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## Declining popularity increases lack of diversity: extending the discourse of the discipline

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### Abstract

*The number of young people selecting a university Information Technology (IT) course is low and has been declining alarmingly in the last few years. While young women appear to be rejecting the discipline at a greater rate than young men, the declining popularity of IT university courses is a worrying trend that is affecting the culture of the discipline and the industry nationally and internationally. The discourse of the discipline is often focused on curriculum content and industry applications with little or no attention to the type of student who is taking our courses. This paper presents senior secondary school and university enrolment statistics that emphasise a steady decline in popularity of IT courses since 2000. Results of a quantitative survey of over 700 undergraduates are presented to provide a lens into the current student experiences in IT in secondary school, the home and at university. Factors underpinning the declining popularity of the discipline as a course and career option are explored and some thoughts on the future of the discipline are offered.*

### Keywords

Diversity, IT Education, IT Student Experience , Career choice

### INTRODUCTION

The declining popularity of the Information Technology (IT) discipline is evident in universities as well as secondary school classes. For the purpose of simplicity the term IT is used as an umbrella term to incorporate all flavours of the discipline from Information Systems to Computer Science including the recently popular term ICT (Information and Communication Technology). Currently students, male and female, are not choosing this career path in the same numbers as the 1990's, with females turning away at a greater rate than males. A primary concern of IT academics and professionals worldwide is that the pool of talent being attracted to this discipline is not diverse enough (Richardson 2003). Many believe that attracting a wider variety of students, females and males to IT will enrich the discipline because the increasingly narrow cohort that is currently being attracted does not incorporate a cross-section of society in general. There is a fear that the discipline may become homogenous and moribund leading to a lack of innovation and creativity. The decline in popularity should be worrying to all of us who are involved in IT education in universities because it not only puts our employment in this field under threat, but implies that we are not engendering and inspiring a wide and on-going interest in this field.

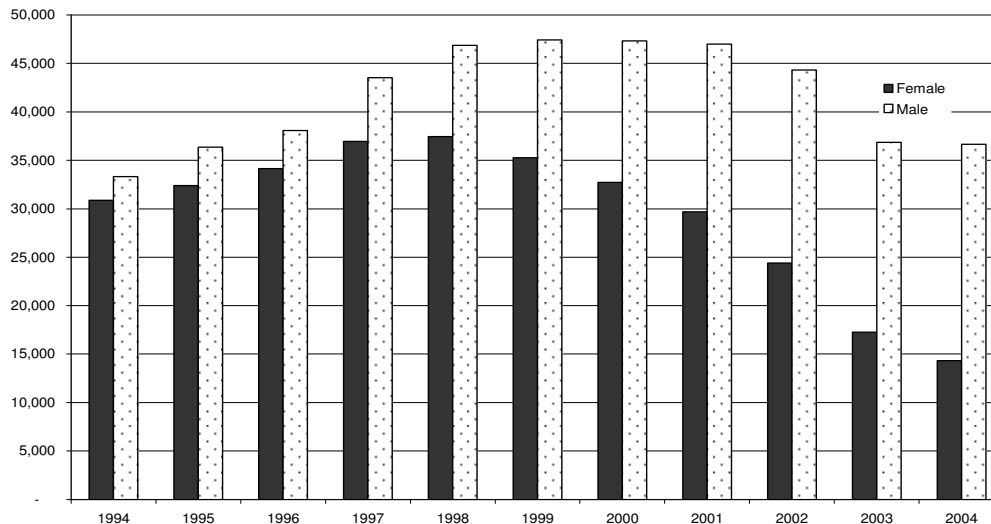
The phenomenon of declining popularity is not confined to Australia. A recent international study of the proportional gender representation in the discipline carried out by analysing graduation trends from twenty-one industrialised countries emphasized the widespread masculinity of the field (Charles and Bradley 2006). However there was disparity between countries in the degree of overrepresentation of males. The male to female ratio was three times stronger in some countries than others (Charles and Bradley 2006 p.191). The male 'overrepresentation factor' was the lowest for Turkey (1.79) and the highest for Czech Republic 6.36, with Australia at 2.86(Charles and Bradley 2006p. 190).

Around the world governments, industry and educational institutions have initiated many programs to address the lack of diversity in higher education IT courses with varying degrees of success, some of which will be

discussed later in this paper. The following section will set the scene for this issue by presenting trends in the selection of university courses and university enrolments in the Australian state of Victoria.

## SENIOR SECONDARY SCHOOL IT SUBJECT ENROLMENT TRENDS

Secondary school teachers offer various anecdotal reasons for the decline in popularity of IT subjects, and the apparent gender differentiation in this declining popularity. The state-wide statistics shown in Figure 1, illustrate the dramatic nature of the trend. It should be noted that the totals represent raw number of enrolments, not completions, and that most students enrol in two units each year, so in fact the total number of students studying IT subjects has declined from over 40,000 in 1998 to approximately 25,000 in 2004.



**Figure 1 VCE IT subject enrolment trends (VCAA 2004; VCAA 2006)**

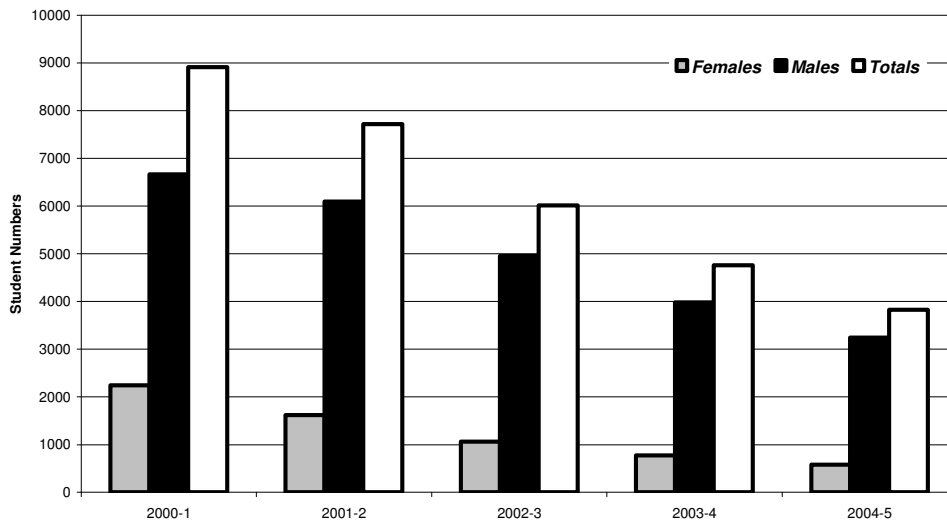
One reason put forward for the decline in popularity of senior secondary IT subjects is the dramatic failure of many IT companies during the "Dot.com crash" that began in 2000 (Cassidy 2002), although the downturn in young women choosing this subject area began two years prior to this event. Another is the irrelevance of curriculum which focuses on easily mastered skills and applications that many students are already familiar with. Finally the fact that senior school VCE IT is not a direct pre-requisite for entry in to any university course implies that students are maximising their options by studying pre-requisite courses as much as possible and discounting IT for this reason. This anecdotal evidence is open to interpretation but these opinions put forward by secondary school teachers cannot be discounted.

Recent Victorian Government research investigating student attitudes to IT careers and courses emphasize that student perceptions of IT are stereotypical and have not changed with the increasing pervasiveness of computing in their everyday lives. The study reported that while students were aware of a variety of employment and career opportunities available in IT, they preferred to pursue a career they found more interesting (MMV 2001 p.4). This adds credence to the assumption that the current curriculum and early IT experiences are not engendering any academic curiosity for the discipline. In this same study students reported that their secondary school IT classes were boring while acknowledging that the technical skills associated with IT were valuable. The second commissioned report published in late 2004 had similar findings (MMV 2004). The perception that IT careers were isolated and hardware focussed was pervasive, but more worrying still was of those surveyed 68% admitted that they did not know enough about careers in IT. Of all the students interviewed who were studying IT courses at school, only 60% expressed a desire to continue in this field (MMV 2004 p. 5), and more than half thought that school IT subjects were uninspiring. Only 6% of all final year secondary school students interviewed (154 in total) expressed an interest of continuing in IT at university or TAFE and none of these were females (MMV 2004 p.5). It is no surprise then that the student numbers in IT courses in university are also in decline. Not only are young women not choosing to study IT, but many young men also do not consider this career path.

## UNIVERSITY IT COURSE PREFERENCE TRENDS

In the Victorian education system students submit a selection of their preferred university courses towards the end of their final year of schooling and prior to receiving their academic results. These course preferences are

widely regarded in higher education circles as popularity indicators. Students have eight course choices which they are counselled to make according to their likelihood of success and future career choice. Figure 2 displays the decline in IT as a first choice selection over the last few years.



**Figure 2: IT as first choice selection (VTAC 2005)**

The number of students selecting IT courses as their first preference for higher education has declined by 57% since 2001. When this figure is analysed by gender, there is an overall decline in IT course selection of 74% amongst females compared to 51% amongst males (VTAC 2005). All Victorian universities are suffering from this decrease in popularity of their IT courses. The student numbers in some courses have more than halved in the last five years resulting in a cut back of academic positions in most IT faculties.

There is an active network of interested parties in business and education developing strategies to redress this decline with the view that changes to the IT discipline that makes it a more attractive career option to young women will have the flow on effect of attracting a wider variety of young men. This strategy has in fact succeeded in a university in the USA and will be discussed in more detail in the next section.

## FACTORS UNDERPINNING REDUCED DIVERSITY

Common perceptions are difficult to change and there is a lack of understanding by the population in general that an IT career involves more than programming. The image of the lone programmer working long hours in a room lit by the glow of a computer screen is often reflected in popular media. There is little understanding that strong communication and teamwork skills are needed in the discipline. Analysts and Project Managers need to communicate with people from technical and business backgrounds to solve the problems of stakeholders. These scenarios are not readily identifiable as those of IT professionals.

Over the last twenty years, many reasons have been presented to explain the under-representation of women in the field. It is claimed that the nature of the IT discipline is not attractive to females due to long working hours to meet deadlines or late night stints debugging code or finishing projects for university credit or employers. It has been claimed that the IT working environment is not supportive of females, nor anyone who prefers work-life balance (Johnson and Miller 2002 p.10). The safety issue of walking to cars at night through unlit paths or car parks has been written proffered as well as the inhospitable IT lab environment that has been likened to a male locker room (Pearl 1995 p 45). It is also claimed that the small number of females in the IT field leads to a lack of role models and perpetuation of the image of the discipline as being 'male'. The lack of validation of seeing similar people to oneself, be it same gender or same ethnicity, contributes to feelings of isolation (Taylor 2002 p 22). Related is the perception that the current females in computing are somehow 'different' because they are challenging society's impression of what a female should be (Turkle 1995 p.56)

Media portrayals and student perceptions contribute to the lack of diversity in the field, an outcome of which is the basis for a syndrome named "I can, but I don't want to" (Durdell, Glissov et al. 1995 p 226). This research reported no evidence that females were no less able than males to achieve in IT, they just chose not to pursue this field. An Australian study reported that females rated the IT field to be of medium difficulty (Art being the

lowest, and Law the highest) and the lowest in human interaction (Jewell and Maltby 2001) confirming the perception that the discipline is not seen as too difficult, just too isolating. Another survey of over 200 female secondary students in Australia found that the most common response for why they believed females were not choosing computing as a career path was a lack of interest (Lang 1999). These researchers all report that it is not the difficulty of programming that is deterring females from following the discipline, but the perceived isolation and lack of stimulation of the tasks associated with the discipline that is contributing to its declining popularity.

Corneliussen reported that by redefining computing as a social skill enabled women to grow to “love” their computers and what they could do with them (Corneliussen 2005). The University of Bergen, Norway removed a Computer Science core subject from the Science and Engineering Faculty and delivered the same subject within the Arts Faculty to cohorts that were traditionally female skewed. Teaching the same curriculum within an Arts faculty resulted in young women expressing surprise at both the positive female gender balance of the course, as well as their own ability to successfully manipulate the computer via programs and applications. The students enjoyed using computers to solve problems, and the young women also enjoyed not having to apologise for loving computing. Corneliussen theorises the answer to the lack of diversity in IT lies in redefining what it is by emphasizing its human and social aspects and applications, therefore giving young women and a wider variety of young permission to love IT (Corneliussen 2005).

## **INCREASING DIVERSITY CREATES SIMILARITY**

Over the last 25 years a number of interventions to encourage girls to consider IT have been tried. Many have had initial and localised successes, but none appear to have influenced on-going enrolment patterns more than that at Carnegie Mellon University (CMU) in the USA (Margolis and Fisher 2002). Female enrolments in the Computer Science Faculty increased from 9% to 42% in a five year period as a direct result of interventions such as pro-active recruiting of females combined with a re-definition of the Computer Science curriculum. Career advice to students was combined with sessions for parents and teachers. A professional development program for secondary school teachers was also initiated to deliver a more accurate picture of what a degree in Computer Science involved. Recent published papers from CMU indicate that while the high of 42% female participation has not been sustained over the last few years, the current curriculum and outreach programs have sustained a diverse student population with a healthy proportion of women (30%) and also a more diverse cohort of men in the student population. “The spectrum of interests and personality types of men and of women becomes more alike than different” as an outcome of these interventions (Blum and Frieze 2003 p 1).

Our own Victorian university has experienced a decline in popularity of IT courses as well as a decline in the diversity of students selecting our courses. An internal grant to investigate this decline and implement strategies to counter it was funded for three years by the Chancellery as part of the Strategic Initiative Fund 2005, with additional support from the Faculty of Information and Communication Technologies (FICT). The project is the first part of a three-year investigation aimed at gaining a deeper, conceptual understanding of this phenomenon as the basis for informed intervention at a range of levels and is reported on in the second part of this paper.

## **WOMEN IN IT – SWINBURNE (WIT-S)**

The WIT-S project is an investigation into understanding the collapsing number of women enrolling in IT courses at our own university, and the subsequent decline in rates of female participation in the IT industry. The first stage of the project was to gain a better understanding of our students and in particular whether FICT students are a unique cohort in the wider student body. To this end data was gathered on student backgrounds in terms of experiences with IT both in educational and social contexts, their perceptions of courses and career choices, and their current university experiences. A questionnaire was designed with these elements in mind, influenced by a range of previous similar research, in particular that used by Margolis and Fisher at CMU (2002) and the Australian National First Year Experience questionnaire (DEST 2005). In order to better appreciate the extent to which IT student profiles confirmed to wider norms, it was decided to administer the survey university wide.

Swinburne University of Technology has a history of a strong identification with industry based learning. There are five faculties over six campuses incorporating Business, Engineering, Social Sciences, Creative Design and ICT. To ensure a broad range of students were surveyed the selection process for gathering data involved firstly determining the core under-graduate degree courses in each faculty, then determining the core units of study in those degrees. All surveys were conducted during the core lectures and explain, administer and collect the surveys. This was the most expedient way of gaining a cross section of the student body. The key outcomes of this survey are presented in the following sections, and provide an insight into the perceptions of our students and the lack of diversity of student attracted to IT courses. The total number of students surveyed was 712 (284 females and 428 males) which constituted 50% of the new under-graduate enrolments in 2005.

The first stage of the project gathered information on student's experiences and student attitudes to and perceptions of IT. The responses to these questions with particular comparison of students enrolled in the FICT with rest of the student body to determine if there are any obvious differences in experience and use of IT is presented in the following section.

### Student backgrounds in maths and ICT

Students were asked to report the highest level of mathematics and IT they studied at secondary school (Figure 3). The responses indicate that students who choose IT at university are most likely to have completed IT at senior secondary school (84% both males and females). VCE enrolment statistics (2005) show that only 7.6% of VCE students were enrolled in a final year IT subject, and of this small number only one third were female. It appears that a very high proportion of our students perceive that senior secondary school IT is a necessary prerequisite for studying IT at university. The perpetuation of a declining diversity within the student cohort at university is embedded in the small pool of talent students are being selected from.

The level of senior school maths completed by all our students is also high (85% FICT females, over 90% all others). The previously cited study by Charles and Bradley reported on the negative correlation between Maths and IT and its contribution to reduced diversity in the discipline. "Girls may be less prone to 'like' math or regard themselves as competent in math when a wide array of more 'gender-appropriate' options present themselves". (Charles and Bradley 2006 p. 193). It can be surmised that this self-selection away from maths is reducing the potential pool of IT students even more.

	FICT %		All Other %	
	F	M	F	M
Studied IT to Senior Sec School	84	84	41	59
Studied Maths to Senior Sec School	85	95	90	92

**Figure 3 Level of IT and Maths studied in Secondary School**

The next question asked students what age they were when they started using computers (Figure 4). The FICT female students started marginally later than all other students (43% under 10 years of age), but there is no significant difference between each cohort. This reflects what has been reported in other studies that most students are both IT savvy and capable, but that this does not necessarily translate into a career choice (MORI 2001).

	FICT %		All Other %	
	F	M	F	M
Under 10	43	56	52	57
11-15 years	43	26	35	31
15+ years	14	17	12	12

**Figure 4 Age when started using computers**

These results are in alignment with those reported by the Multimedia Victoria study. All students understand the importance of IT, but this does not translate to interest in IT careers.

### Perceptions of and attitudes to ICT

There were questions in the survey that asked students to rate their level of agreement or disagreement with statements reflecting perceptions and attitude to computers. These statements, although self-reported, can be attributed to students' feelings of competency and efficacy in computer use (Figure 5). Some of these responses are particularly interesting. The proportion of FICT female students who reported that they were "Ok" at learning computing skills at school is at least 10% lower than that reported by all other students (male and female). However their level of disagreement with the statement "I was no good at using computers at school" was the strongest of the cohorts (89.5%).

FICT males and females reported more experience with creating programs, with the males considerably greater (53.6%) than the females (30%) who had less experience than even the non-FICT males (36.5%). The young women who chose to study IT at university had some experience with programming but less than young men who chose NOT to study IT.

	Female	Male
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		FICT	Other	FICT	Other
I was OK at learning computing skills at school	Agree	<b>60.0%</b>	<b>70.8%</b>	77.8%	<b>76.0%</b>
	Undecided	25.0%	19.0%	9.1%	14.1%
	Disagree	15.0%	10.3%	13.1%	9.9%
I was no good at using a computer at school	Agree	5.3%	9.9%	10.2%	9.9%
	Undecided	5.3%	11.5%	6.1%	10.8%
	Disagree	89.5%	78.6%	83.7%	79.3%
I created simple computer programs at school	Agree	<b>30.0%</b>	18.7%	53.6%	<b>36.5%</b>
	Undecided	15.0%	15.5%	20.6%	16.2%
	Disagree	55.0%	65.9%	25.8%	47.3%
I learnt to make my own websites at school	Agree	65.0%	43.9%	57.7%	48.9%
	Undecided	15.0%	11.8%	14.4%	14.7%
	Disagree	20.0%	44.3%	27.8%	36.4%
I am confident about my ability to learn new skills on the computer.	Agree	<b>70.0%</b>	<b>72.0%</b>	81.6%	<b>79.4%</b>
	Undecided	25.0%	22.2%	10.2%	12.7%
	Disagree	5.0%	5.8%	8.2%	7.9%
I have a lot of ability to learn programming	Agree	<b>40.0%</b>	35.5%	60.4%	<b>47.3%</b>
	Undecided	40.0%	37.5%	29.2%	32.4%
	Disagree	20.0%	27.0%	10.4%	20.3%

**Figure 5: Use and attitude to IT: Self-efficacy**

It would appear that non-FICT female students express slightly more confidence in their ability at IT at school. This supports the “I can but I don’t want to” attitude expressed in earlier research by (Durndell, Glissov et al. 1995). They reported that it is not lack of ability that is turning young women away from computing, but a lack of desire.

FICT male and female students had significantly more experience in creating simple programs and websites which indicated that we are possibly just attracting the ‘geek’ girls and boys. A ‘geek’ in computer parlance has come to mean someone who enjoys or takes pride in using computers or other technology, often to what others consider an excessive degree. There is a hint of disapproval often implied in the use of ‘geek’. This disapproval has more to do with the connotation that geek privileges the technical over the social and hence can overlook or ignore the human components in the world of ICT. The confidence expressed by male FICT students in their programming ability, which is significantly higher than that expressed by females supports the theory that IT at university is only attracting geeks.

Statistical analysis of responses by students to questions related to perceived confidence were as expected; males reported significantly higher levels of perceived computer skills than females and students enrolled in the IT faculty reported significantly higher levels of perceived computer skills than other faculties within their gender, but females in IT have less confidence than males in other faculties.

Can it then be surmised that males have significantly higher confidence levels because they are the majority in the course, or as Corneliussen states, IT is gendered as male in our society and therefore males have an expectation of mastery that may or may not align with actual capability (Corneliussen 2004 p.174). If this is indeed the case, we can assume that the pool of talent could be widened to include this large proportion of potentially capable young men who are not considering IT as a career of discipline option. In our own university the Faculty of Business is experiencing a growth in popularity and is considered the new ‘generalist’ degree by many students usurping the position that an Arts degree once held in our society. It can be deduced that a reasonable proportion of students who are choosing a generalist business degree could be well suited to an IT degree, but are not considering it due to current perceptions and stereotyping of what IT involves.

### Experiences with ICT in schools

When students were asked to report on their access to computers (Figure 6) FICT students reported slightly more access to computers than non FICT students in primary school. This could be where the confidence in use of computers is engendered. Interestingly however, FICT females reported that they had slightly less access to computers in secondary school than females from other faculties. Students from other faculties also report that their primary school teachers were more encouraging than FICT females. FICT females report their friends NOT liking computers significantly more than other students.

		Female		Male	
		FICT	Other	FICT	Other
I regularly had access to computers in my secondary school classrooms	Agree	<b>47.4%</b>	<b>66.4%</b>	65.3%	61.1%
	Undecided	42.1%	16.6%	22.4%	20.6%
	Disagree	10.5%	17.0%	12.2%	18.4%
My primary school teachers encouraged me to develop computing skills	Agree	<b>15.0%</b>	<b>29.8%</b>	27.4%	34.0%
	Undecided	30.0%	25.9%	29.5%	28.3%
	Disagree	55.0%	44.3%	43.2%	37.8%

**Figure 6: Use and attitude to computers: School experiences**

### Gendered differentiation and stereotyping

The concept of gender differentiation is explored further in student responses to a number of gender related statements (Figure 7). FICT girls report an awareness that boys took over computers more at school, also a some recognition of gender stereotyping by both males and females in reporting that boys used computers more than girls for playing games.

		Female		Male	
		FICT	Other	FICT	Other
The boys often took over the computers at my school	Agree	<b>26.3%</b>	<b>16.0%</b>	34.4%	32.1%
	Undecided	10.5%	18.9%	30.1%	28.8%
	Disagree	63.2%	65.2%	35.5%	39.1%
Girls were better skilled at using the computers at school than boys	Agree	<b>15.0%</b>	<b>13.4%</b>	<b>8.5%</b>	<b>8.6%</b>
	Undecided	45.0%	48.3%	33.0%	43.9%
	Disagree	40.0%	38.2%	58.5%	47.5%

**Figure 7: Use and attitude to computers: Self-reported gender perceptions**

There was some differentiation between FICT students and students from other faculties in response to the statements related to skill perceptions and computing (Figure 8). The noticeable difference is the percentage of male and female students from other faculties that are unsure if programming is the most important component for studying IT (52.4% and 46.3%). This perception confirms MMV findings that many students don't know what an IT career involves, or that they perceive it as a technical career path (MMV 2001).

		Female		Male	
		FICT	Other	FICT	Other
I believe that programming is the most important component of studying IT.	Agree	30.0%	18.3%	30.2%	23.3%
	Undecided	25.0%	<b>52.4%</b>	26.0%	<b>46.3%</b>
	Disagree	45.0%	29.4%	43.8%	30.4%

**Figure 8: Use and attitude: Skill perception**

### Computers and leisure

The final section of this questionnaire asked students their perceptions about computer use (Figure 9). In these responses a significantly greater percentage of young women from FICT reported that they cannot remember life without a computer (71% compared to 50% or less for all other cohorts). FICT males and females reported more experience, with making their own websites with the FICT males almost double that of every other group (61.8%). There was a commonality in the proportion of students agreeing and disagreeing with responses to other questions. Males in FICT have a stronger commitment to a career in IT than females in the same faculty (81.2% compared to 66.7%).



		Female		Male	
		FICT	Other	FICT	Other
I cannot remember life without a computer	Agree	<b>71.4%</b>	45.2%	50.0%	40.9%
	Undecided	14.3%	17.0%	16.7%	20.0%
	Disagree	14.3%	37.8%	33.3%	39.1%
I learned to make my own websites at home	Agree	<b>33.3%</b>	<b>17.8%</b>	<b>61.8%</b>	<b>36.6%</b>
	Undecided	23.8%	12.4%	13.7%	17.5%
	Disagree	42.9%	69.8%	24.5%	45.9%
Girls play computer games at home as much as boys	Agree	<b>23.8%</b>	<b>20.1%</b>	<b>18.0%</b>	<b>17.8%</b>
	Undecided	42.9%	29.0%	28.0%	31.7%
	Disagree	33.3%	51.0%	54.0%	50.5%
Girls play different computer games to boys	Agree	23.8%	<b>34.4%</b>	<b>51.0%</b>	<b>42.8%</b>
	Undecided	42.9%	42.6%	31.6%	37.9%
	Disagree	33.3%	23.0%	17.3%	19.3%
I want to pursue a career in the IT industry	Agree	<b>66.7%</b>	<b>14.3%</b>	<b>81.2%</b>	<b>31.7%</b>
	Undecided	23.8%	21.3%	9.9%	24.8%
	Disagree	9.5%	<b>64.3%</b>	8.9%	43.5%

**Figure 9: Students own gender perception of computer use**

## CONCLUSIONS

The snapshot achieved by this survey indicates that the young men and women studying IT at our university are already competent users of IT before enrolling. Most have completed both IT and Mathematics in their senior secondary school subjects. The women who have chosen to study in the IT Faculty however are not as confident in their IT ability as the young men who have chosen degrees in other faculties. Some of the results from these questions can be extrapolated to imply that FICT females already perceive themselves as challenging the norm of societal expectations. Even in the first year of the degree, a surprising number of students in the FICT courses were ambivalent about pursuing a career in the discipline, (33% females and 19% males). It begs the question of why they chose this course, or if the course itself is turning off a career in IT. Follow up interviews will help shed greater light on some of these issues.

The WIT-S project is in its early stages. It would appear that we need to work on redefining IT in our Faculty as well as in the wider community. Experiences at CMU also indicate that closer connections with secondary educators are significant and something that needs to be developed. The WIT-S project has modelled itself on the successful CMU model to some extent. The first piece of advice given by Margolis and Fisher is to gain a solid understanding of the student experience, which is what we are obtaining via the questionnaire and in-depth interviews (Margolis & Fisher, 2002).

The next step is to consider the course content for relevance and diversity and build links with secondary schools via outreach programs. The CMU example has shown that there is no simple solution to the declining diversity of IT but that changes on several levels can bring the desired result of increasing the diversity of the student body. It is a multi-faceted problem that needs multi-faceted responses. In secondary schools the ubiquitous nature of IT skills has resulted in IT being removed as a separate unit in the technology stream and being embedded in all subject curricula in the junior school. This may be the future of faculties of IT in universities in Australia with IT specialist units delivered in other areas according to need and fit (i.e. Information Systems in Business, Software Engineering in Engineering faculties), either way, the discipline and the industry will be enhanced by a greater diversity of students entering the field.

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