Australian Council of Deans of ICT

ACDICT Learning & Teaching Academy (ALTA) Commissioned Good Practice Report

Overview

This report provides a summative evaluation of the good practices and key outcomes related to the topic. Included are a literature review of the good practices and key outcomes from national and international research and practice, and areas for further work or development.

Topic: Recruitment and retention of female ICT students

Project Title: *Exploring the antecedents and contexts of ICT degrees with high female participation*

Lead author details

Name: Assoc. Prof. Jo Coldwell-Neilson	
Position: Assoc. Head (T&L)	
ICT Faculty/School/Department*: School of Information Technology	
Institution*: Deakin University	
Email: jo.neilson@deakin.edu.au	**Phone:** 03 5227 1417

Collaborator

Name: Dr Jenine Beekhuyzen	
Position: Adjunct Professor	
ICT Faculty/School/Department*: School of Information & Communication Technology	
Institution*: Griffith University	
Email: jenine@griffith.edu.au	**Phone:** 0405272068

Executive Summary

This report provides a summative evaluation of the good practices and key outcomes related to the recruitment of female Information and Communication Technology (ICT[1]) students. The investigation of the antecedents and contexts of ICT degrees with high female participation are reported based on a thorough literature review of good practices and key outcomes from national and international research and practice, and based on our analysis of higher education statistics from uCube and from specific university departments. Through this secondary data it is possible to identify key trends and patterns in the recruitment of female students in ICT degrees. Areas for further work are identified.

An inspection of uCube (DEEWR, 2013) reveals a significant difference in female participation in degrees categorized in the information technology (IT) field of education (FoE=2). Figures from 2012 (as reported in 2013) show that female participation in IT degrees range from a high of 35.5% to a low of 9.1%. The average participation across all IT degrees is 17.8% which is in line with industry participation rates (AWPA, 2013). This project explores the contexts of the ICT degrees with high and low female participation with a longer term goal (outside the scope of this project) of exploring the antecedents and consequences of these degrees.

The aims of this project are to:

- Identify IT degree programs that are attracting higher female participation rates; and
- Identify common themes across these degrees.

In order to address the project aims three main activities are undertaken:

- A literature search of factors influencing female choices of careers and further studies;
- Identification of degrees that are categorized in FoE=IT in selected institutions in the upper quartile, lower quartile and near the average of reported female participation and collate female participation in each degree offered by the selected institutions;
- Investigation of the context of the identified degrees in terms of naming conventions and curriculum as described in publicly available documents (such as institutional web pages).

This investigation allowed the researchers to gain an improved understanding of factors influencing female participation rates. This is illustrated through the identification of common themes amongst the degrees that are more successful at attracting females. The two key findings of this study are that:

1. women are more attracted to postgraduate studies in IT than undergraduate studies in IT; and
2. studies in double degrees or degrees that imply an area of study in addition to IT are more attractive to women than single degrees.

[1] ICT and IT are used interchangeably in this report.

The deliverables include a framework of common themes that may potentially influence female choices. The longer term project plan that aims to explore the environment of these degrees in depth includes the external environment (schools, community, intervention strategies etc.) and internal environment (curriculum, curriculum delivery, female role models etc.) is in the planning stage.

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1. Introduction

There is ongoing research into the (not shrinking) disparity between male and female engagement in the IT disciplines, at secondary, further and higher education levels as well as in the workforce. The number of females completing an IT related undergraduate degree is at an all-time low (Camp, 2012). According to Camp (2012) the percentage of degrees in computer science being awarded to women in the US has been steadily decreasing since 1984, at a high of over 37%, to a low in 2009 of under 18%. This trend is not restricted to the US but is occurring globally throughout the industry. This trend is also evident in Australian higher education and is in stark contrast to the generally increasing numbers of students entering tertiary education. There is a significant decline in student uptake of studies in IT and an even bigger decline in female participation in the discipline despite a growing demand for skilled IT professionals (DEEWR, 2013). In secondary education, not only are the number of females choosing to study ICT programs at years 11 and 12 decreasing, the total number of students taking up ICT in their senior years is decreasing despite increasing numbers of students completing year 12 (VCAA 2013). A continued decrease in students interested in ICT studies can only lead to increasing numbers of schools abandoning their ICT programs at years 11 and 12 through lack of demand. Adding to the negativity are the recent news items regarding low female participation in the industry which is reinforcing the perception that IT careers are the domain of men. Leading employers including Apple, Yahoo, Google, Facebook and others "are largely white and male" most having just 30% female participation (Guynn and Weise, 2014), even lower when focusing on technical positions. This is not a healthy situation for the industry at a number of levels.

There are many interventions aimed at increasing awareness of high school students to potential careers and pathways into IT and hence increase their interest in completing studies in the discipline. A recent addition to this portfolio is Digital Careers[2] which aims to increase the number of ICT graduates in Australia while contributing to the robustness and sustainability of Australia's ICT capability to support the digital economy. An initiative that has been operating for some time is Go Girls Go for IT[3], a one day event that showcases what the ICT industry can offer as a future career. Up to and including 2012, numbers of students participating in this event had been declining but in 2014 Go Girls Go for IT attracted over 1100 Victorian school girls. However, these interventions do not appear to be having a significant impact on transition to IT studies, despite the growing demand for IT professionals across the sector. A longitudinal study of the Go Girls event from 2006 to 2010 has shown that although the event is considered a success on the day, with over 90% of the participants indicating a positive feeling about careers in IT after the event, any increase in the uptake of IT in schools that occurred as a result of attending the event was only transitory (Coldwell-Neilson et al, 2014). However, what constitutes a successful intervention is still an open question.

Despite this generally gloomy trend, there are some universities in Australia that *are* attracting females to their IT courses (categorised by DEEWR as field of education 2). A comparison of participation in IT related degrees across Australian universities indicates a significant difference in uptake and particularly uptake by females. The chart in figure 1 shows the percentage of all females commencing studies in IT from 2009 to 2012. The bars suggest some significant differences between universities across Australia as well as some

[2] http://digitalcareers.edu.au/

[3] http://gogirl.org.au/

significant differences within some universities across the four-year period. For example, female enrolments at the University of Tasmania have consistently been around 30%, significantly higher than the average of around 18%. At the other end of the scale, Griffith University figures suggest a low enrolment although an increase is noted in 2011. It is difficult to suggest reasons for such diversity in participation without delving deeper into the data.

The picture becomes more confused when inspecting participation of domestic and international female students which highlights significant differences within Australian universities. Of the 38 universities, 27 have higher international female student participation than domestic in IT. In 2012 the biggest difference was at University of Tasmania with 18% domestic female participation and 37% international female participation, a substantial difference of 19%. On the counter side, Central Queensland and Charles Darwin Universities record higher female participation in the domestic cohort (University of Sunshine Coast has the biggest difference, but the international cohort is zero). See figure 2 for details.

An investigation into factors that are impacting these significantly different participation rates is warranted. Potential benefits of improved understanding in this area include (but are not limited to) identifying factors that make IT qualifications attractive to females and strategies that encourage females to select IT studies. The aims are to identify possible positive and negative factors to inform an extensive, comprehensive study to develop a holistic framework to engage more women in IT.

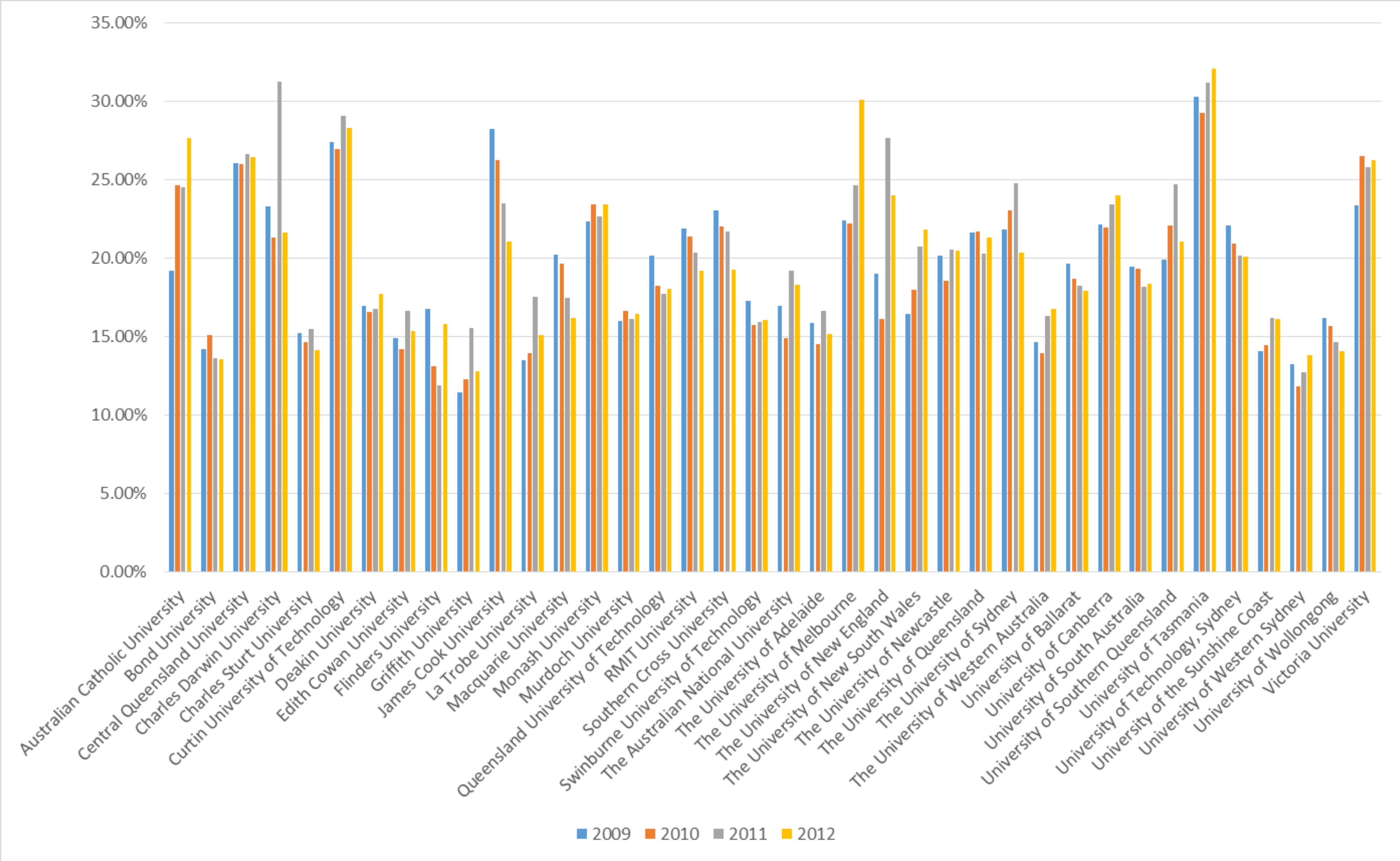

Figure 1 Female enrolments in IT degrees

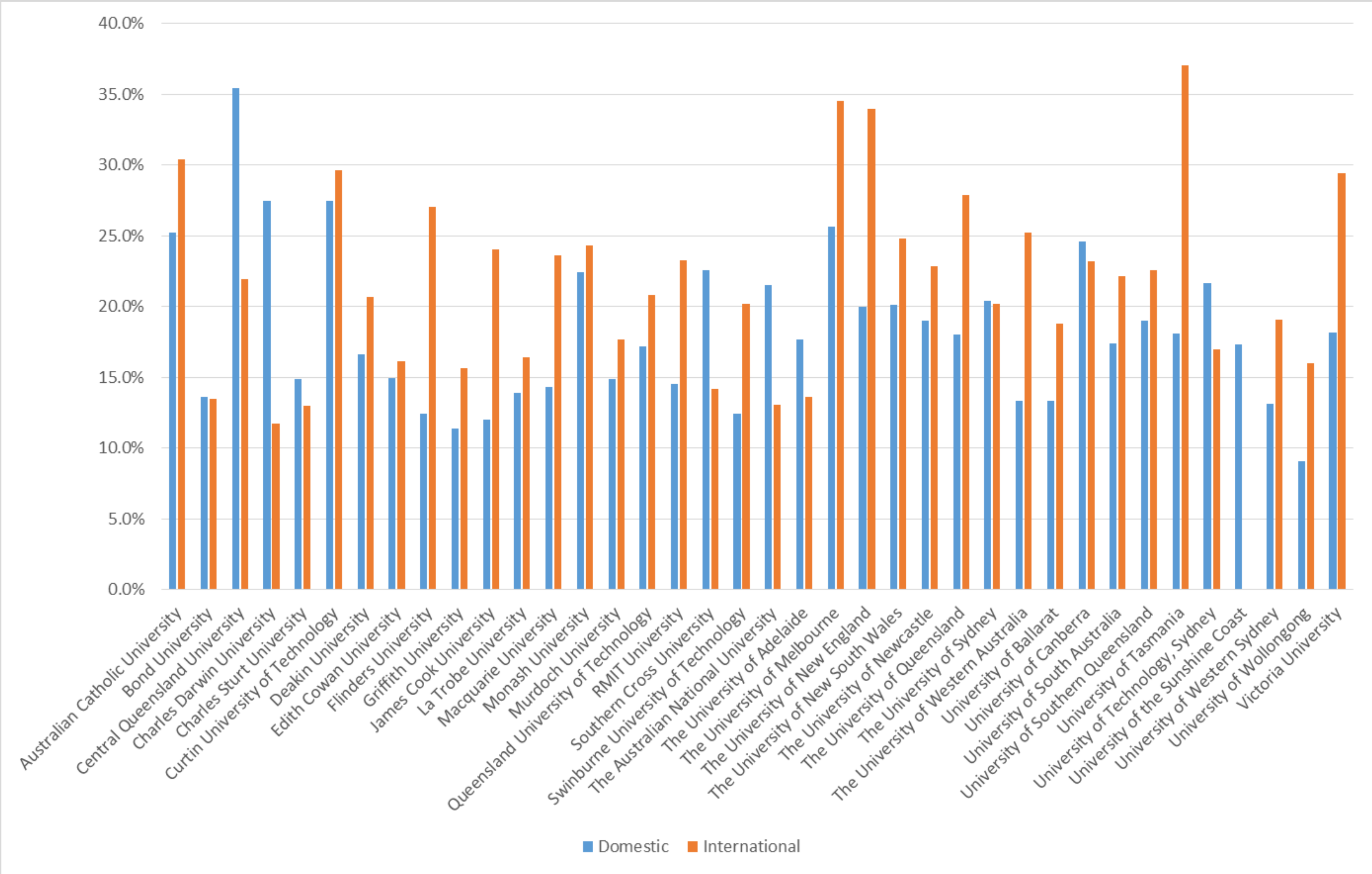

Figure 2 Domestic and international female enrolments in IT degrees in 2012

2. Project Design

Ideally, an investigation of the environment in which ICT degrees that appear to attract higher female participation should include:

- Pre-selection environment including high school, intervention strategies, significant influencers, etc.
- Selection – tertiary admissions processes and advertising of degrees, etc.
- Enrolment – curriculum, delivery, and role models
- Transition to graduate employment.

Most of these activities are outside the scope of this project, but easily accessible degree advertising such as information publicly available on university web sites, together with a comprehensive literature review, can be used as an initial proxy to identify broad factors influencing trends in participation rates at Australian universities. As the primary focus of this study is on domestic enrolments in IT related degrees, selection of universities to investigate in more detail was based on their performance with respect to domestic female enrolments. However, international enrolments were also investigated within the selected institutions.

This project included a number of stages:

- Stage 1 was a comprehensive literature review of factors influencing female choice of career;
- Stage 2 involved an inspection of uCube data (DEEWR, 2013) to identify institutions for detailed investigation;
- Stage 3 was an inspection of selected university data to identify degrees with high and low female participation rates; and finally,
- Stage 4 involved an analysis of publicly available institutional descriptions of selected degrees (i.e. course descriptions on institutional web pages).

The following sections of this report describe the processes and outcomes of each of these four stages, commencing with the literature review. A discussion of the outcomes of the analysis undertaken follows, concluding with some recommendations and suggestions for future investigation.

3. Factors influencing female choices of ICT degrees

Men's and women's relationships to technology have been marked by their differences; in fact, we have been talking about the 'digital gender gap' in the western world since the late 1970s (Corneliussen 2012, p. 1). There has been a change over time, as explained by Corneliussen (p. 1), where efforts to recruit, include, and retain women in computer education and related occupations have been redefined from 'a problem with girls and women' to a problem with institutions and the culture of technology. Despite general increases in women's representation in science, engineering, and mathematics, women's representation in computer science is not approaching parity with men's (Cohoon & Aspray 2006). Extensive effort has been put into promoting women's participation in computing and such efforts are described by Cohoon and Aspray (2006, p. ix) as ‘ethical to economic’. Cohoon and Aspray, like many others, reject the idea that biological gender differences explain the situation. They also offer (p. ix) two possible explanations: one being that the causes are so numerous and deep-seated in our institutions that society is not willing to make the changes that would produce gender equity; the second, is that the issue is complex, making it difficult to know how to go about reaching gender balance in IT. However, gender-technology relations, as argued by Corneliussen (2012, p. 8) have not remained stable and she explores questions of change and stability on several levels while arguing the importance of seeing difference not only between men and women, but also, within each gender group, between men and between women; these are in addition to changes in individuals’ relationship to computer technology. This notion supports Cohoon and Aspray’s concepts of complexity; they reminds us (p. 472) that a narrow focus on the immediate conditions is like ‘washing floors on a rainy day’.

With this commentary in mind the following is an exploration of the extensive literature on factors that influence students’ choices, and their perceptions of ICT. The focus is on recent literature.

3.1 How students make decisions

How adolescents form attitudes to ICT that may influence their study and career choices is an important question and one that Lang (2010, p. 16) explores through the influence of self-efficacy beliefs in career decision-making, gendered confidence levels in the use of technology and the prevailing socialisation of careers and their gendered labels in western society. Her findings show that parents were the main factors influencing students in their future study and career options, showing a strong alignment between daughters and mothers and sons and fathers. Her findings also confirm, to some extent, the relationship between consideration of future careers and popular media, particularly with the younger students. Senior school students placed stronger emphasis on ability and self-efficacy in a discipline as an influencing factor when they considered future course and career options and she concludes that the findings related to pride in ICT proficiency. Lang (2010, p. 194) asserts that this pride resided strongly in the males, was noticeably absent in the females interviewed, and these complicated the finding that ‘girls rely on a degree of personal connection when considering possible future careers’.

The two important predictors of student academic choices, according to Vekiri (2013), are students’ beliefs about their competence and the value they attribute to particular academic subjects. In a study conducted by Sainz and Eccles (2012), it was found that gender differences in the choice of ICT studies can be explained by the influence of self-concept of computer ability for students at the age of 15 and 16 years. Their results suggest that students, males in particular, have come to think of their mathematical abilities as particularly important for success in the ICT field. They also explain that having high mathematical ability is also relevant to pursuing other science related degrees as well as humanities and social sciences.

An important finding that contributes to current understanding of females’ under representation in science, technology, engineering and mathematics (STEM) fields has been documented by Wang, Eccles and Kenny (2013). In their longitudinal study, their findings suggest that students’ mathematical and verbal ability patterns in 12th grade predict their occupations at age 33. It appears that mathematically capable individuals who were also high in verbal skills were less likely to pursue STEM careers than individuals with high mathematical skills but moderate verbal ability. Notably, the high-math/high-verbal ability group included more females than males. Wang, Eccles and Kenny also drew on a large body of research that suggests that individuals are more likely to choose a given pathway if they believe in their capacity to succeed in that area and suggest that it is therefore possible that heightened math-ability self-concepts draw individuals with high mathematical and moderate verbal ability toward STEM occupations. In the same vein, it is likely that individuals with high mathematical and high verbal ability who, in their study, were predominantly female, believe in their potential to succeed in both STEM and non-STEM occupations and thus are in a position to consider how STEM or a non-STEM occupation would fulfil their life goals and values.

Although discussing science, engineering and doctoral-track medial careers, Morgan, Gelbgiser and Weeden (2013) show that gender differences in work-life attitudes, in high school coursework and in academic performance explain only small portions of the gender gap in the choice of a science major, ranging from 2% to 15%. Work-life attitudes, in particular, show but a very weak relationship to the gender gap in major choice; their results are consistent with other recent studies. However, they are inconsistent with gender essentialist accounts that point to women's decisions to choose motherhood over science or with expectancy-value models that emphasize the importance of gender role ideologies in the development of subjective valuations of science relative to family. Morgan, Gelbgiser and Weeden call for greater attention to gender-differentiated processes early in the college career that lead to the attrition of women who, at one time, had aspirations to enter science, but who wind up in majors that are gateways to other occupations. They note that their results imply that scholars need to look yet earlier in the life course, to understand how gender differentiated occupational plans are formed and evolve, how these plans affect educational decisions, and how, ultimately, they affect the mix of skills and credentials that women and men bring to the labour market.

3.2 Girls, youth and ICT

The influences that affect the uptake of ICT[4] subjects in the senior secondary years in Australia, was explored by Downes and Looker (2011) who assert that there are three key factors: gender; the time spent in using a computer at school; and the value students place on ICT subjects. They explain that the latter two factors are inter-related and educational intervention is possible. Downes and Looker (2011) argue that:

> any school-based interventions that focus on increasing use of ICT at school, and increasing the 'value' of ICT subjects, need to also address both increasing home use and the self-perceived skill levels in tasks associated with both home and school use. (p. 195)

They explain that this would require very careful curriculum and pedagogical planning and a concomitant increase in teacher expertise and dispositions towards use of IT in classrooms. In particular, they suggest that it might require a rethink about the main purpose of computer literacy, computer use and early years' study of ICT related topics. It might also require a shift in balance from a focus on discipline-based subject matter knowledge and skills, to a focus on building confidence and relevance, as well as knowledge and skills, within the early and middle years. When discussing core experiences, Downes and Looker (2011) warn that:

[4] Downes and Looker refer to Communication and Information Technologies (CIT). Such references have been changed to ICT for consistency in this report.

> when choice exists, gendered interests lead to stereotypical participation patterns. The enduring gender difference, however, does remind us that any design framework will only partly address subsequent gendered choice. (p. 195)

A computer club for girls (CC4G) targeting girls aged 10 to 14 in the United Kingdom was the focus of a study conducted by Fuller, Turbin and Johnston (2013). In providing gender relevant experiences of IT through the CC4G club, they provided activities that were formulated around existing gender lines, rather than the perceived harder aspects of IT. They explain that the favourite and most common activities undertaken in the club tended to be both stereotypically gendered and non-technical in content and argue that this approach misinterprets the problem and replicates rather than challenges existing gender stereotypes and divisions within IT. Their data suggests that a lack of knowledge often went alongside a lack of interest in finding out about careers in the IT sector and whilst nearly all girls interviewed reported that CC4G did not provide them with any careers information, beyond those implicit within the activities, they also suggest that they would not have been interested anyway. However, Rivas (2013) has put into place an after school program model called *DIY Girls* that provides a continuous pathway of support to a technical career for girls from 5th grade to high school graduation, in the US. After completing an engineering degree, Rivas went back to her elementary school where, in her youth, she had been inspired by her 5th grade teacher to program a computer. She explains that her DIY Girls program helps girls to develop a mind-set of self-sufficiency and learning-by-doing as girls enter adolescence and start to form career interests. The program model integrates three factors to ensure girls' success: engagement, capacity building and continuity. Over the next seven years, she hopes to build a continuum of services where each year 30 girls are added to the program. Rivas stresses that this program is not a one-time program or event, but aims to engage girls with technology, build their skills and continue to support them until they finish high school and are college or career ready.

Stoeger, Duan, Schirner, Greindl and Ziegler (2013) measured the effectiveness of a one year personal mentoring program for eleven to eighteen year old female college preparatory students. They found that mentoring in STEM offered various advantages and provided girls with appropriate role models, females who are expert in STEM fields. They explain that the influence of mentors goes beyond their effect as role models because the female mentors also help their mentees by counselling, advising, instructing, and sharing knowledge with them. Stoeger et al's study also helps to acquire knowledge and effective action opinions in STEM which, they believe, can lead to learning and achievement gains and offer effective learning strategies. This, they explain, includes contributing to a strengthening of their mentees' self-confidence, by helping mentees deal with setbacks. They also support their mentees in setting appropriate and challenging goals. They motivate mentees and increase their interest in STEM topics through conversations and learning activities. Mentors also effect positive changes in their mentees' learning environments by providing their mentees with learning opportunities, learning materials, and chances to meet other people interested in STEM. They suggest that promotional efforts should start before girls reach the point at which their STEM interests tend to decline, but such programs stand and fall with the quality of their mentors. E-mentoring, as explained by Stoeger et al, can surmount both the challenges of time inflexibility and lack of mobility – which for younger girls, are givens – and thereby offer participants an exceptional chance to find and be inspired by highly appropriate mentors. They stress that it is important to consider evidence that small effects can also lead to large benefits and that it is also important to develop effective programs for training the mentors.

Given recent trends in school reform related to student-centred learning and teaching for meaning, Wang (2012) notes that it is particularly important that a greater understanding of how teachers create supportive class environments is developed and how different aspects of the learning environment influence student motivation and future educational career interests. Her study has practical implications for teachers that can be applied to increase student motivation and, ultimately, increase their interest in, and pursuit of, education and careers in mathematics. It appears that this can also be extrapolated into other areas of STEM such as technology and computing. Specifically, Wang suggests, students are more likely to have greater expectancy-values in mathematics, which in turn lead to taking more maths courses and aspiring to a mathematics occupation, when they:

1. are encouraged to cooperate, interact with, and help their classmates during lessons;
2. view the curriculum and teaching as meaningful and relevant to their lives;
3. perceive their teacher as understanding and supportive, and
4. feel their teachers have high expectations for their learning achievement.

3.3 Female university students perceptions of technology

College students may not yet be capable of accurately defining the value affordances of their expected careers or their perceptions may be biased by their interest and own value endorsements. These were the findings suggested by a study conducted by Weisgram, Dinella and Fulcher (2011) that examined the contributing role of masculinity and femininity to gender differences and the roles of these constructs in predicting the traditional and value affordances of college students' expected future careers. This is interesting and helps to explain a study conducted by Lang (2010), of university students already enrolled in an IT discipline. Lang's study found that, when in high school, these students made their decision to study IT during their final year, or even after the publication of university entrance scores.

Many students do not learn the skills needed to master technology as quickly as others and this is a concern since the perceived ability that students have when using technology is a vital aspect in their frequency of use of technology (Huffman, Whetten & Huffman 2013). In their investigation of university students and the relationship between technology self-efficacy and gender roles, Huffman, Whetten and Huffman (2013) show that gender roles, specifically masculinity, is the source of difference in technology self-efficacy beyond what can be explained by other contributing factors, such as previous computer hassles and perceived structural technology support. Their goal was to investigate what factors lead to differences in computer self-efficacy between men and women and they suggest that technology self-efficacy relies less on biological sex and more on societal based gender norms. They found that masculinity continued to be a stronger predictive factor of technology self-efficacy than previous preparation or university support. They propose that this is due to gender role theory's premise that because men have more socially acceptable interactions with technology they have formed masculine gender roles that include skills, motives and beliefs necessary to complete technological tasks.

Huffman, Whetten and Huffman further argue that, understanding that students' attitudes towards technology are based more on gender roles and not just biological sex, impacts future studies on the use of technology in education. They suggest that universities should develop strategies to ensure they have gender diverse instructors and, if students are only being taught computer skills by male or masculine teachers, they may be implicitly learning that boys and men are not only better at this type of skill, but that they should be more interested in it than girls and women. They further add that if students are able to see successful role models or mentors, they may be more prone to become more technologically successful and feel more comfortable and become more confident with technology use. Similarly, trainers need to make sure that training materials and style do not reinforce gendered stereotypes and hence the use of more feminine examples when talking about technology or directing questions and comments to both male and female students can ensure that women feel more comfortable with the technology content. Huffman, Whetten and Huffman highlight methods that have been shown to be successful in improving technology self-efficacy; methods that include not only teacher training, but also structured activities and ownership of technology.

When investigating gender stereotyped attitudes towards occupations, DiDonato and Strough (2013) explain that most research is based on women whilst men are generally not thought to experience disadvantage in the workplace. However, in discussing their US based research, they declare that the importance of understanding both men's and women's career decisions is apparent when considering the larger context of contemporary society. Their study found that students hold gender-stereotyped attitudes about the occupations that are appropriate for men, but not about the occupations that are appropriate for women. However, even though students' attitudes indicated that it was acceptable for women to hold stereotypically masculine occupations, women's college majors and occupations still reflected gender stereotypes.

3.4 Girls attraction to creativity and multimedia

An Australian investigation by Doube and Lang (2012), into female motivation to study and pursue computer programming as a career, found that the distribution of male and female participants in the study was approximately equal; this numerical balance presented a rare opportunity. The university study involved an interdisciplinary elective programming subject, including animation and multimedia focusing on production in web programming, 2D animation programming as well as graphics. Doube and Lang (2012) found that:

> females were highly extrinsically motivated to learn programming, only slightly less than males, indicating that they were motivated by factors such as good marks, competition and approval or respect of others. They were even more intrinsically motivated to learn programming, slightly more than males, indicating that they found computer programming interesting, challenging and enjoyable. (p. 73)

Further, Doube and Lang explain that these students were not aiming for careers in traditional computing but in multimedia development and production. They suggest that the creativity utility of the curricula was important in ensuring that females persisted in the class, despite having lower self-efficacy and greater anxiety than their male peers. The females could expect their needs for relatedness to be fulfilled because they were learning and working with peers with similar status and interests.

Also, the high values for extrinsic goal orientation support this view by suggesting that impressing their peers and others with their results and the portfolio that they could produce during their studies, could be important to multimedia students. Doube and Lang (2012) posit that:

> females could be motivated to learn technical concepts that are associated with domains which are considered creative, fashionable and sociable and which are not perceived as dominated by anti-social masculine stereotypes. (p. 74)

3.5 Gender and IT careers

Technology has penetrated almost every aspect of our lives; however, this exposure needs to be equally positive for both genders (Huffman, Whetten & Huffman 2013). If women are not exposed to technology to an equal degree as men, argue Huffman, Whetten and Huffman (2013), they will not acquire the needed skills and values and will fail to develop the needed technology self-efficacy. Recent neuroimaging studies have accumulated substantial evidence supporting the notion that gender makes a difference in brain connectivity (Gong, He & Evans 2011). This strongly suggests, as argued by Gong, He and Evans, that gender has a significant influence on the patterns of neuronal communication within the human brain, possibly relating to underlying cognitive and behavioural differences between genders. As discussed by Clow and Ricciardelli (2011), the role of leader is perceived as a better fit with the male gender role in comparison to the female gender role. However, Kabeer and Natali (2013) argue that gender equality contributes to economic growth while Hankivsky (2013), in an examination of gender mainstreaming over five countries, calls for the need to sufficiently map and analyse what shapes and conditions men's and women's lives and how to build a socially just society. This, she explains, requires looking at a myriad of power and related structures that shape human beings, their lives, values and norms.

Supported by a range of academic studies, Vekiri (2013), explains that boys tend to express more confidence in their computer abilities and more positive attitudes towards ICT and have more opportunities to develop positive beliefs about their computer abilities and the value of computers, and they tend to receive more encouragement from their parents to improve their knowledge about ICTs. In her research, Vekiri aimed to identify practices of information science instruction that may affect student motivational beliefs, and to examine links between these practices and changes in boys' and girls' beliefs about information science.

Gender differences in career choices are apparent in gender segregation of the workforce, perhaps as a result of differences in the occupational values that men and women endorse (Weisgram, Dinella & Fulcher 2011). Research in many countries, as argued by Vekiri (2013), shows that females are less likely to enrol in advanced computer classes in high school. She argues that this limits the opportunities of females to develop skills that are considered necessary in many areas of employment, as well as their access to careers in IT. This, she explains, perpetuates economic gender inequalities and it also:

> 'deprives technological fields from the breadth of perspective that support scientific developments and lead to technological innovations which take into account social diversity (Barker & Aspray, 2006 cited in Vekiri 2013, p. 104).

A range of research studies supporting the notion that women's under-representation in male domains, such as ICT, cannot be attributed to gender differences in aptitudes are provided by Vekiri (2013). She argues that this under-representation is the result of complex social and psychological processes that shape adolescents' career aspirations and academic choices. These processes, she explains, are gendered and involve school and informal learning experiences as well as the influences of socializers, cultural stereotypes and social gender-role expectations.

In offering ways to change the image of computer science, a study by Cheryan, Drury and Vichayapai (2013) demonstrates that interventions that promote current stereotypes of the field, even inadvertently, may be less effective in changing women's and girls' attitudes towards a field, than interventions that downplay or alter these stereotypes. They suggest:

- downplaying these stereotypes by presenting an image of male-dominated fields that is more consistent with aspects of the female gender role that women deem important;
- practitioners who use role models to aid recruitment should pay careful attention to whether these role models convey a sense of belonging to recruits;
- develop ways to share a unique similarity or emphasise shared values;
- use male role models to also play an important role in recruiting women into computer science, but consider whether they may be promoting a stereotypical image of the field.

Cheryan, Drury and Vichayapai (2013) are also concerned that the current prevalence of representations of scientists and engineers in the media who fit current stereotypes may be preventing more women from entering the field of computer science. Consciously changing these representations and disseminating new ones may be necessary to increase the number of women who choose to enter the field. Interventions that are developed to alter stereotypes, based on these findings, could be used in concert with other changes such as changing curriculum and eliminating negative stereotypes about women's abilities. Also, using other vehicles of stereotyped change, such as creating and exposing women to non-stereotypical computer science environments and widely disseminating non-stereotypical media representations, may also be effective tools for explicitly changing the image of computer science. Cheryan, Drury and Vichayapai examine whether a brief exposure to a computer science role model who fits stereotypes of a computer scientist has a lasting influence on women's interest in the field. They make the assumption that one-time exposure to a role model, someone who is seen as competent and successful in her or his field, will improve students' long-term interest in entering that field. However, as part of these efforts, women are often exposed to computer scientists and engineers who fit current stereotypes of those in the field, such as being singularly focused on technology and being socially isolated.

It is important to note that Cheryan, Drury and Vichayapai (2013) found that women who encountered a role model who embodied computer science stereotypes were less interested in majoring in computer science and felt less belonging to the field compared to women who interacted with a non-stereotypical role model or no role model. Their findings are particularly notable because interactions were on average less than 2 minutes long. Their findings also revealed that female role models were no more effective than male role models in inspiring women and girls to develop an interest in computer science. In fact, non-stereotypical male role models were more effective in increasing women's interest than female role models who fit current stereotypes. They note that female role models may be effective in reducing stereotype threat for women who already strongly identify with their field and in improving women's attitudes about their own abilities, but they may be less important in motivating women to enter these fields. They suggest that sharing a unique similarity may make role model influence more likely to occur, and the possibility exists that non-stereotypical role models may have been perceived as typical of the field or as being unrealistic precisely because they did not fit stereotypes.

When interviewing females studying IT at an Australian university, Connolly (2013) provides insight into what drove the students to pursue a career in technology, how to best close the gender gap and why working in IT is a wise choice. The girls explain that, being female, they provide a different perspective going into a male dominated industry and offer new thoughts and ways of approaching things. They note that it is important to integrate into the male dominated company culture and to be able to take criticism. The girls stress that personality and the ability to change and adapt is also very important; being female does not hinder them in technical or business aspects of jobs. The girls accept that they have less experience because of their age, but they also have the capability to learn and they see themselves as good resources. In agreeing that perceptions are important, they see the need to remove the idea that IT professionals are geeks sitting in front of the computer all day and to build an understanding in regard to what IT professionals actually do with computers. They argue that the ways in which IT professionals approach problems and the many communication processes, regardless of technology, are important aspects of taking on an IT career and they explain that the IT field is a diverse area and includes how technology is used to improve business. The girls explain that misunderstandings exist in regard to technology careers and there are many challenges when overcoming these including the large number of male executives sitting on boards. They stress that such misunderstanding are not just a technology problem but also a business problem as well. In the interviews, these women were inspired by female role models and explain that it helped them to understand that they could also be successful and to understand that it is their work that is being judged. They argue that it is about how they work and perform, it is not about gender. They agree that the notion of the males being in the majority in the IT industry can be seen to be intimidating, but once you do start it becomes less of an issue.

3.6 Gender and post-secondary education

In spending time selling computing as a potential career to school children, Petrie (2013) tries to get them to see the creative angle. Inevitably, she explains one of the questions young girls often ask is: "Is it hard to be a girl in computing?" The computing discipline cannot be fully successful without more women (Georgia Tech 2013). Diversity of thought, as stated on the Georgia Tech website, is integral to the field of computer science reaching its full potential. Their *Women in Computing*[5] initiative involves an extensive outreach program to increase the number of qualified computing teachers in Georgia and to increase the number and diversity of computing students.

As part of a discussion forum regarding students' desire to pursue studies in STEM as a major in college, Coger et al. (2012) argue that two factors influence students' decisions:

1. personal capabilities and preparedness to succeed; and
2. a desire to pursue that discipline.

Based on 30 years of experience as a female engineering student, a mechanical engineering educator and an engineering administrator, she explains that the quality and rigour of the content of primary, secondary, and higher education programs is key to the first factor and it is important to nurture the layperson's understanding of STEM occupations and the relevance of STEM to a student's own reality. She notes that current STEM practitioners serve as role models, ambassadors and gatekeepers of the fields and, hence, play a key role in a newcomer's persistence in a STEM major. Successes in improving the gender gap in computer science can be seen at Carnegie Mellon University (CMU), Georgia Tech, and Harvey Mudd College and these have changed the cultural climate and had remarkable success in recruiting and retaining female computer-science students (Coger et al. 2012). Other points raised by Coger et al. (2012) include:

[5] see http://women.cc.gatech.edu/outreach.php

- Girls rarely get the encouragement they may need to overcome their hesitancies to try computing. When they do find themselves in a computing course, they are often uncomfortable in the male-dominated climate they encounter.

- Sustained efforts are needed to alter the messages girls receive about technology.

- Girls need to be provided with engaging computer-science-related activities in elementary and middle school.

- Computing has the potential to transform our world and this information needs to be dispersed and related to high-quality courses,

Frieze and Quesenberry (2013), from Carnegie Mellon University (CMU), argue that gender difference thinking, with regard to attitudes towards computing, can work against diversity in the field of computing, and they state that the years of attention and funding applied to women in computing issues have not paid off. They believe that gender difference approaches to the participation of women in computing have not provided adequate explanations for women's declining interest in computer science and related technical fields, nor has the "Changing Face of Computing" (p. 1) led to significant changes in the levels of women's participation. They argue that a cultural approach to the issue is needed if we are to develop a more effective framework for investigating and increasing women's participation in computing. They explain that at CMU they began to observe what they believed to be the evolution of a new culture of computing as the environment shifted from an unbalanced to a more balanced environment. By balance they refer to three specific areas: balance in terms of gender, in terms of breadth of student personalities, and in terms of development of a professional and social organization. They explain that at CMU, their women in computing program, Women@SCS[6], provides crucial educational and professional experiences that are often taken for granted by the majority in the community (for example the networking and mentoring that goes on quite naturally among the majority male population in computing courses). With this more balanced environment, they explain, women began to participate, contribute, and be successful in the computer science major, without accommodating presumed gender differences or any compromises to academic integrity. Frieze and Quesenberry (2013) argue that a cultural perspective can both broaden and focus our thinking, and allows us to look at factors outside of gender as leading contributors to different levels of participation. This is noted more clearly in Blum and Frieze (2005) where it is concluded that gender differences in earlier studies 1995-1999 tell more about the biases in their former admissions criteria (and take a limited view of the undergraduate major) than about significant or intrinsic gender differences in potential computer scientists.

Harvey Mudd College in 2006 had few women majoring in computer science, but in 2012 it had nearly 40% (Hafner 2012). In an interview with Hafner, Dr Maria Klawe, president of Harvey Mudd College in Claremont California, explains that her faculty was able to reduce the intimidation factor for female computer science majors. This was done by dividing the course into two sections, "gold" for those with no prior experience, and "black " for everyone else and changed the focus of the course to computational approaches to solving problems across science. They were able to demonstrate that computer science was not all about programming, but has intellectual depth and connections to other disciplines (Hafner 2012). In support of the new program, Dr Klawe provided money from the college for every female freshman to travel to the annual Grace Hopper conference where students are surrounded by

[6] see http://www.women.cs.cmu.edu/Resources/Papers/

female role models. The idea was to make the introductory course enjoyable and interesting enough that women who were thinking of other majors might choose computer science instead.

Hafner (2012) explains that it is difficult to know if Harvey Mudd's success can be replicated on a larger scale and explains that at Carnegie Mellon, the percentage of incoming women enrolled in the computer science program has been rising since 2008. It is notable that the University of California, Berkeley, and a few others have also redesigned their computer science courses to be less intimidating. Jennifer Tour Chayes, Managing Director of Microsoft Research New England, in support of Dr Klawe and the turnaround at Harvey Mudd College, says women are often questioned, and then they take the 'imposter syndrome' (Hafner 2012, p. 2) as their inner voice, as proof that they shouldn't go on. She explains that what they need to know is that women, like Dr Maria Klawe, also had that inner voice, and luckily ignored it leading to successful careers.

3.7 Supporting uptake of ICT studies

There are global concerns in regard to the current and future roles of women in computing occupations and these seem even more important with the emerging information age (Wikipedia 2013). Recent efforts to turn this issue around, according to the Wikipedia website include:

1. Ada Developers Academy[7], a tuition-free programming school for women;
2. Technology Alliance[8] a not-for-profit organization of leaders from Washington's technology-based businesses and research institutions aimed to advance excellence in education, research and entrepreneurship;
3. Girl Develop It[9] an international organization, certified by the Board of Education that exists to provide affordable and accessible programs to women who want to learn software development through mentorship and hands-on instruction;
4. Hackbright Academy[10] a 12-week accelerated software development program designed to help women become programmers;
5. Doing IT Around the World Albums[11] role models representing a wide diversity of women in technology industries.

On a larger scale, the CS/10K Project aims to develop an effective new high school curriculum for computing, taught in 10,000 high schools by 10,000 well-qualified teachers by 2015 (CS10K Community 2013). 'The CS/10K Project is an ambitious and bold endeavour that represents our best opportunity to transform computing education beginning where we must begin – at the high school level' (Cuny 2011, p. 107).

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[7] http://adadevelopersacademy.org/

[8] http://www.technology-alliance.com/

[9] http://www.girldevelopit.com/

[10] http://www.hackbrightacademy.com/

[11] http://www.passionit.info/albums.php

A report from the Pew Research Centre's Internet and American Life Project found that from 2008 to 2013, the percentage of women using social media outranked the percentage of men doing so by 8 percent (cited in Baker 2013). Reports such as this clearly indicate that women are interested in aspects of computing. The computer-based tools so prevalent in modern life might be even more useful if more women took part in developing them (Baker 2013). In university courses, as explained by Baker, girls are too quickly discouraged by getting lower grades than male peers who often have an earlier background in computing, but if they just get the degree then they will get jobs. Baker explains that computer skills lend themselves to home-based creation of new products, and creating an app, website or game can provide an ongoing flow of cash for people living in poverty, such as young mothers. A booming job market means it's possible to drop into and out of the career, depending on family needs (Baker 2013). A group of five successful women in computing careers, in a video clip from the 2012 USENIX Women in Advanced Computing Summit, discussed their experiences in working in computing and provided advice and strategies for success (WiAC 12 2012). Their discussion includes:

- Share successes with enthusiasm;
- Be confident enough to ask questions;
- Say yes to opportunities as they arise, since people are seeing the capabilities within you, then go with this;
- Surround yourself with smart people;
- Be comfortable with who you are;
- Develop the mentality that you belong;
- Don't accept things that are not okay.

3.8 Evaluating interventions

In investigating why women and minorities are underrepresented in computer science majors Bock et al. (2013) searched for barriers that were keeping women and minorities from pursuing computer science degrees. They found that the main reason female students were not pursuing a computer science degree was the perception that computer science is for geeks and nerds. This continues to be a significant trend of thinking when searching for reasons why females are not choosing to study computing at universities. The following provides a summary of the influencing factors and suggestions found throughout this literature review.

It appears that each approach that has been taken towards improving the gender balance in computing has its strengths and weaknesses and there are many gaps in our knowledge in regard to how to increase the number of women in IT. Cohoon and Aspray (2006, p. 472) explain that the value of any research project depends on how well it is undertaken and they warn (2006, p. 473) that if the root causes have not changed then the results could remain localized or the trends could reverse when efforts are discontinued. They note that evaluation often favours short-term, countable and anticipated outcomes and they offer the following examples to highlight the importance of high quality evaluation (p. 472):

1. We can measure whether women in a peer-support program persist in their computing major at higher rates than women who are not in the program, but we seldom think to measure whether participants enrol in computing graduate programs after raising their

families. If we did, we might find that their support program had no immediate effect on undergraduate persistence, although it did result in more returning women graduate students.

2. We might miss the success of interventions with high school teachers of computer science if we look only for greater gender balance in their high school classes, and ignore the more positive image of computing those teachers communicate and the subsequent high rates of students from their school choosing a computer science major in college.

3. The practical constraints that focus evaluation on immediate and recognizable results raise the chance that programs labelled as ineffective and discontinued may actually produce longer-term or unanticipated positive results.

4. Funding only interventions that have been proven effective can lead to a small range of cookie-cutter programs even though one size might not fit all.

5. Failing to recognize the role that institutional control plays in the success of a program could lead to misplaced efforts or the discontinuation of support for programs that work only in particular settings.

Corneliussen (2012, p. 7) calls for more research of different kinds and asserts that, in relation to change and stability, questions such as the following should be considered:

- Have we become blind to seeing change in gender-technology relations: could it be that we have been ‘looking for’ stability instead of change, or for gender differences instead of similarities or ‘differences within’?

- Recent gender and ICT research has pointed out the need to recognize diversity, variations, and multiple masculinities and femininities: “are these variations change, or are they seen as examples of exceptions, special cases, or extraordinary individuals?

- Does change need to involve a majority, a consensus, or perhaps ‘relevant social groups‘?

- Does change need to be permanent, include a ‘critical mass’, or go in a particular direction to be recognized as change?

4. Selection of institutions to investigate further

The original project plan limited the scope of the investigation to a total of six institutions, two each selected from the upper quartile, lower quartile and median range of universities, ranked by domestic female participation in IT degrees. A simple inspection of Figure 2 above suggests a number of institutions that warranted in depth investigation with respect to domestic female enrolments. At the positive end, Central Queensland University (CQU) lead the rankings with over 35% domestic female participation in IT degrees in 2012. This was the only institution that achieved a participation rate of 30% or more that year. At the other end of the rankings, the University of Wollongong (UoW) achieved the lowest rate with 9% domestic female participation in 2012. The average domestic female participation rate was 18% which was achieved by Victoria University, University of Tasmania, University of Queensland and University of Adelaide.

However, it was determined that basing selections on just a single year did not take into account themes or trends in participation rates so an analysis of participation rates over the period 2001-2012 (the available uCube data) was undertaken. All the available domestic data is shown in Appendix 1. A number of factors were considered including:

- Highest/lowest overall
- Highest/lowest recently (last 3 years and last 6 years).
- Consistent increase/decrease over the 12 year period.

As far as high performing institutions are concerned, CQU and Charles Darwin University were the stand-out high achievers as they topped the list on all measures. These two institutions were selected from the upper quartile of the rankings.

At the low end of the scale, the picture was less clear. The University of Western Australia featured in all categories except for the consistent decrease. The University of Wollongong featured in the lowest more recently as did James Cook University. The two institutions selected to represent the lower quartile were University of Wollongong and University of Western Australia (UWA). James Cook University was omitted on pragmatic grounds as Queensland appeared to be over represented in all selection categories. Including UWA widened the geographic representation of institutions.

The average performing institutions were as consistent in their performance as those in the upper quartile. Three institutions where selected here include Queensland University of Technology, The University of New South Wales and the University of Queensland.

Appendix 2 shows the outcomes of this trend analysis for domestic female participation.

A similar analysis was completed for international female participation, the outcomes of which is shown in Appendix 4. Interestingly there was no overlap in institutions appearing in the upper and lower quartiles but both QUT and UNSW were average performers in the international market as well as the domestic market. As a result of this analysis, University of Tasmania was added to the list of institutions in the upper quartile to be further investigated and the University of Queensland was omitted from the average ones.

To summarize, the following institutions were selected to investigate further:

- Central Queensland University
- Charles Darwin University
- University of Tasmania
- Queensland University of Technology
- University of New South Wales
- University of Wollongong
- University of Western Australia

A request was made to each of these institutions, through the auspices of an academic in the IT area who is known to the researchers. The following email was sent to each academic:

Dear <*academic*>
I'm seeking your help with a research project that I am undertaking on behalf of ACDICT. I was fortunate to gain an ALTA grant which aims to explore factors influencing female choices of IT degree (classified by DEEWR as in Field of Education=2 i.e. IT).

I am seeking your help with obtaining this information from <*institution*>. What initiated this project was the data that is publically available in uCube (DEEWR website). It provides annual figures by FoE and by University for international and domestic students. It shows that <*institution*> performs <*very well/quite poorly/on average*> as far as attracting female domestic and international students to IT and I'd like to use this data as one of the benchmarks for this research.

What I want to do is drill down into the data for <*institution*> which means I need the following information:

- Which degrees the University classifies as being in FoE = 2; and
- Male and female enrolments in these degrees for as many years as you can easily get hold of :)

It would help me considerably if I can get the numbers and percentage of commencing international and domestic students but understand if this is asking too much.

I really appreciate any help you can provide in assisting me in obtaining these figures. If you require any clarification please do not hesitate to contact me.
Regards
Jo

Data was received from

- Central Queensland University (CQU),
- Queensland University of Technology (QUT),
- The University of Wollongong (UoW), and
- University of Western Australia (UWA).

The data sets received from the four universities identified in the previous section were collated into a form that could be entered in SPSS. The data sets included a variety of year ranges so these were standardized to include data from 2009 to 2012 inclusive, a range that was common to all.

5. Descriptive quantitative analysis of degrees

There were 153 separately coded qualifications reported in the combined data sets. However a significant number of these had no commencing students in the period 2009 to 2012 suggesting that these qualifications were being pipelined over this four-year period. Of the qualifications with commencing students, UoW and CQU each reported on 13 qualifications, UWA reported on 16 and QUT reported on 34, a total of 76 qualifications. The programs covered the whole gamut of tertiary qualifications including Diplomas, Bachelors, Graduate Certificates, Graduate Diplomas and Masters Degrees. One institution also reported on PhD programs specifically in IT.

There was considerable variation in the terminology used to represent the IT discipline in the qualifications, ranging from the traditional to the modern. These included:

- computer science, computing, computing studies, computing technology;
- computer and mathematical sciences;
- information systems, business information systems, business process management;
- information technology, information technology management, information technology studies;
- computer engineering, telecommunications engineering;
- health informatics;
- games and interactive entertainment.

A number of reported qualifications included double degrees such as the “Bachelor of Business and Bachelor of Information Technology” or “BinfoTech/BMaths”. CQU reported 5 such qualifications, as did QUT and UWA. Interestingly, UoW did not report any such qualifications. Combined degrees included IT (or a variation thereof) with Maths, Law, Arts, Science, Applied Science, Commerce, Business, Economics, Engineering, and Project Management.

Further, many of the qualifications included appellations such as “extended”, “professional”, “honours”, or which defined specific study areas such as “StudyAreaA”, “InfoSys”, “SoftArch”. Some of the degrees that included such qualifiers could have been combined in the following analysis (for example the various BInfTech qualifications offered by QUT), however, without delving into the curriculum of each it was not clear how much overlap existed within each program which would justify such data manipulation. Ultimately the data was analysed as reported. Quite a few of the appellations were acronyms and, on occasion, were not particularly informative (such as StudyAreaA). It is unclear how the acronyms would be interpreted by prospective students or whether they added to the information that the program name provided.

Tables 1, 2 and 3 show the top 10 courses with the largest *numbers* of female students. Table 1 shows the total number, table 2 the number of international students and table 3 the total number of domestic students. As would be expected the larger courses, the majority of which are undergraduate programs, have the higher numbers of female students. UWA is the only institution not represented in the top 10 courses by female enrolment and inspection of the data provided in Appendix 5 provides an indication as to why. The top performing programs at UWA are the Bachelor of Computer Science (60130) and Bachelor of Computer and Mathematical Sciences (50100) both of which have just 19 commencing female students.

Table 1 Top 10 courses by total female students

University	Course	Total Females	Total Males	Total Enrolled
UoW	Master of Computer Science(585)	37	249	286
CQU	Master of Information Systems	46	188	234
QUT	IT44 - MInfTech(Adv)(StudyAreaA)	55	203	258
UoW	Undergrad Telecommunications Engineering(U-TELE)**	73	256	329
QUT	IT04 - B Games and Interactive Ent	88	567	655
UoW	Bachelor of Computer Science(766) (on shore)	89	1565	1654
UoW	Bachelor of Information Technology(1807) (on shore)	135	1217	1352
QUT	IT23 - BInfoTech	164	1153	1317
CQU	Bachelor of Information Technology	181	670	851
QUT	IT43 - MInfTech(StudyAreaA)	233	554	787

Inspection of table 1 suggests that females are slightly more likely to enrol in an undergraduate program than a postgraduate graduate one (six undergraduate entries compared to 4 postgraduate qualifications). However when comparing these figures by domestic and international students, domestic students are much more likely to enrol in an undergraduate than postgraduate program.

Table 2 Top 10 courses by international female students

University	Course	Int'l Females	Int'l Males	Int'l Enrolments
UoW	Master of Computer Science(585)	34	232	266
UoW	Postgrad Telecommunications Engineering(P-TELE)**	34	235	269
UoW	Bachelor of Information Technology(1807) (on shore)	36	377	413
CQU	Master of Information Systems	41	177	218
UoW	Bachelor of Computer Science(766) (on shore)	42	516	558
QUT	IT44 - MInfTech(Adv)(StudyAreaA)	52	183	235
QUT	IT23 - BInfoTech	69	299	368
UoW	Undergrad Telecommunications Engineering(U-TELE)**	72	199	271
QUT	IT43 - MInfTech(StudyAreaA)	88	305	393
CQU	Bachelor of Information Technology	134	383	517

Two programs appear somewhat anomalous, Undergrad and Postgrad Telecommunications Engineering both offered by UoW. These appear to be very popular in the international market but do not figure in the domestic market. It is interesting to note that the most popular programs are tagged as Information Technology. Interestingly, although CQU ranked the highest institution overall as far as female participation in the IT FoE is concerned, it ranks only 5th in the top 10 courses by domestic female students (see table 3), equal with UoW which was amongst the lowest rank institutions overall.

Table 3 Top 10 courses by domestic female students

University	Course	Domestic Females	Domestic Males	Domestic Enrolments
UWA	Bachelor of Computer Science (60130)	14	126	140
CQU	Bachelor of Business and Bachelor of Information Technology	17	34	51
UoW	Bachelor of Business Information Systems(1838)	18	65	83
QUT	IT85 - GradCertInfTech(StudyAreaA)	18	69	87
CQU	Bachelor of Information Technology	47	287	334
UoW	Bachelor of Computer Science(766) (on shore)	47	1049	1096
QUT	IT04 - B Games and Interactive Ent	85	537	622
QUT	IT23 - BInfoTech	95	854	949
UoW	Bachelor of Information Technology(1807) (on shore)	99	840	939
QUT	IT43 - MInfTech(StudyAreaA)	145	249	394

Although large numbers of females is a positive aspect of the courses included in tables 1-3, the picture is somewhat different when looking at female *participation* rates. Table 4 shows the top ranked courses based on percentage female participation. Although some of the raw totals are very small (for example QUT's MInfTech and DInfTech), table 4 provides a more rounded picture of where and what females are choosing to study in the IT FoE. Interestingly, UWA presents a more positive outlook in this analysis than in the analysis of raw female numbers.

An analysis of the type of degrees females are commencing provides an interesting picture. Inspection of the entries in table 4 shows that of the courses in the top 10 rankings (16 in all[12]) 10 are postgraduate courses and 5 are undergraduate. Of the 5 undergraduate courses, 4 are double degrees and only 1 is a single degree, which is QUT's BInfoTech(Hons).

[12] Note that the ranking allows for multiple courses in one rank without making any adjustment to the numbering of the following lower ranked entry. Hence there are more than 10 courses in the top 10 rankings.

Table 4 Total female participation ranked by percentage

University	Course	Total Females	Total female percentage	Rank
CQU	Graduate Diploma of Information Technology	14	32.00%	10
CQU	Bachelor of Business and Bachelor of Information Technology	17	33.00%	9
QUT	IT28 - BInfoTech(Hons)	2	33.00%	9
QUT	IT35 - GradDipInfTech(StudyAreaA)	1	33.00%	9
QUT	IT81FSE - DInfTech	1	33.00%	9
CQU	Bachelor of Commerce and Bachelor of Information Technology	10	34.00%	8
UoW	Master of Health Informatics(1540)	20	37.00%	7
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Economics (61030)	2	40.00%	6
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	7	44.00%	5
QUT	IT60FSE - MInfTech(Research)	5	50.00%	4
QUT	IT80MCA - DInfTech(InfoSci)	1	50.00%	4
QUT	IT80MCB - DInfTech(CompSci)	1	50.00%	4
CQU	Master of Information Systems and Master of Project Management	7	54.00%	3
QUT	IT60MCA - MInfTech(InfoSci)	5	56.00%	2
QUT	IT60SMA - MInfTech(Research)	1	100.00%	1

Tables 5 and 6 show the courses that rank highly in international and domestic female participation rates. Although there is a high incidence of postgraduate courses that domestic and international students are commencing, there is a stark difference between these two cohorts. Of the 16 courses ranked in the top 10 for international students, 6 are at the postgraduate level and 9 at the undergraduate. Of the 9 undergraduate courses, 6 are single degrees and just 3 are double degrees (refer to table 5). However, in the domestic market, 15 courses are in the top 10 rankings with 10 postgraduate courses and 5 undergraduate courses being listed (refer to table 6). All the undergraduate courses are double degrees.

Further inspection of the naming conventions for the degrees show that there are a number of similarities, with information technology (and variations thereof) featuring strongly. However, health informatics features in the list for domestic students but not international; computing technology features in the international list but not domestic. This observation is a curiosity but it is not possible to judge whether such differences are related to characteristic of the student cohort or availability of qualification.

Table 5 International female participation ranked by percentage

University	Course	Int'l Females	Int'l female %	Rank
UWA	Master of Information Technology - Coursework (61520)	10	26.00%	10
CQU	Bachelor of Information Technology	134	26.00%	10
UoW	Undergrad Telecommunications Engineering(U-TELE)**	72	27.00%	9
QUT	IT53 - MBusProcessMgt	18	30.00%	8
CQU	Master of Computing Technology	3	30.00%	8
QUT	IT35 - GradDipInfTech(StudyAreaA)	1	33.00%	7
UWA	Bachelor of Computer and Mathematical Sciences (50100)	11	34.00%	6
UWA	Bachelor of Computer Science and Bachelor of Commerce (61020)	3	38.00%	5
UoW	Bachelor of Business Information Systems(1838)	4	40.00%	4
CQU	Graduate Diploma of Information Technology	3	43.00%	3
CQU	Bachelor of Commerce and Bachelor of Information Technology	1	50.00%	2
QUT	IT28 - BInfoTech(Hons)	1	50.00%	2
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	3	50.00%	2
UWA	Bachelor of Computer Science (Honours) (6013H)	1	50.00%	2
CQU	Master of Information Systems and Master of Project Management	1	100.00%	1
QUT	IT80MCB - DInfTech(CompSci)	1	100.00%	1

Table 6 Domestic female participation ranked by percentage

University	Course	Domestic Females	Domestic female %	Rank
CQU	Graduate Diploma of Information Technology	11	30.00%	10
QUT	IT53 - MBusProcessMgt	14	31.00%	9
CQU	Master of Information Systems	5	31.00%	9
CQU	Bachelor of Business and Bachelor of Information Technology	17	33.00%	8
CQU	Bachelor of Commerce and Bachelor of Information Technology	9	33.00%	8
QUT	IT43 - MInfTech(StudyAreaA)	145	37.00%	7
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	4	40.00%	6
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Economics (61030)	2	40.00%	6
CQU	Master of Information Systems and Master of Project Management	6	50.00%	5
CQU	Master of Information Systems Extended	1	50.00%	5
QUT	IT60FSE - MInfTech(Research)	5	56.00%	4
QUT	IT60MCA - MInfTech(InfoSci)	5	56.00%	4
UWA	Master of Computer Science (60600)	8	57.00%	3
UoW	Master of Health Informatics(1540)	11	73.00%	2
UoW	Master of Information Technology Studies Advanced(1611)	1	100.00%	1
QUT	IT60SMA - MInfTech(Research)	1	100.00%	1
QUT	IT80MCA - DInfTech(InfoSci)	1	100.00%	1
QUT	IT81FSE - DInfTech	1	100.00%	1

6. Qualitative analysis of degree descriptors

Qualitative analysis of the degree descriptors was undertaken, to provide a more detailed picture building on the descriptive statistics discussed in the previous section. The text describing each degree was extracted from university web sites and imported to NVivo to enable the analysis. As not all degrees could be located on the various websites, table 7 shows the degrees that are included in this analysis. To better understand the courses being offered and how they are being described, an analysis of the most frequently used words used when advertising the degree on the university website was undertaken. Rather than looking at individual degrees, the analysis was undertaken holistically by university, since it seemed likely that the lexicon used at each institution is monitored and controlled centrally.

It is interesting to analyse the naming conventions of the courses offered and consider if what audience they may appeal to. For instance, UWA has only 1 course out of 11 that does not begin with “Bachelor/Master of Computer …”. This is quite different to QUT who have “Bachelor/Master of Information Technology …” in their naming conventions; 10 out of 13. UoW uses more of a variety of terms in their course names than the other universities analysed such as “Business Information Systems” “Computer Science”, “Engineering”, “Health Informatics” and “Information Technology”. At CQU they predominantly use “Information Technology”, and also “Information Systems”, “Engineering”, and “Business”.

Table 7 Degrees included in Qualitative analysis

CQU	UoW
Bachelor of Business Bachelor of Engineering Bachelor of Information Technology Graduate Diploma of Information Technology Master of Information Systems Master of Information Technology	Bachelor of Business Information Systems Bachelor of Computer Science Bachelor of Engineering (Computer Engineering) Bachelor of Engineering (Telecommunications Engineering) Bachelor of Information Technology Master of Computer Science Master of Computer Studies Master of Engineering Master of Health Informatics Master of Information Technology Management Master of Information Technology Studies Master of Information Technology Studies Advanced
QUT	**UWA**
Bachelor of Business/Bachelor of Games and Interactive Entertainment Bachelor of Games and Interactive Entertainment Bachelor of Information Technology Bachelor of Information Technology (Honours) Bachelor of Information Technology/Bachelor of Mathematics Doctor of Information Technology Graduate Certificate in Information Technology Master of Business Process Management Master of Information Technology Master of Information Technology (No Major) Master of Information Technology (Advanced) (No Major) Master of Information Technology (Research)	Bachelor of Arts and Bachelor of Computer Science (62100) Bachelor of Computer and Mathematical Sciences (50100) Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150) Bachelor of Computer and Mathematical Sciences and Bachelor of Economics (61030) Bachelor of Computer Science (60130) Bachelor of Computer Science and Bachelor of Commerce (61020) Bachelor of Computer Science and Bachelor of Economics (61030) Bachelor of Computer Science Honours degree (6013H) Bachelor of Science and Bachelor of Computer Science (52100) Graduate Diploma in Computer Science (60360) Master of Computer Science (60600)

An analysis of the terms used to describe degrees at each institutions provides further insights into the lexicon used. Table 8 shows the most frequently used words in the text used to describe the degrees.

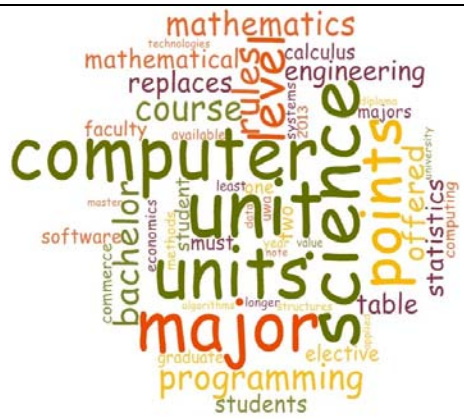
Across the four universities, the word *information* was mentioned most frequently by all but UWA. The discourse UoW use in their course profiles more strongly reflects the course content, using terms such as *engineering*, *computer*, and *technology* in their top five used terms. UWA uses *computer* and *science,* with QUT using *technology* and *research*, and CQU using only *technology* when discussing the course content.

Table 8 Word Frequency in Degree Descriptors

Word	UOW	QUT	UWA	CQU
information	157	143	-	178
engineering	105	-	-	-
computer	82	-	190	-
technology	76	79	-	106
UoW	69	-	-	-
course/s	66	77	99	47
campus	64	-	-	-
research	60	78	-	-
master	51	-	-	-
systems	49	-	-	60
QUT	-	82		-
bachelor	-	64	97	-
study	-	64	-	122
time	-	51	-	-
get	-	50	-	-
business	-	46	-	55
unit	-	-	205	-
science	-	-	197	-
units	-	-	184	-
major	-	-	183	-
points	-	-	155	-
level	-	-	133	-
rules	-	-	102	-
program	-	-	-	122
programs	-	-	-	60
CQU University	-	-	-	46
education	-	-	-	43

An inspection of the sets of most frequently used words by each university reveals some subtle differences.

University of Western Australia



We found that UWA uses quite descriptive words in their course profiles, with *unit/units*, *computer*, *science* and *major* the top five words that appear. Other descriptive words not related to the content of the courses were also identified as appearing the most (*points*, *level*, *rules*, *course*, *bachelor*).

University of Wollongong

We found that UoW uses *information*, *engineering*, *computer*, *technology* and *uow* as their top five most frequently occurring words in the way they describe their courses. They also use descriptive words (*course*, *campus*, *research*, *masters*, *systems*) with some of these more relevant to the course content such as *research* and *systems*) than those at UWA.

Queensland University of Technology

An analysis of QUT's course profiles revealed the five most frequently used words as *information*, *qut*, *technology*, *research* and *course*. Descriptive terms used included *bachelor* and *study*, but interestingly *time*, *get* and *business* were also frequently used in the description of the courses.

Central Queensland University

When comparing CQU's most frequently used words in their course profiles, we found *information*, *study*, *technology*, *program* and *programs* the five most appearing. The following five were *systems*, *business*, *courses*, *cquniversity* and *education*.

7. Discussion and Conclusions

The word graphics above, and the word frequencies shown in table 8, highlight the differences in lexicon at each University. CQU's frequently used terms imply a holistic approach to studies. Other than *information* and *technology*, terms such as *study* appears prominently and *education*, *professional* and *graduate* also appear. CQUniversity is also prominent in the graphic. On the other hand, the terminology predominately used at UWA focuses on the technology and administration of the degrees, with terms such as *science*, *points*, and *programming*. It is also discipline oriented, with *mathematics*, *calculus*, *engineering*, *programing* and *statistics* appearing prominently in the graphic. Similarly, the terminology used by UoW is heavily focused towards the technologies, with *engineering*, *telecommunications*, and *security* appearing clearly in the word graphic. Other than *information* and *technology*, technological and administrative terms do not figure prominently in the QUT word graphic. Interestingly QUT's Wordle is the only one to include *scholarships* and *alumni*. Recalling that CQU has a high female participation rate, UoW and UWA both have low participation rates and QUT is approximately average, it would appear that the lexicon used to advertise degrees does have some impact on how positively females perceive them.

From the data we analysed we found trends to show that females are more likely to enrol in double degrees or Masters degrees. This fits with our experience teaching in universities for decades where females prefer to have options (two possible careers paths with two degrees) and degrees such as the Bachelor of Arts and Bachelor of Computer Science (UWA), the Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (UWA), and the Bachelor of Business/Bachelor of Games and Interactive Entertainment (QUT). CQU and UoW do not offer double degrees in this area. Bearing in mind the preponderance of double degrees or degrees implying double majors, it is interesting to speculate whether titles such as *computing and technology* or *computing and management* would fare better than computer technology or computer management.

An appealing factor to females is to see the application of technology in other areas, such as the Master of Health Informatics (UoW), and the Bachelor of Games and Interactive Entertainment (QUT). This is supported by the findings reported by Gorbacheva et al (2013) who evaluated an intervention strategy targeting school girls. All of the other degrees use terminology including Information Technology, Engineering, Computer Science, or Mathematical Sciences reinforcing the technology rather than the *use* of the technology. These findings are aligned, to some extent, with Doube and Lange's (2012) and Petrie's (2013) studies both of which suggest that the creativity aspects of IT is perceived as being more female-friendly and has the potential to attract more female participation. Coger's et al (2012) study reinforces this finding, indicating that the transformation potential of technology is an attractive aspect of IT to females. Perhaps a focus on the enabling and disruptive aspects of technology could be used as hooks to attract female participation in IT.

Outcomes of the literature review suggest that young people are influenced strongly by their parents (Lang, 2010) and that student beliefs regarding their competence and perceived value of academic subjects also influence their study and career choices (Vekiri, 2013; Downs and Looker, 2011). The implications for higher education are profound. It suggests that there is little that Universities can do to influence student choices, and yet the female participation rates in the high performing degrees seem to belie this. The reducing opportunities for secondary school students to choose advanced IT subjects at school is reinforcing the perception that IT is of lower value than other subjects. But a number of studies emphasise the importance of role models to encourage female participation in IT (Stoeger et al, 2013; Connolly, 2013). Others suggest that exposure to technology, both at home and at school are essential precursors to technology adoption (Huffman et al, 2013; Vekiri, 2013). However, Connolly (2013) also advises to beware the inadvertent promotion of negative stereotypes, which is further aggravated by the imposter syndrome (Hafner, 2012). Many institutions run intervention strategies, either by going to schools or encouraging schools to come to the institutions (Coldwell-Neilson et al, 2014), providing opportunities for students to be exposed to IT, IT applications and positive IT role models. These observations, together with Lang's (2010) observation that tertiary study choices are made late, even as late as release of tertiary entrance scores, suggests that this is a good time for universities to advertise their courses. However, the lexicon that is used may have a significant impact on how such approaches are viewed by prospective students. The analysis described in section 6 above suggests that any course promotion needs to focus on the benefits of studying (generally) at institution XYZ, the potential for IT skills to be used for the benefit of society, and how IT studies can be combined with other less technical, more application focused, areas.

The analysis presented here provides some new insights into choices women make regarding IT studies and helps to at least partially explain the situation as high performing degrees with respect to female participation rates exist across all four institutions investigated, regardless of the level of female participation in IT at the institutional level.

The aims of this project were to identify IT degree programs:

1. that are attracting higher female participation rates, and
2. to identify common themes across these degrees.

In response to the first aim it was found that:

- women are more attracted to postgraduate studies in IT than undergraduate studies;

and in response to the second aim:

- studies in double degrees or degrees that imply an area of study in addition to IT are more attractive to women than single degrees.

8. Future work

Although we cannot draw any definitive conclusions from the findings reported here, they do provide some evidence to indicate a broader study is warranted. The two key findings of this study need to be examined as hypotheses in a broader study. Further, primary data needs to be collected to better understand how the lexicon used to advertise courses influences student choices. An area that has not been explored in this study that the literature suggests is linked to the choices implied by the above two findings is what interactions, if any, did females who have chosen IT at either undergraduate or postgraduate levels have with intervention programs or other IT related activities prior to selecting studies in IT.

Further studies to determine at what stage the choice to study IT was made and why may lead to some insights into what interventions are reaping benefits, either directly or indirectly. A survey of undergraduate and postgraduate female students in IT is proposed to explore this further.

We also noted significant differences in the uptake of IT amongst domestic and international students. Although the primary focus of this study was on domestic female student participation, this finding suggests a comparative study of the antecedents of studies in IT is warranted.

The uCube data provided by DEEWR indicates that it is not just female numbers that are dwindling in the IT studies sector, but the number of males who are choosing to study IT is also reducing. Any study that purports to explore participation in IT at any level should include all stakeholders, including both males and females.

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Appendix 1 – Analysis of domestic female students in IT by University

	Domestic											
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australian Catholic University	23.1%	22.2%	21.3%	22.6%	21.6%	20.7%	19.2%	22.2%	19.8%	26.8%	25.8%	25.2%
Central Queensland University	28.2%	28.5%	28.8%	27.9%	25.5%	29.9%	34.7%	35.0%	36.4%	37.6%	34.7%	35.5%
Charles Darwin University	25.4%	25.0%	22.4%	26.3%	23.2%	28.8%	31.3%	30.2%	25.8%	25.2%	34.6%	27.5%
Charles Sturt University	25.4%	25.3%	20.7%	18.4%	18.4%	15.8%	17.0%	18.3%	17.3%	15.8%	17.8%	14.9%
Curtin University of Technology	21.5%	20.4%	16.9%	17.3%	17.8%	20.3%	18.8%	20.0%	24.9%	23.9%	26.3%	27.5%
Deakin University	27.0%	25.6%	23.5%	19.8%	19.6%	17.3%	16.4%	16.4%	17.2%	15.5%	15.8%	16.7%
Edith Cowan University	19.4%	17.4%	17.7%	16.6%	13.6%	13.8%	12.3%	15.1%	13.5%	12.7%	16.1%	14.9%
Flinders University	27.2%	27.8%	25.0%	25.6%	21.6%	20.5%	21.3%	18.2%	13.5%	11.9%	11.7%	12.5%
Griffith University	21.7%	20.0%	17.7%	17.3%	17.3%	14.8%	14.2%	13.5%	11.2%	12.5%	14.7%	11.4%
James Cook University	22.3%	23.8%	24.2%	23.8%	20.5%	17.5%	19.0%	15.9%	12.6%	10.9%	10.1%	12.0%
La Trobe University	25.3%	22.3%	18.2%	16.2%	14.3%	16.7%	15.2%	15.9%	13.7%	14.0%	16.2%	13.9%
Macquarie University	26.6%	26.1%	26.4%	24.6%	23.2%	21.6%	22.4%	21.2%	21.1%	19.2%	17.2%	14.3%
Monash University	31.0%	30.3%	29.8%	27.3%	26.2%	26.3%	24.7%	24.1%	21.5%	22.5%	21.9%	22.4%
Murdoch University	21.1%	17.7%	18.7%	15.2%	14.3%	13.6%	14.5%	16.8%	15.9%	16.7%	13.8%	14.9%
Queensland University of Technology	24.4%	22.7%	21.5%	20.7%	19.6%	17.5%	17.8%	20.0%	19.1%	17.6%	16.9%	17.2%
RMIT University	28.6%	26.0%	23.3%	22.7%	21.0%	19.6%	17.3%	18.2%	18.6%	16.4%	16.0%	14.5%
Southern Cross University	26.8%	25.6%	24.7%	24.9%	20.8%	20.3%	20.7%	19.7%	26.6%	28.7%	26.1%	22.6%
Swinburne University of Technology	27.4%	25.4%	23.4%	21.1%	19.2%	16.8%	14.8%	15.0%	16.2%	12.8%	12.2%	12.4%
The Australian National University	20.5%	19.1%	18.6%	16.8%	16.3%	17.5%	17.0%	15.6%	14.2%	12.9%	20.9%	21.6%
The University of Adelaide	16.0%	14.8%	16.3%	12.0%	10.5%	12.4%	7.5%	10.9%	11.1%	11.1%	21.1%	17.7%
The University of Melbourne	30.7%	31.3%	30.6%	29.4%	26.9%	23.7%	21.2%	20.0%	18.1%	19.6%	20.0%	25.6%

The University of New England	19.4%	19.7%	16.8%	16.2%	17.4%	12.3%	13.0%	15.7%	14.3%	9.0%	24.5%	20.0%
The University of New South Wales	27.4%	25.9%	24.2%	22.1%	18.8%	16.3%	15.0%	16.1%	15.3%	17.3%	19.9%	20.1%
The University of Newcastle	14.5%	14.3%	15.5%	15.6%	14.9%	13.2%	12.8%	13.7%	14.6%	15.2%	18.6%	19.0%
The University of Queensland	21.8%	21.0%	18.2%	17.9%	19.4%	18.1%	19.1%	18.3%	20.1%	18.2%	18.1%	18.0%
The University of Sydney	30.9%	29.3%	28.5%	25.1%	23.2%	23.6%	21.4%	18.1%	21.6%	21.0%	21.2%	20.4%
The University of Western Australia	23.9%	19.0%	13.3%	12.7%	13.7%	12.3%	18.6%	11.3%	10.5%	9.8%	12.7%	13.3%
University of Ballarat	22.1%	21.4%	17.9%	16.3%	16.1%	17.9%	12.8%	15.4%	15.2%	12.8%	16.4%	13.4%
University of Canberra	27.6%	25.8%	24.4%	26.9%	24.5%	25.0%	25.1%	23.5%	23.4%	22.5%	23.5%	24.6%
University of South Australia	27.1%	27.1%	29.4%	27.0%	25.0%	20.7%	19.8%	18.0%	18.7%	18.6%	18.1%	17.4%
University of Southern Queensland	22.8%	21.9%	21.2%	20.7%	25.1%	22.1%	28.0%	19.2%	20.1%	21.8%	22.5%	19.0%
University of Tasmania	18.6%	19.3%	18.8%	18.7%	18.6%	19.6%	19.4%	18.5%	16.9%	14.3%	20.5%	18.1%
University of Technology, Sydney	29.6%	29.0%	25.9%	24.4%	23.2%	24.7%	23.6%	24.2%	24.9%	23.3%	22.3%	21.7%
University of Western Sydney	22.3%	22.5%	20.4%	17.9%	17.9%	16.5%	15.4%	15.1%	14.2%	12.6%	12.2%	13.1%
University of Wollongong	24.1%	21.8%	20.3%	19.0%	18.7%	18.0%	16.3%	14.6%	13.4%	11.7%	10.8%	9.1%
Victoria University	31.4%	28.5%	28.1%	25.0%	23.5%	22.9%	21.1%	18.3%	17.7%	19.5%	19.8%	18.2%

Appendix 2 - Trends in Domestic Enrolments

Trend	University	Notes	Recommendation
Highest overall	Central Queensland University Charles Darwin University	31.9% 27.1%	Central Queensland University Charles Darwin University
Highest recently (6)	Central Queensland University Charles Darwin University	35.7% 29.1%	
Highest last 3 years	Central Queensland University Charles Darwin University	35.9% 29.1%	
Consistent increase	Central Queensland university Charles Darwin University	28.2 -> 35.5 25.4 -> 27.5	
Lowest overall	University of Adelaide The University of Western Australia	13.4% 14.3%	University of Wollongong James Cook University The University of Western Australia
Lowest recently (6)	University of Wollongong The University of Western Australia The University of Adelaide James Cook University	12.6% 12.7% 13.2% 13.4%	
Lowest last 3 years	University of Wollongong James Cook University The University of Western Australia	10.5% 11% 11.9%	
Consistent decrease	Most universities have seen a consistent decrease Deakin Monash University of South Australia University of Sydney Victoria University RMIT	 27.0 -> 16.7 31 -> 22.4 27.1-> 17.4 30.9 -> 20.4 31.4 -> 18.2 28 -> 14	
Average overall (20.00)	University of Queensland Queensland University of Technology The University of New South Wales	19.0% 19.6% 19.9%	Queensland University of Technology The University of New South Wales University of Queensland
Average recently (18.39)	University of Queensland Queensland University of Technology The University of New South Wales	18.6% 18.1% 17.3%	
Average last 3 years (18.36)	University of Queensland Queensland University of Technology The University of New South Wales	18.1% 17.2% 19.1%	

Appendix 3 – Analysis of international female students in IT by University

	Overseas											
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australian Catholic University	14.9%	19.9%	17.9%	19.3%	19.7%	18.5%	9.0%	15.0%	18.3%	20.5%	23.0%	30.4%
Central Queensland University	15.1%	17.8%	18.2%	14.4%	12.9%	12.9%	14.7%	18.5%	23.3%	22.9%	24.0%	21.9%
Charles Darwin University	28.8%	31.1%	20.4%	34.5%	38.1%	0.0%	20.0%	3.6%	15.4%	10.4%	24.7%	11.7%
Charles Sturt University	25.6%	21.8%	20.4%	19.1%	17.3%	15.6%	14.9%	13.4%	12.3%	13.1%	12.1%	13.0%
Curtin University of Technology	36.3%	30.1%	26.0%	26.5%	31.7%	27.6%	28.4%	27.4%	30.4%	30.7%	32.8%	29.6%
Deakin University	22.2%	21.7%	23.4%	20.7%	18.5%	18.3%	14.0%	16.1%	16.4%	19.0%	19.0%	20.7%
Edith Cowan University	24.7%	30.3%	28.9%	22.5%	17.6%	18.6%	16.5%	16.4%	16.0%	15.6%	17.4%	16.1%
Flinders University	22.6%	23.3%	25.0%	25.0%	19.3%	21.2%	19.7%	41.4%	26.7%	16.7%	12.8%	27.1%
Griffith University	21.7%	20.6%	18.0%	19.8%	16.4%	14.8%	13.9%	14.2%	12.0%	12.0%	17.4%	15.6%
James Cook University	24.2%	34.1%	33.9%	27.7%	13.5%	22.9%	28.9%	29.6%	31.4%	30.0%	27.9%	24.0%
La Trobe University	21.5%	19.6%	15.9%	12.2%	12.7%	13.9%	14.0%	16.7%	13.3%	13.9%	19.1%	16.4%
Macquarie University	25.5%	27.9%	24.2%	23.2%	22.1%	22.0%	17.9%	14.3%	17.2%	21.2%	19.0%	23.6%
Monash University	36.8%	36.8%	34.2%	30.2%	25.3%	24.5%	23.0%	22.0%	23.1%	24.3%	23.3%	24.3%
Murdoch University	21.9%	26.8%	28.9%	26.3%	22.5%	21.1%	18.6%	16.2%	16.2%	16.7%	18.5%	17.7%
Queensland University of Technology	26.9%	27.4%	26.7%	22.6%	20.5%	20.0%	21.3%	20.9%	23.2%	20.1%	20.4%	20.8%
RMIT University	29.3%	30.1%	27.8%	26.7%	23.2%	23.2%	22.9%	23.4%	24.5%	24.9%	23.6%	23.3%
Southern Cross University	17.0%	25.9%	21.6%	20.5%	19.7%	17.3%	19.6%	23.0%	20.9%	16.7%	17.3%	14.2%
Swinburne University of Technology	23.6%	23.7%	20.5%	20.7%	21.3%	18.7%	17.4%	17.1%	17.9%	17.9%	19.4%	20.2%
The Australian National University	30.6%	25.0%	21.1%	19.3%	15.3%	16.8%	12.7%	16.8%	22.2%	18.0%	16.5%	13.1%

The University of Adelaide	28.1%	27.6%	26.1%	22.2%	17.3%	16.3%	15.9%	17.9%	18.7%	16.4%	13.6%	13.6%
The University of Melbourne	42.6%	41.2%	40.3%	36.4%	29.3%	26.0%	22.6%	26.9%	28.8%	25.7%	30.0%	34.6%
The University of New England	23.8%	20.6%	15.1%	7.9%	10.0%	12.5%	13.0%	19.6%	30.3%	32.0%	36.2%	34.0%
The University of New South Wales	29.4%	25.5%	24.7%	21.6%	19.8%	18.4%	13.5%	16.8%	18.8%	19.2%	22.2%	24.8%
The University of Newcastle	25.0%	25.0%	21.6%	22.2%	20.2%	21.9%	21.8%	23.9%	24.5%	21.8%	23.2%	22.9%
The University of Queensland	32.4%	33.1%	32.4%	27.8%	23.5%	19.5%	23.0%	25.4%	26.1%	29.2%	24.6%	27.9%
The University of Sydney	34.2%	29.6%	24.4%	25.2%	22.5%	20.5%	24.1%	21.5%	22.2%	26.1%	30.4%	20.2%
The University of Western Australia	27.5%	27.1%	21.8%	20.8%	19.0%	20.8%	24.4%	21.9%	23.2%	22.9%	25.4%	25.3%
University of Ballarat	14.4%	19.1%	12.0%	8.9%	8.9%	9.7%	13.8%	17.8%	20.1%	19.4%	18.6%	18.8%
University of Canberra	19.8%	20.5%	18.1%	15.4%	16.2%	17.7%	19.6%	21.1%	20.1%	21.3%	23.4%	23.2%
University of South Australia	24.8%	24.7%	24.5%	22.9%	17.4%	14.6%	15.7%	17.3%	20.6%	21.0%	18.6%	22.1%
University of Southern Queensland	31.0%	30.1%	27.9%	19.4%	17.8%	17.4%	20.4%	20.3%	19.8%	22.4%	26.4%	22.6%
University of Tasmania	31.8%	39.2%	41.0%	38.7%	37.7%	33.6%	32.2%	33.6%	34.9%	34.7%	34.9%	37.1%
University of Technology, Sydney	27.8%	26.5%	24.0%	22.2%	17.8%	15.3%	15.2%	16.6%	17.4%	17.2%	16.5%	17.0%
University of Western Sydney	17.5%	19.1%	25.6%	27.7%	37.2%	37.5%	41.1%	16.1%	8.7%	8.0%	16.7%	19.0%
University of Wollongong	28.9%	25.8%	24.0%	23.2%	20.8%	19.4%	18.0%	18.1%	17.1%	17.1%	16.1%	16.0%
Victoria University	13.4%	14.4%	17.2%	17.7%	18.0%	19.9%	22.4%	23.4%	26.7%	29.9%	28.3%	29.4%

Appendix 4 - Trends in International Enrolments

Trend	University	Notes	Recommendation
Highest overall	University of Tasmania The University of Melbourne Curtin University of Technology	35.8% 32.0% 29.8%	University of Tasmania Curtin University of Technology **OR** University of Melbourne UNE is good for the increase it has achieved
Highest recently (6)	University of Tasmania Curtin University of Technology The University of Melbourne	34.6% 29.9% 28.1%	
Highest last 3 years	University of Tasmania The University of New England Curtin University of Technology The University of Melbourne	35.6% 34.1% 31% 30.1%	
Consistent increase	The University of New England	23%-34% (7.9% -> 34% last 9 years)	
Lowest overall	University of Ballarat La Trobe University Charles Sturt University Griffith University	15.1% 15.8% 16.6% 16.4%	Charles Sturt University Griffith University
Lowest recently (6)	Charles Sturt University Griffith University	13.2% 15.0%	
Lowest last 3 years	Charles Sturt University Griffith University	12.7% 15.0%	
Consistent decrease	A number of universities show large decreases Monash ANU	 36%->24.3% 30% -> 13.1%	
Average overall (21.6)	Queensland University of Technology The University of New South Wales Macquarie University	20.4% 22.1% 21.3%	Queensland University of Technology The University of New South Wales Macquarie University
Average recently (6) (20.9)	Queensland University of Technology The University of New South Wales Macquarie University	21.1% 19.2% 18.9%	
Average last 3 years (22.0)	Queensland University of Technology The University of New South Wales Macquarie University	22.6% 21.2% 21.5%	

Appendix 5 – Female participation rates in courses by University

Uni	Course		Total Course Females	Total female %	Rank
CQU	Master of Information Systems Extended	Total	5	11.00%	10
CQU	Master of Computing	Total	2	17.00%	9
CQU	Master of Information Systems	Total	46	20.00%	8
CQU	Master of Information Technology (Professional)	Total	30	21.00%	7
CQU	Bachelor of Information Technology	Total	181	21.00%	6
CQU	Master of Computing Technology	Total	5	23.00%	5
CQU	Graduate Diploma of Information Technology	Total	14	32.00%	4
CQU	Bachelor of Business and Bachelor of Information Technology	Total	17	33.00%	3
CQU	Bachelor of Commerce and Bachelor of Information Technology	Total	10	34.00%	2
CQU	Master of Information Systems and Master of Project Management	Total	7	54.00%	1
CQU	Master of Computing Technology (Extended)	International	1	7.00%	10
CQU	Master of Information Systems Extended	International	4	9.00%	9
CQU	Master of Information Systems	International	41	19.00%	8
CQU	Master of Information Technology (Professional)	International	28	21.00%	7
CQU	Master of Computing	International	2	22.00%	6
CQU	Bachelor of Information Technology	International	134	26.00%	5
CQU	Master of Computing Technology	International	3	30.00%	4
CQU	Graduate Diploma of Information Technology	International	3	43.00%	3
CQU	Bachelor of Commerce and Bachelor of Information Technology	International	1	50.00%	2
CQU	Master of Information Systems and Master of Project Management	International	1	100.00%	1

CQU	Bachelor of Engineering and Bachelor of Information Technology	Domestic	2	13.00%	10
CQU	Master of Information Technology (Professional)	Domestic	2	14.00%	9
CQU	Bachelor of Information Technology	Domestic	47	14.00%	8
CQU	Master of Computing Technology	Domestic	2	17.00%	7
CQU	Graduate Diploma of Information Technology	Domestic	11	30.00%	6
CQU	Master of Information Systems	Domestic	5	31.00%	5
CQU	Bachelor of Commerce and Bachelor of Information Technology	Domestic	9	33.00%	4
CQU	Bachelor of Business and Bachelor of Information Technology	Domestic	17	33.00%	3
CQU	Master of Information Systems Extended	Domestic	1	50.00%	2
CQU	Master of Information Systems and Master of Project Management	Domestic	6	50.00%	1
UoW	Bachelor of Computer Science(766) (on shore)	Total	89	5.00%	10
UoW	Undergrad Computer Engineering(U-COMP)**	Total	28	10.00%	9
UoW	Bachelor of Information Technology(1807) (on shore)	Total	135	10.00%	8
UoW	Postgrad Telecommunications Engineering(P-TELE)**	Total	34	12.00%	7
UoW	Master of Computer Science(585)	Total	37	13.00%	6
UoW	Master of Information Technology Management(1509)	Total	27	15.00%	5
UoW	Master of Information Technology Studies(1610)	Total	21	18.00%	4
UoW	Undergrad Telecommunications Engineering(U-TELE)**	Total	73	22.00%	3
UoW	Bachelor of Business Information Systems(1838)	Total	22	24.00%	2
UoW	Master of Health Informatics(1540)	Total	20	37.00%	1
UoW	Bachelor of Computer Science(766) (on shore)	International	42	8.00%	10
UoW	Bachelor of Information Technology(1807) (on shore)	International	36	9.00%	9
UoW	Master of Information Technology Management(1509)	International	20	13.00%	8
UoW	Postgrad Telecommunications Engineering(P-TELE)**	International	34	13.00%	7
UoW	Master of Computer Science(585)	International	34	13.00%	6
UoW	Postgrad Computer Engineering(P-COMP)**	International	11	17.00%	5
UoW	Master of Information Technology Studies(1610)	International	20	18.00%	4

UoW	Undergrad Computer Engineering(U-COMP)**	International	17	21.00%	3
UoW	Master of Health Informatics(1540)	International	9	23.00%	2
UoW	Undergrad Telecommunications Engineering(U-TELE)**	International	72	27.00%	1
UoW	Undergrad Telecommunications Engineering(U-TELE)**	Domestic	1	2.00%	10
UoW	Bachelor of Computer Science(766) (on shore)	Domestic	47	4.00%	9
UoW	Undergrad Computer Engineering(U-COMP)**	Domestic	11	6.00%	8
UoW	Bachelor of Information Technology(1807) (on shore)	Domestic	99	11.00%	7
UoW	Master of Computer Science(585)	Domestic	3	15.00%	6
UoW	Master of Information Technology Studies(1610)	Domestic	1	17.00%	5
UoW	Bachelor of Business Information Systems(1838)	Domestic	18	22.00%	4
UoW	Master of Information Technology Management(1509)	Domestic	7	23.00%	3
UoW	Master of Health Informatics(1540)	Domestic	11	73.00%	2
UoW	Master of Information Technology Studies Advanced(1611)	Domestic	1	100.00%	1
QUT	IT23 - BInfoTech	Total	164	12.00%	10
QUT	IT10 - DipInfTech	Total	18	13.00%	9
QUT	IT04 - B Games and Interactive Ent	Total	88	13.00%	8
QUT	IX63 - BBus/BGames&InteractiveEnt	Total	11	14.00%	7
QUT	IX57 - BInfoTech/BMaths	Total	6	16.00%	6
QUT	IT85 - GradCertInfTech(StudyAreaA)	Total	18	21.00%	5
QUT	IT44 - MInfTech(Adv)(StudyAreaA)	Total	55	21.00%	4
QUT	IX65 - BAppSc/BGames&InteractiveEnt	Total	8	22.00%	3
QUT	IT53 - MBusProcessMgt	Total	32	30.00%	2
QUT	IT43 - MInfTech(StudyAreaA)	Total	233	30.00%	1
QUT	IT04 - B Games and Interactive Ent	International	3	9.00%	10
QUT	IT10 - DipInfTech	International	18	13.00%	9
QUT	IT23 - BInfoTech	International	69	19.00%	8

QUT	IT44 - MInfTech(Adv)(StudyAreaA)	International	52	22.00%	7
QUT	IT43 - MInfTech(StudyAreaA)	International	88	22.00%	6
QUT	IT22 - BInfoTech(StudyAreaA)	International	1	25.00%	5
QUT	IT48 - MInfTech(Adv)	International	1	25.00%	4
QUT	IT53 - MBusProcessMgt	International	18	30.00%	3
QUT	IT35 - GradDipInfTech(StudyAreaA)	International	1	33.00%	2
QUT	IT80MCB - DInfTech(CompSci)	International	1	100.00%	1
QUT	IT23 - BInfoTech	Domestic	95	10.00%	10
QUT	IX63 - BBus/BGames&InteractiveEnt	Domestic	11	14.00%	9
QUT	IT04 - B Games and Interactive Ent	Domestic	85	14.00%	8
QUT	IX57 - BInfoTech/BMaths	Domestic	6	16.00%	7
QUT	IT85 - GradCertInfTech(StudyAreaA)	Domestic	18	21.00%	6
QUT	IX65 - BAppSc/BGames&InteractiveEnt	Domestic	8	22.00%	5
QUT	IT53 - MBusProcessMgt	Domestic	14	31.00%	4
QUT	IT43 - MInfTech(StudyAreaA)	Domestic	145	37.00%	3
QUT	IT60MCA - MInfTech(InfoSci)	Domestic	5	56.00%	2
QUT	IT60FSE - MInfTech(Research)	Domestic	5	56.00%	1
UWA	Bachelor of Computer Science (60130)	Total	19	11.00%	10
UWA	Graduate Diploma in Computer Science (60360)	Total	1	14.00%	9
UWA	Bachelor of Computer and Mathematical Sciences (50100)	Total	19	17.00%	8
UWA	Master of Information Technology - Coursework (61520)	Total	11	22.00%	7
UWA	Master of Computer Science (60600)	Total	15	23.00%	6
UWA	Bachelor of Computer Science and Bachelor of Commerce (61020)	Total	10	24.00%	5
UWA	Bachelor of Arts and Bachelor of Computer Science (62100)	Total	2	29.00%	4
UWA	Bachelor of Science and Bachelor of Computer Science (52100)	Total	4	29.00%	3
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Economics (61030)	Total	2	40.00%	2

UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	Total	7	44.00%	1
UWA	Graduate Diploma in Information Technology (60320)	International	0	0.00%	10
UWA	Graduate Diploma in Information Technology (Honours) (6032H)	International	0	0.00%	9
UWA	Master of Computer Science (60600)	International	7	14.00%	8
UWA	Bachelor of Computer Science (60130)	International	5	19.00%	7
UWA	Graduate Diploma in Computer Science (60360)	International	1	25.00%	6
UWA	Master of Information Technology - Coursework (61520)	International	10	26.00%	5
UWA	Bachelor of Computer and Mathematical Sciences (50100)	International	11	34.00%	4
UWA	Bachelor of Computer Science and Bachelor of Commerce (61020)	International	3	38.00%	3
UWA	Bachelor of Computer Science (Honours) (6013H)	International	1	50.00%	2
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	International	3	50.00%	1
UWA	Master of Information Technology - Coursework (61520)	Domestic	1	10.00%	10
UWA	Bachelor of Computer and Mathematical Sciences (50100)	Domestic	8	10.00%	9
UWA	Bachelor of Computer Science (60130)	Domestic	14	10.00%	8
UWA	Bachelor of Computer Science and Bachelor of Commerce (61020)	Domestic	7	21.00%	7
UWA	Graduate Certificate in Information Technology (60220)	Domestic	1	25.00%	6
UWA	Bachelor of Arts and Bachelor of Computer Science (62100)	Domestic	2	29.00%	5
UWA	Bachelor of Science and Bachelor of Computer Science (52100)	Domestic	4	29.00%	4
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Economics (61030)	Domestic	2	40.00%	3
UWA	Bachelor of Computer and Mathematical Sciences and Bachelor of Commerce (61150)	Domestic	4	40.00%	2
UWA	Master of Computer Science (60600)	Domestic	8	57.00%	1