	21.2	25.9	19.9
Macquarie University	20.6	19.2	14.1	14.6	13.1	13.7	17.2	15.2
Southern Cross University	37.3	45	31.5	30.2	34.6	24.7	27.8	20.9
The University of New England	32.7	36.8	29.1	15.4	18.5	15	23.8	29
The University of NSW	11	10.9	10.5	12.7	10.7	13.6	14.1	13.6
The University of Newcastle	15.7	17.5	21.7	16.2	12.5	15.8	16.2	12
The University of Sydney	12.6	12.9	25	13.6	9.9	10.8	8.73	8.73
University of Technology Sydney	19.2	15.2	12.6	12.3	12.6	14.1	12.3	8.63
University of Western Sydney	20.4	16.3	18.7	20.9	16.2	16.5	21.7	17.4
University of Wollongong	9.56	10.3	18.5	14.1	13	20.4	12.8	10.3
Sub-total	17.5	17.4	18.9	16.6	14.8	16.8	16.1	13.2
Victoria								
Deakin University	18	18.5	13	14.9	15.9	14.6	17.1	20.6
La Trobe University	17.3	19.7	18.1	17.3	16.9	16.4	22.7	20.9
Monash University	11.9	12.3	11.3	12.3	12.2	12.8	13.6	11.1
RMIT University	22.6	18.4	16.6	20.5	17.3	22.4	15.8	15.9
Swinburne University of Tech.	22.4	17	15.4	18.4	18.3	12.6	16.7	15.9
The University of Melbourne	5.26	7.44	8.39	7.85	9.4	10.2	9.31	3.66
University of Ballarat	22.8	15.3	18.7	10.6	17.3	18.8	24.7	19.4
Victoria University	24.2	22.1	19.7	20.2	20.6	24.4	20.1	20.3
Sub-total	17.2	15.8	14.6	15.1	15.9	17	17.5	16.3
Queensland								
Central Queensland University	14.1	18.4	20.2	13.2	19.8	24.8	32	22.5
Griffith University	15.9	21.4	21	24.3	23.5	19.1	21.7	22.2
James Cook University	25.4	28.5	25.7	29.6	28.2	17.1	17.5	20.6
Queensland University of Tech.	13	12.9	10.6	14.7	16	14	18.5	16.4
The University of Queensland	13.1	16	12.7	17	13	17.2	20.6	18.1
University of Southern Qld	26	32	23.5	22.4	26.8	19.9	18	16.9
University of Sunshine Coast	23.3	38.3	44.3	31.5	36.2	31	25	31.6
Sub-total	15.9	19.4	17.8	17.2	20.2	19.8	22.3	19.8
Western Australia								
Curtin University of Technology	21.7	25.3	23.4	17.2	27.6	20.7	18	21.5
Edith Cowan University	19.3	18.7	21.5	19.3	20.5	19.5	20.5	18.8
Murdoch University	16.2	20.1	20.1	21.4	21.5	15	19.4	23.7
The University of WA	15.2	11.8	10.6	15.7	18.4	12	16	18.6
Sub-total	19.1	20	20.5	18.5	22.9	18.4	19.2	20.4
South Australia								
The Flinders University of SA	24.4	22.9	22.9	20.1	12.2	12.9	21.1	24.1

The University of Adelaide	29.5	28.2	25.1	15	11.5	9.36	17.9	18.2
University of South Australia	21.8	17.2	18.3	18.1	13.8	19.5	19.7	16.9
Sub-total	22.6	19.9	20.1	17.9	13.2	16.5	19.3	18.3
Tasmania								
University of Tasmania	14.6	17.9	9.65	17.8	6.87	15.2	11.7	19.3
Sub-total	14.6	17.9	9.65	17.8	6.87	15.2	11.7	19.3
Northern Territory								
Charles Darwin University	39.4	31	36.1	31.4	35	40	34.3	32.7
Sub-total	39.4	31	36.1	31.4	35	40	34.3	32.7
Australian Capital Territory								
The Australian National Univ.	10.5	16.6	13.7	19.9	12.5	19.1	9.94	11.9
University of Canberra	18.7	14.1	15	15	18.1	20.9	16.5	19.9
Sub-total	16.5	14.8	14.6	16.8	15.9	20.2	13.8	16.6
Multi-State								
Australian Catholic University	22.7	20.3	25.3	22.7	26.2	20.8	16.2	21
Sub-total	22.7	20.3	25.3	22.7	26.2	20.8	16.2	21
Total	17.5	17.7	17.1	16.5	16.9	17.7	18	16.7

*Data purchased by the project from DEEWR (2010)