Exploring the gender inequity in tertiary Computer Science courses: influential factors in females' choices in Australia and Taiwan

Shu-Hua Chao

BEd, MEd.

Submitted in total fulfilment of the requirements of the degree

Doctor of Philosophy

April 2013

Faculty of Education

Monash University

Abstract

This thesis presents an analysis of a range of social, psychological and motivational factors which accounted for the inequitable representation of females in Computer Science (CS) courses in both the Australian (AU) and Taiwanese (TW) educational contexts. It draws on the literature on educational and vocational achievement related choices and decision-making to identify the key factors and how they influence males and females in making educational choices in their respective educational contexts.

A mixed methods approach was chosen, using surveys for gathering the general characteristics of the undergraduates studying CS and non Computer Science (NCS) courses by educational context during the first phase (Phase 1), then interviews to examine in more detail the reasons for individuals' course participation in the second phase (Phase 2). Results of surveys (Phase 1: AU=106, TW=52) and interviews (Phase 2: AU=7, TW=10) were analysed and presented by gender, group membership (CS and NCS) and educational context. This research offers a cross-national insight into the reasons behind females' participation and non-participation in CS courses in two different educational contexts, which is not captured in the existing literature.

The study found that an interest—enjoyment value attached to IT and/or CS encouraged Australian students to pursue CS courses. In contrast, Taiwanese students' high self-efficacy beliefs in mathematics and programming skills encouraged their choice of CS courses. However, Taiwanese students' course selection was dependent on the attainment value they attached to attending particular institutions, whether or not in CS. Stereotypical notions about CS related courses and careers were found to have discouraged both Australian and Taiwanese NCS females from enrolling in CS courses.

This thesis concludes that although the trend of inequitable female representation in tertiary CS courses exists internationally, including in Australia and Taiwan, the factors accounting for the gender imbalance in CS vary across countries. Therefore, the strategies to address the issue of gender inequity should also reflect these differences across countries. Recommendations for the Australian context call for schools to re-consider the nature of the tasks provided in IT classrooms. As for the Taiwanese context, building female confidence in general IT learning through pre-tertiary and on-going programs, as well as instituting positive discrimination for females in CS course enrolment in Taiwanese universities, may increase the likelihood of Taiwanese females studying CS courses. Females in both contexts should be provided with broader and more accurate information regarding CS courses and careers rather than being left ill-informed with stereotypical perceptions of CS and thus choosing NCS courses. An understanding of the motivational and discouraging factors in females' participation in CS courses in both the Australian and Taiwanese contexts provides a starting point for tackling the gender imbalance in the CS field in both contexts.

Declaration

This thesis contains no material that has been accepted for the award of any other degree or diploma in any educational institution and, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed: [redacted]

The research for this research received the approval of the Monash University Standing Committee for Ethical Research on Humans (CF09/3316 - 2009001772).

Acknowledgements

I initially wanted to enrol in a PhD because of the enjoyment I gained from my previous Master's research project. I was so fascinated with the reasons why females chose to study or not to study senior secondary IT, I believed it would be good to investigate the reasons for females' participation and non-participation in an IT-related course like Computer Science at the tertiary level. As I ventured further into my PhD journey, I found myself grappling with the research question, reading theories I had never encountered with before, and gathering and analysing data from students in two different educational contexts. I found all those circumstances challenging yet rewarding at the same time. I was very fortunate to be supervised by Dr. Michael Henderson, who has constantly encouraged and guided me through every stage of my PhD journey, and offered thorough and constructive feedback whenever I needed it the most. I would also like to thank Professor Helen Forgasz for giving me advice on analysing the survey data quantitatively, as well as advising me on the presentation of findings and discussions. Many thanks to Mr Mayur Katariya for being patient and responding professionally to all my queries regarding forms and applications, as well as my fellow PhD candidates in the Learning with New Media Research Group, who have given me so much encouragement and support as we strive ahead on our respective research paths. Finally, I am deeply indebted to all the participants, who took the time to complete the questionnaire and, in some cases, to also respond so thoughtfully to my questions at interview.

On a more personal level, I am hugely indebted to my mum, who has been unselfishly supporting me throughout the emotional years of PhD study. She has taken up most of the household management, and has been supportive whether I was at a high or a low. Thank you, Rosemary Viete, a true mentor and friend, for proofreading this thesis, and helping me to differentiate my i.e.s from my e.g.s. I have now learnt to structure my sentences much better. And lastly, thanks to all my friends, who have been there throughout my PhD journey, I would not have been able to complete my thesis without your support. The support and encouragement freely given by all of you, particularly in the final stages when I so often felt I could not finish, helped me to complete the thesis. Please accept my heartfelt thanks!

Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

1.1 Background of research

Information Technology (IT) courses in Australia and Taiwan have long been dominated by high male to female ratios in terms of teaching and student representation. In 2010 only 19.5% of commencing IT students were female in Australia (Department of Education Employment and Workplace Relations, 2012). The proportion of females studying IT courses in Taiwan was only 12% in 2010 (Ministry of Education (Taiwan), 2012a). Studies in Australia (Lang & McKay, 2006; Miliszewska, 2006; Miliszewska, Barker, Henderson, & Sztendur, 2006; von Hellens & Nielsen, 2001), and in Taiwan (Fan & Li, 2005; Fan, Li, & Niess, 1998) have pointed out that the disproportionate representation not only reflects the inequitable domination of males, it also leads to a cycle of inequity in which females continue to be underrepresented not only in IT courses but also in IT-related professions.

My interest in females' participation in Computer Science (CS) developed from a study previously conducted in my Master's thesis, which examined the factors females consider when choosing IT subjects in high schools. One of the findings of that study proposed that females' secondary school IT experiences may form one of the factors in females' participation in IT-related courses such as CS in tertiary institutions. Females interviewed who revealed they found IT useful and/or interesting during their senior secondary school were the ones who indicated their intention to pursue IT-related courses at university. Was the perceived usefulness or interest in IT what encouraged them to pursue IT courses, and were the stereotypical notions regarding IT-related courses or careers the deciding factors for those who did not want to consider IT courses, or were females' course choices due to a wider range of factors?

After reading further into the literature the research question for this study was constructed: “What are the factors, and how do they influence individuals’, particularly females’ participation and non-participation in CS courses in Australia and Taiwan?” In trying to answer this question, the study utilises Eccles et al.’s (1983) expectancy value model (EVM) which explores a complex range of social, psychological and motivational factors that may account for individuals’ educational choices. Literature on females’ participation in secondary and tertiary IT education fields in general is presented first, followed by a closer examination of females’ participation (and non-participation) in CS using the EVM.

This study provides an international insight into the similarities and differences in factors for CS and non-Computer Science (NCS) course choices by males and females from two different educational contexts, thus attempting to contribute to a lack of acknowledgement and understanding in past studies which were mainly conducted in Anglo Saxon educational contexts with very few cross-national comparisons. The inclusion of male perspectives rather than solely those of females sought to ensure that the inequitable domination of males in IT and CS fields was also understood from males’ points of view, to better avoid the reinforcement of females’ perspectives on their participation without male input and perspectives. Many studies in the past, have risked such biased views from females alone. Male and female insights together provide more thorough and insightful perspectives on the gendered trend in IT and CS participation, and are valuable for comparing similarities and differences in factors accounting for CS and NCS participation by gender and by educational context (Australian/Taiwanese).

The terms ‘sex’ and ‘gender’ are often used interchangeably, especially in popular media. However, there is an important distinction which this thesis draws on, using Grouws’ (1992) definition of ‘sex’ and ‘gender’: ‘sex differences’ refer to biological distinctions between males and females, while ‘gender differences’ refer to nonbiological, psychological or social characteristics. In this thesis, the term ‘sex’ is used when describing the grouping of males or females; the term ‘gender’ is used when discussing findings relating to males and females based on nonbiological factors.

To examine the factors accounting for CS course participation by gender in both educational contexts, it is essential to gain an overview of the trends of individuals’ participation in Australian and Taiwanese secondary and tertiary IT fields of study. The following sections present females’ participation in secondary and tertiary IT education by educational context (Australia and Taiwan).

1.1.1. Australian context

1.1.1.1 Australian students in senior secondary IT

The generation of school students who have been using computer technology within the classroom since pre-school are often referred to as “‘digital natives’” (Prensky, 2005). These students are generally confident users of technology yet this confidence and acceptance of IT does not reflect a high participation in secondary IT subjects and beyond. An Australian study by Multimedia Victoria (2007) on perceptions of 14-19 year olds toward IT careers and studies found that only close to half of the students surveyed showed some interest in IT, and a mere 13% expressed “strong interest” (Key findings section, para. 2). A lack of interest in IT also suggests that student participation in secondary IT studies is likely to be low, resulting in lower participation in IT courses at the tertiary level and subsequently in the Australian IT workforce. While females make up 45% of the Australian workforce, only 18% of the IT workforce in 2009 were women (Fisher, 2011, para. 2). The continuing scarcity of females in tertiary IT courses and the workforce reveals a need to explore this on-going male-dominant trend in the field.

Craig (2005) suggests that a complex range of issues may have contributed to producing the underrepresentation of females in IT-related fields of study at the tertiary level. These issues include stereotypical images of computing, particularly those portraying solitary male nerds working on computers alone (Lewis, Lang, & McKay, 2007; Stockdale & Stoney, 2007), a lack of understanding of the IT industry as well as the careers associated with tertiary IT courses (Clayton, 2006; Newmarch, Taylor-Steele, & Cumpston, 2000; Redmond, 2006), a lack of association and interaction with female role models including female IT teachers, professionals and mentors (Jepson & Perl, 2002; Wasburn & Miller, 2004), the degree of supportiveness of teachers in developing IT-related skills not only for set tasks but also for individual interests, and the delivery and teaching of IT curricula (Clayton, 2004; Murphy, 2006). It is therefore important to gain a more comprehensive understanding of what the factors are and how they have contributed toward individuals' – and particularly females' – decisions in pursuing CS or NCS courses at the undergraduate level.

The decline in IT graduates in the United Kingdom, United States of America, Canada, Taiwan, Spain and Ireland is noted in Millar and Jagger's (2001) study. The decline in computing graduates could also be due to the low proportion of females studying IT subjects during senior secondary school. For example, in the state of Victoria, Australia, students participating in the Victorian Certificate of Education (VCE) could choose "IT Applications" or "Software Development" or both for their final year (Year 12) IT studies, each of which consists of a Unit 3/4 sequence (Victorian Curriculum and Assessment Authority, 2012b). The enrolment numbers for both IT subjects have been in decline over the past decade (Victorian Curriculum and Assessment Authority, 2012a) (see Table 1).

Table 1

Student Enrolment (and Percentage Decline or Increase) in Victorian Year 12 IT Subjects, 2001-2011

	IT Applications				Software Development			
	Male		Female		Male		Female	
Year	Enrolment N	% change	Enrolment N	% change	Enrolment N	% change	Enrolment N	% change
2001	7517	N/A	5446	N/A	2833	N/A	433	N/A
2002	6770	(-10%)	4603	(-15%)	2617	(-8%)	358	(-17%)
2003	5950	(-12%)	3481	(-24%)	2502	(-4%)	261	(-27%)
2004	5079	(-15%)	2447	(-30%)	2278	(-7%)	180	(-31%)
2005	4392	(-14%)	1933	(-21%)	1822	(-20%)	161	(-11%)
2006	3691	(-16%)	1512	(-22%)	1683	(-8%)	141	(-12%)
2007	3364	(-9%)	1162	(-23%)	1398	(-17%)	104	(-26%)
2008	2935	(-13%)	1043	(-10%)	1292	(-8%)	92	(-12%)
2009	3129	(+7%)	953	(-9%)	1229	(-5%)	64	(-30%)
2010	2742	(-12%)	747	(-22%)	1119	(-9%)	98	(+53%)
2011	2535	(-8%)	567	(-24%)	1209	(+8%)	94	(-4%)

Note. Students must have completed Unit 3 satisfactorily prior to commencing Unit 4, and must have been enrolled in Unit 4 in order to complete either or both IT subjects. This table shows students who were enrolled in Unit 4 of each IT subject. Source: Victorian Curriculum and Assessment Authority (2012a).

Table 1 shows the male and female enrolment numbers and enrolment percentage changes (decline or increase) by year in the two Year 12 IT subjects: IT Applications (ITA) and Software Development (SD). There are higher enrolment percentage declines for females than males in both subjects, with a significantly higher proportion of males than females enrolled in SD. A steady decline is shown in student enrolment in ITA and the female enrolment more than halved in a three-year period from as many as 5446 in 2001 down to just 2447 in 2004. The lowest female enrolment percentage declines in ITA were recorded for 2008 (-10%) and 2009 (-9%), whereas a 15% or greater enrolment percentage decline was observed for other years. Male enrolment in ITA, in contrast, revealed a lower enrolment percentage decline, yet the enrolment numbers declined from as many as 7517 in 2001 down to just 3691 in 2006, a 51% enrolment percentage decrease within a five-year period. Male enrolment decline rates in ITA were however comparatively lower than their female counterparts, and the lowest enrolment percentage decline rates were noted in 2007 (-9%) and in 2011 (-8%).

Female enrolment numbers in SD experienced an even more significant decline, from as many as 433 students enrolled in 2001 down to just 180 enrolled in 2004, a 58% decline in merely three years. The highest female enrolment percentage decline of 31% was noted in 2004 in SD. It was however particularly interesting to note that there was a high female enrolment percentage increase for the year of 2010 in SD, where the number of females enrolled in SD increased from 64 in 2009 up to 98 in 2010, an unexpected enrolment percentage increase of 53%. Although male enrolment numbers in SD have also been in decline over the past decade, the enrolment percentage decline was not as significant. Male enrolment numbers in SD did decrease from 2833 in 2001 down to just 1822 in 2005 over a four-year period. Two particularly high male enrolment percentage declines were noted for the years of 2005 (-20%) and 2007 (-17%), while the other years experienced an enrolment percentage decline of less than 10%.

The enrolment numbers as well as percentage increases (or decreases) from both ITA and SD revealed a gender disparity. Although both subjects illustrate a continuous decline in both male and female enrolment, SD highlights a particularly gendered participation, with 2278 males studying the subject compared to just 180 female students in 2004. Similarly, in ITA males also outnumbered females but with a much lower male to female ratio, with 5079 males and 2447 females enrolled in 2004. While enrolment percentage decline rates for males and females in both IT subjects were observed, female enrolment percentages seemed to be in decline at higher rates than those of their male counterparts in both ITA and SD. For instance, in ITA the highest male enrolment percentage decline was 16% in 2006, while the female enrolment percentage decline was 21% or higher for the period of 2003-2007, as well as for 2010-2011.

Greater fluctuations in male enrolment percentage decline were observed in SD, where the two highest enrolment declines were observed for 2005 (-20%) and 2007 (-17%), with the other years revealing an enrolment percentage decline of less than 10%. Female enrolment decline in SD was much higher in comparison, with the two highest enrolment declines noted for 2004 (-31%) and 2009 (-30%), while the other years experienced an 11% or greater decline in enrolment, except for 2011 (-4%). It is evident that while male enrolment numbers exceeded female enrolment numbers in both ITA and SD, SD remained the IT subject with a higher male over-representation and a higher female enrolment decline. The numbers of students enrolled, as well as the enrolment percentage decline of both males and females in ITA and SD not only highlight a strong male domination, but also a greater gendered disparity in SD, as further illustrated by the male to female ratio in ITA and SD (see Table 2).

Table 2

Male to Female Ratio in Victorian Year 12 IT Subjects, 2001-2011

Year	IT Applications	Software Development
2001	1.38:1	6.54:1
2002	1.47:1	7.31:1
2003	1.70:1	9.59:1
2004	2.07:1	12.66:1
2005	2.27:1	11.31:1
2006	2.44:1	11.94:1
2007	2.90:1	13.44:1
2008	2.81:1	14.04:1
2009	3.28:1	19.20:1
2010	3.67:1	11.42:1
2011	4.47:1	12.86:1

Note: Figures are based on enrolment statistics from Victorian Curriculum and Assessment Authority (2012a).

Table 2 outlines high ratios of males to females in ITA and SD throughout the period of 2001-2011. The male to female domination in ITA increased year by year, except for 2008 where a slight decrease in the sex ratio was noted, yet for all other years the sex ratio increased, with the most recent figures indicating the male to female ratio at 4.47:1 in 2011. An even higher male to female ratio was observed in SD, where the male to female ratio was 6:54:1 in 2001 and increased yearly until the ratio decreased from 12.66:1 from the previous year to 11.31:1 in 2005, with the most recent male to female ratio at 12.86:1 in 2011. The highest male to female ratio in ITA was in 2011 at 4.47:1, while SD had the highest sex ratio of 19.20:1 in 2009. These statistics suggest that male participation remains dominant, with SD displaying higher male to female ratios.

It is fair to suggest that ITA attracts more females than SD, perhaps because the former subject's core requirements exclude the learning of programming (Victorian Curriculum and Assessment Authority, 2012b), which is required in the latter subject. However, it cannot be generalised that fewer senior secondary females studied SD due to the learning of programming, as there were only two subjects for those studying VCE IT. Nonetheless, the high male to female ratio in both ITA and SD highlights a pressing need to further understand the key factors in females' selection of either (or both) subject(s) in Year 12, and to further explore whether the very same key factors contributed toward subsequent participation in tertiary CS courses (or majors). It is also important to gain an insight into individuals' experiences of previous secondary IT related experiences and also Year 12 IT studies (if applicable) to identify factors which influenced choices to participate or not in tertiary CS courses. This section has briefly outlined females' participation in Australian senior secondary IT education (Year 12).

1.1.1.2 Australian students in tertiary IT

A critical concern in Australian tertiary institutions and also in many other countries is the continuing decrease of female students applying for entry into IT related courses (Craig, Lang, & Fisher, 2008; Fan & Li, 2005; Fisher, 2011; Kim, Fann, & Misa-Escalante, 2011;

Ma, 2009; McInerney, DiDonato, Giagnacova, & O'Donnell, 2006; von Hellens & Nielsen, 2001). The representation of males continues to dominate that of females in IT related courses at the tertiary level. While IT was nominated by the Australian higher education equity reviews as a non-traditional field of study with the target of 40% participation for females (Department of Education Employment and Workplace Relations, 2004), the target seems to be difficult to achieve, as Australian tertiary institutions have reported decreasing enrolments in their IT-related programs since the millennium (Clayton, 2006). The aggregate proportion of females enrolling as new undergraduate IT students in Australian universities declined from 26.2% in 2001 down to just 19.5% in 2010 (Department of Education Employment and Workplace Relations, 2012). It was found that individuals, and in particular females who possess stereotypes about IT-related studies and careers, are more likely not to choose tertiary IT courses (Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008).

The decline in numbers of Australian females undertaking IT-related courses is exemplified by the decreasing numbers of females enrolling in Monash University’s (2009c) four main undergraduate IT courses, including the Bachelor of Information Technology and Systems (BITS), Bachelor of Business Information Systems (BBIS), Bachelor of Software Engineering (BSE) and Bachelor of Computer Science (BCompSc) as shown in Table 3 (Monash University, 2009b, 2012b).

Table 3

Student Enrolment Numbers in IT Courses by Sex at Monash University, 2006-2012

	BITS		BBIS		BSE		BCompSc	
	Male	Female	Male	Female	Male	Female	Male	Female
Year	N	N	N	N	N	N	N	N
2006	291	85	62	18	110	12	272	31
2007	497	119	127	30	97	7	237	24
2008	626	145	201	49	101	8	208	26
2009	742	175	222	63	101	11	252	23
2010	771	180	222	56	124	15	257	36
2011	712	162	214	69	133	17	271	36
2012	582	126	181	61	140	16	251	37

Note: Figures are from Monash University (2012b).

Table 3 shows that student enrolment in the four main IT courses varied each year during 2006-2012. BITS has the highest male and female enrolments out of the four main IT courses at Monash University, while the other three IT courses had enrolment numbers of less than 300 over the years. BITS also showed the strongest increase in enrolment for both sexes, with male enrolment increasing from 291 in 2006 to 771 in 2010, while female enrolment increased from 85 in 2006 to 180 in 2010. Both male and female enrolments in BITS, however, decreased in 2011 and 2012. Enrolment numbers in BBIS were also high, with male enrolment numbers remaining steady at 201 or more for the period of 2008-2011, yet female enrolments have been less than 70 for the past seven years.

BSE and BCompSc were the two courses with a higher proportion of males enrolled: BSE recorded 97 or more males enrolled compared to female enrolment numbers which ranged from 7 (lowest enrolment figure) to 17 (highest enrolment figure); BCompSc experienced a comparatively lower female enrolment number similar to that of BSE, with male enrolments ranging from 208 to 272 in contrast to female enrolment numbers which ranged from 23 (in 2009) to 37 (in 2012). The relatively higher proportions of males than females enrolled also suggest a high male to female ratio in the four IT courses (see Table 4).

Table 4

Male to Female Ratio in IT Enrolment at Monash University, 2006-2012

Year	BITS	BBIS	BSE	BCompSc
2006	3.42:1	3.44:1	9.16:1	8.77:1
2007	4.17:1	4.23:1	13.86:1	9.88:1
2008	4.32:1	4.10:1	12.63:1	8.00:1
2009	4.24:1	3.52:1	9.18:1	10.96:1
2010	4.28:1	3.96:1	8.27:1	7.14:1
2011	4.40:1	3.10:1	7.82:1	7.53:1
2012	4.62:1	2.97:1	8.75:1	6.78:1

Note: Figures are based on the statistics available from Monash University (2012b).

Table 4 shows a strong male to female ratio in all four IT courses, with BSE having the highest sex ratio of 13.86:1 (in 2007), followed by BCompSc having the highest male to female ratio of 10.96:1 (in 2009); BITS and BBIS in contrast have lower male to female ratios, with the sex ratio in BITS ranging from 3.42:1 to 4.62:1, while BBIS ranged from 2.97:1 to 4.23:1. While the male to female ratio seemed to be increasing year by year in BITS, BBIS experienced some variations in sex ratio, and has had some noticeable decline in male to female ratio from 3.44:1 in 2006 down to 2.97:1 in 2012. The sex ratios of BSE and BCompSc, which ranged from 7.82:1 to 13.86:1, and 6.78:1 to 10.96:1, highlight large fluctuations in ratios in these two particular IT specialisms out of the four main undergraduate IT courses. Certainly, there is a gender imbalance in both specialisms, but the nature of the curriculum, or individuals' perceptions of either course as a focus of study or career could have discouraged more females from pursuing BSE or BCompSc, compared with noticeably lower sex ratios in BITS and BBIS.

Noticeable increase-decrease fluctuations in the male to female ratio in BCompSc within the 2006-2012 period was worth exploring, as it suggests some underlying encouraging and discouraging factors were involved in female participation year by year. For instance, the sex ratio (male to female) increased from 8.77:1 in 2006 to 9.88:1 in 2007, and then decreased down to 8.00:1 in 2008, and then increased up to 10.96 in 2009. The increase-decrease variations in the male to female ratios suggest that particular factors could have prompted or deterred females from pursuing CS, which would result in fewer females graduating with CS qualifications, and further suggests a lack of female academics who can teach CS at the tertiary level or work in CS related professions.

The following section presents the Taiwanese context by presenting the background of the senior secondary IT curriculum in Taiwan, followed by Taiwanese students' participation in tertiary IT and CS courses.

1.1.2 Taiwanese context

1.1.2.1 Taiwanese students in senior secondary IT

Unlike the Australian section where student enrolment numbers in senior secondary IT subjects can be used to discuss the disproportionate participation of females in senior secondary IT, the official websites for the Taiwanese Ministry of Education and the Department of Statistics do not provide statistical data on the exact enrolment numbers of students studying senior IT subjects, particularly in Year 12. According to the Department of Secondary Education (2012c), "Introduction to Information Technology" (IIT) was only made mandatory in the Taiwanese senior secondary school curriculum from 2010. The late implementation of IIT in senior secondary school curriculum was perhaps why no statistical information about students' enrolment in senior high school IT subjects was available on the Ministry of Education (Taiwan) and the Department of Secondary Education (Taiwan) websites. Therefore, in the absence of statistical data on senior secondary enrolment in IT subjects, an understanding of the Taiwanese secondary IT curriculum was deemed essential for understanding the Taiwanese senior secondary IT context. The IIT syllabus states that "students must complete at least two credit points of Introduction to Information Technology during senior high school. Areas outlined in this syllabus which are not covered in class are expected to be taught in the elective subject, "Information Science" (IS)" (Department of Secondary Education (Taiwan), 2012b, p. 1).

Students who have a specific interest in programming are advised to study IS, as the IS syllabus outlines that they will learn about "Basic Programming", "Advanced Programming" and "Information Science and Applied Topics" (Department of Secondary Education (Taiwan), 2012a). Some similarities were observed in the Australian (Victorian) and Taiwanese IT subjects mentioned. For instance, ITA introduces the uses of websites and web authoring software and database management systems (Victorian Curriculum and Assessment Authority, 2012b), while IIT also provides students with the opportunities to use websites and process information using database systems (Department of Secondary Education (Taiwan), 2012b). SD and IS were similar in that both subjects focus on teaching students how to program, with SD's unit outline ensuring that it would teach students programming basics using "an approved programming language" (Victorian Curriculum and Assessment Authority, 2012b, p. 40), while the IS syllabus claims that the elective intends to teach students how to "program, code using programming languages as well as mathematical concepts" (Department of Secondary Education (Taiwan), 2012a, p. 341). Following an outline of the Taiwanese senior secondary IT curriculum, the participation by Taiwanese students in tertiary IT related courses is presented in the following section.

1.1.2.2 Taiwanese students in tertiary IT

The Taiwanese higher education system classifies tertiary IT courses under "Computing", while "Computer Science" is grouped under "Engineering" (Ministry of Education (Taiwan), 2012b). Similar to the enrolment trends in the Australian situation, Taiwanese female enrolment numbers in Computing declined from 49.4% in 2001 down to 34.6% in 2012, while female enrolment numbers in the field of Engineering varied very little, from 11.1% in 2011 to 12.3% in 2012 (Ministry of Education (Taiwan), 2012a). The common IT courses offered by tertiary institutions in Taiwan include electrical/computer engineering (ECE), computer science (CS), management information systems (MIS) and computer science education (CSE) (College Entrance Examination Board, 2003). Since the 1990s many computer science related programs were renamed as ECE or MIS, and only five universities still named their CS courses "computer science" (Fan & Li, 2002b). National Taiwan University (NTU) offers two main IT undergraduate courses in different departments, a Bachelor of Science program (BS) provided by the Department of Computer Science and Information Engineering, of which "the courses offered for undergraduate students give them a solid foundation on the basics of Computer Science and Information Engineering" (National Taiwan University, 2010d), while Bachelor of Business Administration in Information Management (BBAIM) is offered by the Department of Information Management (National Taiwan University, 2012). The numbers of students enrolled in the two main IT courses at NTU (Ministry of Education (Taiwan), 2012c), as well as male to female ratios in both courses, are shown in Table 5.

Table 5

Student Enrolment Numbers in IT Courses by Sex, and Male to Female Ratio at National Taiwan University, 2005-2011

	BS			BBAIM		
Year	Male N	Female N	Male to female ratio	Male N	Female N	Male to female ratio
2005	410	66	6:21	154	66	2:33
2006	407	77	5:29	140	85	1:65
2007	426	74	5:76	129	102	1:26
2008	419	80	5:24	146	105	1:39
2009	437	84	5:20	151	96	1:57
2010	444	77	5:77	149	90	1:66
2011	428	83	5:16	143	76	1:88

Note: Enrolment statistics are from the Ministry of Education (Taiwan) (2012a).

Table 5 shows that, in comparison with BS, BBAIM had a noticeably smaller number of males enrolled, ranging from 129 (in 2007) to 154 (in 2005); a greater fluctuation in female enrolment numbers was also noticed, with enrolment edging up from 66 (in 2005) to 105 (in 2008). The female enrolment pattern in BBAIM demonstrates a continuous increase between 2005 and 2008, then enrolment numbers decreased down to just 76 in 2011. On the other hand the enrolment numbers of male students in BS did not vary much during the 2005-2011 periods, which ranged from 407 (in 2006) to 428 (in 2011). Over the same period female enrolment, in contrast, had a slightly larger increase of 21% from 66 (in 2005) to 83 (in 2011). In terms of the male to female ratio, BBAIM ratios ranged between a low of 1.26 and a high of 2.33. These were low in comparison to those in BS, which had noticeably higher male to female ratios, with the lowest ratio recorded at 5.16 (in 2011) and the highest ratio at 6.21 (in 2005).

It is clear that in terms of enrolment numbers, both Australian and Taiwanese males outnumbered females in enrolments in BCompSc and BS respectively. While male enrolment numbers outnumbered those of females in both BCompSc (Australia) and BS (Taiwan), male to female ratios provided a better indication of female representation in both undergraduate

CS courses (BCompSc and BS). For example, a high male to female ratio was observed in BCompSc at 7.53:1 in 2011, while BS had a lower ratio of 5.16:1 in the same year, yet the ratio in BCompSc dropped in 2012 to 6.78:1. The noticeably higher sex ratio of males to females that prevailed in the Australian BCompSc in comparison to the Taiwanese BS undergraduate course serves as an interesting point of exploration in the following sections, which focus on the female representation in the CS field of study and careers, in the Australian and Taiwanese contexts respectively.

Since the enrolment trends in the CS courses offered in both Australia (e.g., BCompSc) and Taiwan (e.g., BS) both suggest an inequitable representation of females, it is therefore important to gain an understanding of the structures of both the Australian and Taiwanese CS courses, to ensure that the courses are comparably similar for meaningful discussions and comparisons to be made.

1.1.3 Computer Science curriculum of the two institutions

The CS curriculum offered by the Australian and the Taiwanese tertiary institutions are inevitably different yet there are some common course characteristics. Differences between Australian and Taiwanese CS courses are that, while Australian institutions offer three-year CS courses, Taiwanese undergraduate courses including CS are a minimum of four years of study. CS courses are also offered by different faculties due to the differences in classifications used in the Australian and the Taiwanese educational systems. For example, the Bachelor of CS is provided by the Faculty of IT at Monash University (MU), whereas undergraduate CS is offered by the Department of Computer Science and Information Systems at National Taiwan University (NTU). Monash University described CS thus (Monash University, 2009a):

> Computer science is concerned with the scientific design and use of computer hardware and software. Computer science spans a range of areas from its theoretical and algorithmic foundations to cutting-edge developments in robotics, computer vision, intelligent systems, and bioinformatics. This course provides an in-depth study of computing with a focus on the software, hardware and theory of computation to solve commercial, scientific and technical problems.

The undergraduate CS program by NTU was outlined (National Taiwan University, 2010c) as follows:

> The undergraduate program is designed for students whose major interest is in computer science. It gives the student the opportunity to obtain a broad knowledge of computer science and the freedom to tailor the program according to the student's individual needs. Courses focus on Computer Science and Information Engineering basics such as Data Structure & Algorithm, Engineering/Discrete Mathematics, Programming/Assembly Languages, Operating System and Computer Architecture.

In order to ensure the undergraduate CS curriculum provided by Monash University (BCompSc) (Monash University, 2009a), and by National Taiwan University (BS) (National Taiwan University, 2010b) are similar for subsequent discussions of findings, the details of what undergraduates are expected to study are presented in Table 6.

Table 6

Computer Science Course Requirements: Monash University and National Taiwan University

Year level	Monash University (BCompSc)	National Taiwan University (BS)
First	Computer systems I Computer programming IT in organisations Computer science Mathematics for computer science I Mathematics for computer science II Elective I* Elective II*	Student service education I Student service education II Calculus A (General Mathematics) I Calculus A (General Mathematics) II General physics A I General physics A II Introduction to computer Introduction to computer programming Information systems Object-oriented software design
Second	Systems analysis and design Networks and data communications Database Algorithms & data structures Theories of computation Computer systems II Elective I* Elective II*	Data structures and algorithms I Data structures and algorithms II Linear algebra Discrete mathematics Computer organization & assembly languages Digital electronics Probability Systems programming
Third	IT project management Analysis and design of algorithms Software engineering: architecture and design Computer science project or software engineering project Elective I* Elective II* Computer science approved elective I* Computer science approved elective II*	Digital system design Operating systems Digital circuit lab. Formal languages & automata theory Compiler design Computer architectures Computer networks Computer system laboratory Computer network laboratory Student service education III
Fourth	N/A	Database systems Special projects I Special projects II

Note. *BCompSc students at Monash University have the options of studying approved electives during their three-year courses. For example, at Level 1, Introduction to software engineering; Digital logic; Advanced level 1 project (by invitation); At Level 2, Software engineering practice; Technical documentation for software engineers; Advanced level 2 project (by invitation); At Level 3: Formal methods for software engineering; System tools and programming languages; Multimedia programming and the www; Artificial intelligence; Image processing; Programming languages and paradigms; Numerical computing; Computer graphics.

Table 6 shows that the undergraduate CS courses require students at Monash University (MU) and National Taiwan University (NTU) to study mathematics during the first year, such as “Mathematics for computer science I and II” at MU, and “Calculus A I and II” at NTU, as well as programming (e.g., “Computer programming” at MU, “Introduction to computer programming” at NTU). In the second year of the CS courses, both institutions require students to study algorithms and data structures. From the third year onwards, both institutions begin to place more emphasis on the aspect of design, such as "Analysis and design of algorithms" at MU, and "Digital system design" and "Compiler design" at NTU. There are however, some differences in terms of the number of units of study that students have to complete at each institution. For example, CS students at MU only have to study eight units per academic year, whereas students at NTU have to study ten units for the first and third year, eight units for the second year, with the addition of three units for the fourth academic year. A notable difference is also seen in the offering of electives. For example, NTU's CS curriculum does not indicate the choice of electives. In contrast, MU students can choose two electives per year. Other differences observed were that all MU students begin a project in their third year (though some may be invited to engage in another project earlier), while NTU students only commence "Special projects I and II" in their fourth year. Judging from the high number of units which NTU CS students need to study for the first three years, the two special projects may be a major component for their final year CS curriculum.

The undergraduate CS programs offered by MU and NTU aim to teach students specific skills and content knowledge, as well as to equip students with well-rounded graduate attributes which reflect the quality and knowledge that graduates are able to perform after the completion of their CS courses, as MU (2009a) outlines:

> Employers worldwide look for practical and technical IT and people skills in everyone they recruit. You will find that this program provides you with the fundamental skills required for entry-level jobs in information technology fields.

In contrast, the graduate attributes of NTU (National Taiwan University, 2010b) are as outlined:

> The courses offered for undergraduate students give them a solid foundation and interest on related knowledge for computer science and information engineering. The goal…is to make our students competitive candidates for successful researchers or engineers.

The graduate attributes of MU stress the importance for CS graduates to gain “practical and technical IT and people skills” which “employers” seek, with emphases on preparing CS students to possess the necessary skills for future IT employment. In contrast, NTU focuses on the importance of students becoming “competitive candidates for successful researchers and engineers”. This suggests a stronger focus by MU to prepare its CS students to build interactional skills while NTU appears to be more focused on training its students to develop academic-oriented skills and/or highly technical skills.

A closer exploration of the MU and NTU CS undergraduate programs enabled a cross-checking in terms of the coursework requirements and graduate attributes expected of CS students upon completion of their undergraduate CS courses. The cross checking confirmed that the skills and content knowledge required of CS students from the two different educational contexts are very similar; for example, both institutions require students to study mathematics during the first year, algorithms and data structures in the second year, and design in the third year. Although the titles of the units at the two institutions may not be identical, the curriculum content of both institutions demonstrates similar sets of skills and knowledge that students, regardless of educational contexts, are expected to learn in undergraduate CS courses.

1.2 Rationale for the research

The underrepresentation of females in CS has not only been an on-going issue for the past two decades, it also illustrates the inequitable, repeating cycle of female underrepresentation in the field. This study places a specific focus on CS courses rather than a range of IT courses due to the persistent pattern of female underrepresentation in CS courses in comparison with any other IT courses. The gendered participation in both the Australian and Taiwanese CS courses (e.g., BCompSc and BS) further illustrate the presence of gender inequity in CS course participation regardless of educational contexts, yet the key reasons for this trend remained unknown. It is therefore of pivotal importance to understand the factors which contribute toward the underrepresentation of females in both Australian and Taiwanese CS courses. The repeating cycle of gender inequity in CS courses would not only result in even lower numbers of females considering CS courses, it is also likely to result in a CS workforce consisting of predominantly male-oriented solutions to worldly problems without the potential valuable input of females. Lewis, Smith Belanger and Harrington (2008) also pointed to the need of the CS field to add to the "technical skills" which are already prevalent, by bringing in more of the "soft" skills such as the higher-order interpersonal skills and emotional intelligence associated with females and problem-solving strategies, contributing to a more comprehensive design.

In order to identify the factors which have contributed toward the gender inequity in CS courses, the utilisation of the EVM and the literature are used to identify the key factors and how they influence females' course participation in CS and NCS fields. Factors such as exposure to IT, school curriculum, understanding about IT studies and careers, teacher supportiveness and female role models can affect individuals', particularly females' subsequent participation in CS courses (Craig, 2005, 2006; Larose, Ratelle, Guay, Senecal, & Harvey, 2006; Leech, 2007; Papastergiou, 2008; Redmond, 2006).

While past studies based on the US and Canadian contexts have researched individuals' participation in IT studies in general, this study presents males' and females' perspectives on a range of factors accounting for individuals' participation by gender in their respective educational contexts. Identifying the key reasons that influenced course selection by females in Australia and Taiwan, this study provides a fine-tuned analysis with rare cross-national insights from an East Asian educational context (Taiwan) and a predominantly Anglo-Saxon educational context (Australia).

1.3 Research question

The aim is to better understand why there is an inequitable representation of females in CS courses. The literature offers a number of possible causes from social, psychological to motivational constructs. However studies in the past have rarely conducted international comparisons of the key factors influencing the course participation by individuals, particularly by females in the CS field from two distinctively different educational contexts (e.g., Anglo Saxon and East Asian). Therefore the research question for this study is "What are the factors, and how do they influence individuals', particularly females', participation and non-participation in CS courses in Australia and Taiwan?" Both males and females were included in this research as it was deemed that perspectives from both genders would provide a more comprehensive and insightful response to the research question than those from females alone.

1.4 Outline of thesis

Chapter Two consists of theoretical background regarding Eccles et al.'s (1983) expectancy value model (EVM) for examining a range of social, psychological and motivational factors accounting for individuals' educational and vocational choices by gender. Chapter Three consists of a review of literature closely examining a range of intrinsic and extrinsic factors and influences which contribute toward individuals', particularly females', participation in general IT at the secondary level as well as at the tertiary level, and more specifically, identifying what has accounted for individuals' participation and non-participation in tertiary CS courses. Chapter Four demonstrates my understanding of the methodology for this thesis, which is the mixed methods approach. I outline my rationale for the choices of research sites, recruitment and selection of participants as well as data collection and analysis procedures in relation to the research question. Chapter Five consists of the survey results and interview findings from the Australian participants using the EVM as a guide. It discusses factors which influenced these Australian students' participation and non-participation in undergraduate CS courses by gender, by closely examining their secondary school experiences (particularly IT-related experiences), influences of socialisers, personal interests in IT and their understandings of CS related studies and careers. Chapter Six consists of the survey results and interview findings of Taiwanese participants, and, similar to Chapter Five, discusses and presents key reasons accounting for Taiwanese students' participation in CS and NCS courses at the undergraduate level. Chapter 7 offers a synthesis of findings across countries, discussing these in terms of the similarities and differences in the key factors accounting for undergraduates' participation by gender in the two different educational contexts. Chapter 8 concludes this research by revisiting the research question, identifying the key factors in course participation by Australian and Taiwanese females, before providing recommendations for the main findings, remarks on the limitations of the research and on future research.

Chapter 2. Eccles' Theory

2.1 Eccles et al. Expectancy Value Model (EVM)

Eccles and her colleagues noticed a trend in the underrepresentation of females in engineering and applied sciences and were interested in factors accounting for the educational and vocational decisions made by males and females. To better understand the gender differences in educational and achievement-related choices, Eccles and her colleagues drew on theoretical and empirical work associated with decision-making achievement theory and attribution theory (Crandall, 1969; Weiner, 1985), and constructed a theoretical model named "Eccles et al. Expectancy Value Model" (EVM), (Eccles [Parsons] et al., 1983; Eccles, Adler, & Meece, 1984; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Wigfield & Eccles, 1992, 2000).

2.1.1 Achievement and attribution theories

In order to justify the use of the EVM for this research, the underlying theories of achievement and attribution theory must be understood. In Crandall's (1969) studies of sex difference in the expectancy of intellectual and academic achievements, consistent differences in expectancy estimates were found between males and females. The concepts of expectancy were defined by three constructs (Crandall, 1969, pp. 12-13):

1) The nature of reinforcement available in a given situation (e.g., an individual with stronger expectancy would be more likely to see achievement in any setting);

2) The agent responsible for the occurrence of an outcome (e.g., an individual perceives certain outcomes based on his own skills in most achievement tasks); and

3) The ability to obtain a specific reinforcement or class of reinforcements (e.g., an individual's subjective estimate of probability that his/her skills are adequate to obtain a specified reinforcement or level of reinforcement).

Crandall (1969) also states that predictions can be made about children, given that those who have strong expectancies about their ability to perform well in school often spend more time and effort in studying in related intellectual and academic activities. When children have the confidence in their abilities to perform well in achievement-related tasks, their confidence would in turn facilitate their cognitive processes to the maximum level in order to complete the tasks. The greater the expectancy children possess, the greater the acquisition of information and better problem-solving skills children would have. On the other hand, should children perceive they cannot succeed in particular tasks, their lack of confidence would affect the effort they put into the tasks and consequently their chances of success.

Crandall (1969) states that sex differences in expectancy also highlighted: a) reinforcing agents' (such as parents' and teachers') praises or criticism more toward one sex than the other would affect males and females' differences in expectancies; b) internal expectations of individuals may differ due to the two sexes being differently sensitive to positive and negative reinforcements; and c) females gave consistently lower estimates of expectancies for success than males yet achieved better in set tasks, in contrast to males who gave higher estimates but achieved lower than their estimates. In summary, Crandall (1969) found that females tend to provide lower estimates of their own intellectual and academic capabilities compared to males, yet it was also revealed that females often received positive feedback – more in terms of grades – and more criticism regarding intellectual performances. Nevertheless, males were given more praise than their female peers from parents and teachers. Crandall (1969) in general proposes it is important for individuals regardless of gender to possess high expectancies as they are positively related to performance outcomes, since individuals found to have higher confidence levels were the ones who performed the best among their sex.

Weiner (1985) states that an individual's expectancy of attaining (or achieving) a goal determines a particular action that the individual performs, which suggests a connection between attribution thinking and goal expectancy. Weiner (1985) proposes that aspiration and chance tasks are directly related to changes in goal expectancy in achievement-related contexts. When the level of aspiration for a goal increases once it has been achieved and vice versa, increments in expectancy follow success, whereas expectancy decrements follow failure. Chance tasks refer to an individual's subjective perceptions of his/her own probability (and expectancy) of success at achieving a task, and these perceptions change after his or her success or failure. When the aforementioned conditions remain the same, the outcomes experienced in the past are expected to recur. In summary, Crandall (1969) demonstrated the importance of expectancy of both males and females, which correlates with performance in achievement-related tasks, while Weiner (1985) suggested factors for attributional thinking and goal expectancy. Both of the theories laid the foundation for the construction of the EVM, which links achievement-based beliefs and goals to interpretative systems, while examining the expectations individuals possess regarding future success in a range of achievement-related options.

2.1.2 Features of EVM

Eccles proposes that individuals' expectancies for success and the value they have for succeeding are important determinants of their motivation to perform different achievement tasks, and their choices of which tasks to pursue (Wigfield & Eccles, 2002). The Eccles at al. (1983) expectancy value model (EVM) examines a range of social, psychological and motivational factors which influence course enrolment decisions, career aspirations and other achievement-related choices by gender (Eccles, 1985, 1994, 2005a; Lupart, Cannon, & Telfer, 2004; Zarrett & Malanchuk, 2005). In other words, the EVM, links achievement-based beliefs, outcomes, and goals to interpretative systems like causal attributions, to the input of socialisers, to gender role beliefs, to self-perceptions and self-concept, and to one's perceptions of the task itself. Each of these factors are assumed to influence both the expectations one holds for future success at the various achievement-related options and the subjective value one attaches to these various options (Eccles, 1994, p. 587).

Eccles (2005a) notes that the EVM draws on decision-making, achievement and attribution theories, which predict that educational and vocational choices are directly related to individuals' expectation for success and the values they attach to the range of options available to them at the time of decision-making. The original EVM was developed in 1983 and has since experienced some changes. After a direct consultation via email with the original main author, Eccles, the more recent 2010 version of the EVM was deemed suitable for this study. "This [2010 version] is a fine version of the model. I make minor changes in various chapters and talks but for your purpose this one is fine" (J. Eccles, personal communication, July 21, 2010) (see Figure 1).

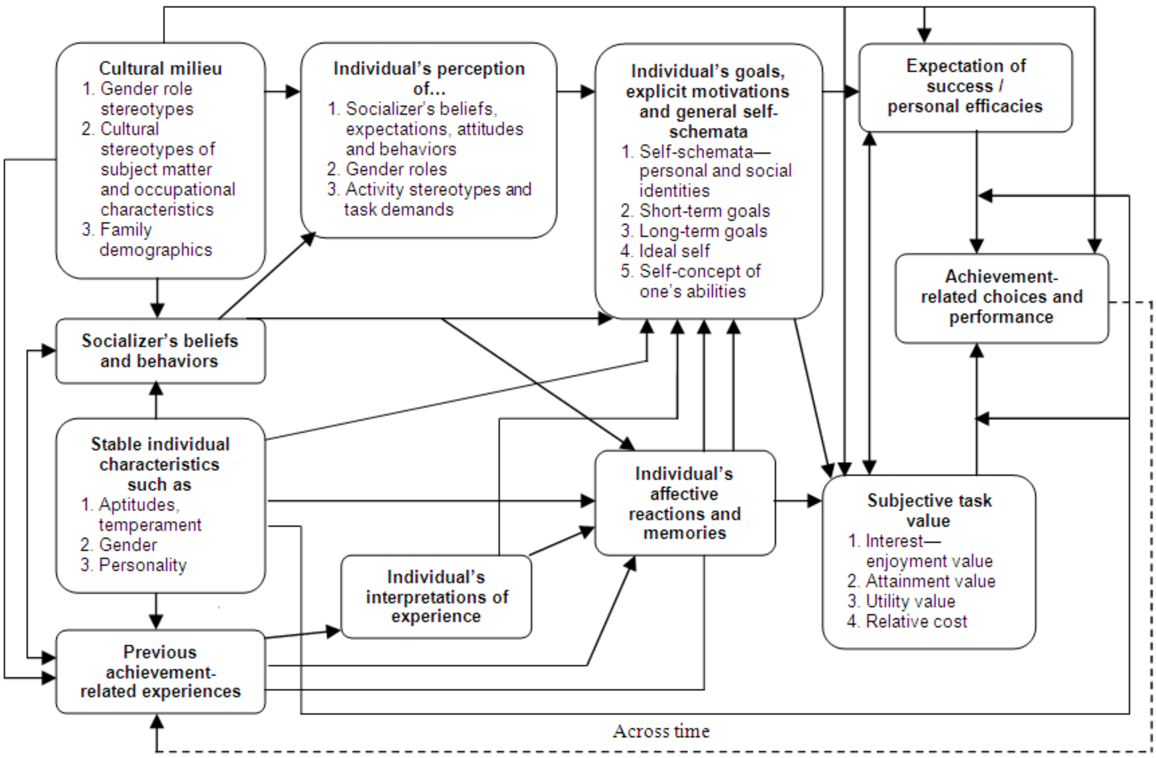

Figure 1. 2010 Eccles et al. Model of achievement-related choices (Eccles, 2011, p. 196).

Figure 1 shows the 2010 version of the EVM which Eccles (2011) used for discussing gendered educational and occupational choices. The subjective task value (STV) component of the 2010 EVM has "relative cost" as an additional STV which explores the cost of participating in a task or activity, or the negative experiences associated with pursuing a particular task. Cost counts as another probable factor for many individuals' choices of particular educational and vocational pathways. Most importantly, the 2010 EVM highlights how the potential impact of previous achievement-related experiences correlate with achievement-related choices and performance *across time*, and vice versa; this influence of the time factor was not highlighted in the 1983 version (see Eccles, 1994).

Individuals' expectancy for success and the value they place on subjective tasks within a particular field of study or work are affected by their specific beliefs and own interpretations of ability and performance in previous related tasks (Lupart et al., 2004). Motivational factors are also important in influencing individuals' subsequent decisions and choices in particular subject enrolments and work roles. Educational, vocational and other achievement-related choices are most directly related to: a) individuals' expectations for success, and b) the value that individuals attach to the options available to them (Eccles, 2005b). The EVM suggests that expectation of success is directly influenced by individuals' beliefs about how well they can perform the task and how they value the task before they participate in particular achievement-related tasks.

Three features of the EVM are particularly useful for understanding gender differences in educational and vocational choices (Eccles, 1994, 2005a, 2005b, 2011). The first feature focuses on achievement-related behaviours involving “choice”, and why females and males make the conscious and non-conscious choices they do (Eccles, 2005b). Both conscious and non-conscious choices made by individuals lead to marked differences between groups, even if the outcomes are strongly influenced by socialisation pressures or cultural norms. The second feature of the EVM highlights that due to individuals’ lack of awareness, knowledge or gender schemas they may not always be able to actively or consciously consider the full range of available options to make informed choices. Eccles (2011) stresses that gender roles can affect an individual’s perceptions of available educational and vocational options as well as non-active and non-conscious selections of options, such as selecting tertiary courses based on inaccurate or insufficient information, or not selecting a wider range of options due to their incompatibility with the individual’s own gender/social roles. The third feature of EVM is the explicit assumption that achievement-related decisions are made from the context of a complex social reality that presents each individual with a wide variety of choices, each of which has long-range and immediate consequences. Decisions and choices are often made between two or more options which have both positive and negative components. For example, a girl may wish to take advanced mathematics but may find that this conflicts with her other favourite subject choices, which means she may not end up studying advanced mathematics as a result. The EVM provides an insight into why capable females do not always select high-status achievement options, as they are more likely to choose tasks which have relatively higher personal values.

In summary, achievement-related educational and vocational choices made consciously or non-consciously by individuals are guided by: a) expectations for success on the various options, as well as one’s sense of competence for various tasks; b) the relation of the options to one’s short and long range goals, core personal and social identities, and basic psychological needs; c) the individual's culturally based role schemas, such as those linked to gender, social class, religious group and ethnic group, and d) the potential cost of investing time in one activity rather than another (Eccles, 2005a, 2005b, 2011). These variables are also influenced by individuals' experiences, cultural norms, behaviours, goals and peers.

2.1.3 Using EVM in empirical studies

The construct of the EVM has been used in a number of longitudinal school-based studies (see Anderson, 2000; Barnes, McInerney, & Marsh, 2005; Eccles, 1994; Lupart et al., 2004; Vickers & Ha, 2007; Zarrett & Malanchuk, 2005), as well as in a number of other empirical studies for range of research purposes and outcomes. One of the earlier adoptions of the EVM for research was Eccles' (1985) earlier study on students' mathematics enrolment decisions in the context of a complex social environment guided by achievement and competency needs, perceptions of sex roles and the subjective values the students attached to mathematics due to past performances in maths. Eccles' (1994) study used the original EVM to examine adolescent high school students' gendered differences in educational and vocational choices. Results indicated that gender role socialisation led females and males to have different core values, as females placed more value than males on making sacrifices for the family in contrast to males who valued fame, income and prestige more. Gender role socialisation also led females and males to place different values on various long-range goals and activities, which can conflict with traditional values assigned to genders. Individuals' gender roles influenced their self-perceptions, expectations for success and values attached to different educational and vocational options due to the influence from socialisers (particularly parents, friends, and teachers) regarding different subjects and occupational opportunities.

In addition to Eccles' studies, Anderson's (2000) study examined how the factor of relative cost (one of the STVs) in the EVM affected a group of graduate students' goals in attending a national conference and their expectations for success and value placed on the conference. Results showed that females and males perceived psychological costs significantly differently, whereas both sexes viewed economic costs similarly. Nevertheless, cost was a significant decision-making factor in participants' attendances in the conference. Lupart et al. (2004) adopted Eccles' original EVM to explore Canadian high schools' perceptions of academic achievement, interest, values and future life role choices by gender and age. The central objective of Lupart et al.'s (2004) study was to utilise the EVM to examine the differences in the educational and vocational preferences between males and females, and to determine whether these differences were affected by institutional, psychological and sociological factors. Results revealed gender-specific preferences for academic courses with males scoring higher for mathematics and science and females scoring higher for English and Language Arts.

While the studies discussed above adopted the original EVM to conduct research, some researchers have adapted or varied the EVM to accommodate their own research focus, particularly for understanding the gendered differences in educational choices in studying particular majors or courses at the secondary or tertiary levels (see Barnes et al., 2005; Eccles, 1985, 1994, 2005a; Lupart et al., 2004). Barnes et al.'s (2005) study of sex differences in science course enrolment adopted a modified version of the original EVM to construct a "Science Enrolment Model" (SEM) to investigate science enrolment intentions at high school. The SEM assumes both "interest value" and "self-concept performance expectations" can influence individuals' enrolment intentions in biology, chemistry and physics. A total of 450 Year 10 students responded to the questionnaire based on the SEM regarding the likelihood of their enrolment in each of the science subjects the following year. Results indicated that "career value" was the largest contributing factor in students' enrolment in the physical sciences and the second largest contributor in biology enrolment. Results suggest that sex differences in elective science enrolment could be narrowed by taking into consideration student interests in prospective tertiary courses and careers.

Another example highlighting the value of adopting the EVM for examining gendered participation in educational choices is evident in Guillet, Sarrazin, Fontayne and Brustad's (2006) study, which examined participation attrition by females in the male sport of handball. Similar to Barnes et al.'s (2005) study, Guillet et al.'s (2006) study constructed a modified version of the original EVM, resulting in a series of tested models (STM) to examine reasons for females' intention to discontinue handball, and also to explore the attributes of masculinity and femininity often associated with sports, identifying which created conflicts between females' own gender roles and those associated with athletes in male-oriented sports. Using STM as a guide, questionnaires were constructed and were administered to 333 female handball team players between ages 13 and 15 years. Results revealed that the female players who continued their handball participation the following season displayed more masculine traits than those who discontinued, which suggests that female attrition in a male sport such as handball is linked to the perception of those female players who discontinued that they had fewer masculine traits. Gender role orientation is linked to the intention to discontinue sport participation indirectly, as mediated by an individual's perceived competence and the value they assign to an activity.

Eccles' (2005a) research on gender differences in educational and vocational choices found that females were more likely to pursue work which assisted others and fitted well with their own family roles, while males were more likely to choose occupations with high income and status. Machina and Gokhale's (2010) study also suggest that the students' subjective interest in a subject is important in identifying their potential course and major choices in the field of IT. Results indicated that youth who considered IT careers were more likely to be in pursuit of a soft IT profession, such as clerical work and word processing. Moreover, very few females considered careers in the hard sciences, and instead planned to attain high levels of education for use in other areas. In contrast, males regarded IT highly as a prosperous career and thus were more likely than females to seek occupations in the field. Similarly Lupart et al. (2004) found that females who did not consider occupations in IT were the ones who perceived themselves as less capable than males in advanced computer skills. Females in Lupart et al.'s (2004) study also reported a feeling of exclusion, due to the fact that materials used for the teaching and learning of computer programs catered mainly for male interests.

In this present study the use of the EVM in two contexts facilitated the identification of differences along cultural lines in how subsequent participation and non-participation in undergraduate CS courses was influenced by the factors of stereotyping, perceptions and parental influences, as well as previous achievement-related experiences in IT and subjective task values attached to various tasks. Hyde and Kling (2001) also stated that the EVM is a model designed specifically to address gender differences in educational or occupational choices. The choice to take on an achievement-related task is the result of an individual's expectations for success at the task and the extent to which the individual values the task. An individual's expectation for success at a task is closely related to his or her task self-confidence, and the STVs he or she attaches to particular tasks or activities. However, an individual must value a task to take it; simply anticipating success at it is not a sufficient motive. In general, task self-confidence and subjective task values are powerfully influenced by gender socialisation processes.

This study uses the range of social, psychological and motivational factors proposed by the EVM which may have accounted for the course enrolment decisions by males and females in CS in Australian and Taiwanese tertiary institutions. The research identifies particularly the key mediating factors, and also the important mediating roles of the STVs for CS course choices by Australian and Taiwanese females in both contexts. The STV component of the EVM is presented in the following section.

2.1.4 Subjective task value (STV) component of the EVM

Eccles (2005b) states that the subjective task value (STV) component of the EVM is closely linked to self-determination theory and goal theory, and that intrinsic motivation influences individuals to participate in activities for their own benefit and out of their own interest; when extrinsic motivations are in place, individuals often do activities for reasons such as for receiving awards. Eccles (2005b) also explains that a basic need for interpersonal relatedness is the reason why individuals transform external regulation into internal regulation through the process of internalisation. Most importantly, it is the role of cost that determines the STV for tasks or activities. Goal theory on the other hand focuses on mastery or task-involved goals and performance/ego-involved goals (Eccles, 2005b). Individuals with task-involved goals in mind concentrate on mastering tasks and increasing competence. Ego-involved oriented individuals focus on favourable evaluations of their competence and on minimising negative evaluations. Expectations for success, confidence in one's ability to succeed and personal efficacy are important mediators of behavioural choices (Eccles, 2005b, 2011).

Eccles' (1994) study of high school seniors found that individuals' hierarchies of values determined their subsequent achievement choices such as course enrolment. It was found that students valuing helping others were more likely to aspire to be choosing courses which would enable them to pursue professions to help others in the future. On the other hand, cultures may differ in the extent to which individuals have "choice" over achievement-related behaviours and related educational activities. For instance, some cultures place less emphasis on individual choice by forcing individuals to pursue occupations deemed appropriate, as determined by their communities (Eccles, 2005b). The effect of culture can force individuals to assign stronger attainment values to behaviours and activities which are consistent with the agreed norms of particular cultures. The effect of culture on the way individuals attach STVs to certain subject matters, activities or tasks can in turn restrict the range of options available to those individuals, leaving them with limited achievement-related choices. However, individuals' non-traditional and non-normative behavioural choices will be greeted with varying degrees of tolerance and or encouraged within their cultures. Gender differences in STVs attached to achievement-related options within certain cultures would vary in the educational and occupational choices, as in some cultures males and females may value mathematics as important for pursuing ideal courses and future careers, while in other cultures females may value humanities more, and so forth.

Eccles' (1994) study found gender differences in expectations for success and confidence in mathematics, athletics and English among high school students: senior high school females had less confidence in the science related professions, whereas males had less confidence in the health related professions. The STV component of the EVM plays an interesting role in shaping individuals' achievement-related decisions about activity choice, participation, and degree of enjoyment (Eccles, 2005b). STVs can predict the decisions made by individuals in educational and occupational choices, based on the value that individuals attach to various options and the expectations of their gender schemata. Eccles (2005b) states task value is a quality of the task which contributes to increasing or decreasing the probability that an individual will select it. She notes that there are four STVs, namely, attainment value, interest—enjoyment value, utility value and relative cost. Attainment value is the link between the task and one's sense of self and identity interest—enjoyment value is the enjoyment one gets from engaging in the task or activity, while utility value describes the instrumental value of the task or activity for helping to fulfil another short or long range goal, and relative cost can be defined in terms of either what may be given up by making a specific choice or the negative experiences associated with a particular choice. It is therefore important to understand the roles of the four STVs, which are presented in the following sections.

2.1.4.1 Attainment value

Attainment value refers to the personal importance individuals attach to doing well on or participating in a given task which fulfils their needs and values (Eccles, 2005b). Tasks are perceived important for individuals when they provide opportunities to express or confirm their sense of self. Attainment values therefore link motivation and engagement to the extent tasks and activities fulfil the human needs of autonomy and competence. For example, if individuals have had success in particular tasks in the past, they may possess competencies and a good feeling when re-engaging with similar tasks. In contrast, when individuals have failed to achieve success in particular tasks, they are likely to attach a lower attainment value to such tasks due to a feeling of incompetence. On the whole, Eccles (2005b, 2011) believes that the attainment value of tasks is influenced by the extent to which these tasks are perceived as being able to fulfil individual needs and personal values. The following principles apply in the ways attainment values are determined: a) individuals identify with characteristics central to their image; b) different tasks provide different confirmations; c) individuals place more value on tasks which confirm self-images or long-term goals; and d) individuals are likely to select tasks with high STV. Attainment value will also be examined in this study to identify to what degree the personal importance individuals attach to IT (and/or CS) related learning affected females' subsequent participation and non-participation in CS courses in both contexts.

2.1.4.2 Interest—enjoyment value

Eccles (2005b) defines interest—enjoyment value as "either the enjoyment one gains from doing the task or the anticipated enjoyment one expects to experience while doing the task" (p. 111). Interest—enjoyment value also refers to the immediate subjective experiences which occur when people are engaged in the activity, which are characterised by: a) holistic feelings of being immersed in an activity; b) the merging of action and awareness; c) focus on one particular field; d) limited self-consciousness; and e) feeling in control of actions and the environment (Eccles, 2005b).

Eccles (2005b) further explains that there are variations of interest—enjoyment value. Individual interest is the feeling-related interest which refers to the feelings associated with an object or an activity, while value-related interest refers to the attribution of personal importance or significance to the object. Both interest aspects relate directly to the object. Learning interest refers to the "desire to learn" which comprises: "a) preference for hard or challenging tasks; b) learning is driven by curiosity or interest; and c) striving for competence or mastery" (Eccles, 2005b, p. 112). These aspects of desire to learn are highly correlated with one and another, and when properly facilitated can produce positive emotional experience that results in high academic achievement. Situational interest, in contrast, is strongly linked to individual interest, except it is produced due to personal relevance, familiarity and novelty, activity level and comprehensibility (Eccles, 2005b). In this study the interest—enjoyment value is explored in terms of participants' individual interest in the IT subjects while at school, as well as learning interest and situational interest in IT/CS related learning which led to their pursuit or non-pursuit of CS courses.

2.1.4.3 Utility value

Utility value refers to the usefulness of a task in fulfilling one's future plans (Eccles, 2005b), such as taking a programming class to fulfil the requirements of an IT course at university. It also relates to an individual's personal goals and sense of self. Once an individual's short-term and long-term goals become integral to his or her needs and identity, the tasks fulfilling these goals then have both utility and attainment values. An example of the importance of utility value was evident in Eccles' (1994) study of high school students, which found that girls placed a stronger utility value than boys on making occupational sacrifices for their families, which suggests females' preferences for jobs with fewer demands which could topple the balance of work and family. The role of utility value is examined in this study by exploring how individuals perceive CS related learning (e.g., studying CS courses or majors) as useful for achieving their future goals and/or career aspirations, which may have resulted in their choices of CS courses.

2.1.4.4 Relative cost

The relative cost value of a task depends on a set of beliefs which can be characterised as the cost of participating in the activity. According to Eccles (2005b), the value of a task should also take into account of a set of beliefs that represent the cost of participating in the activity. Relative cost is influenced by a range of factors, including anxiety, fear of failure, and fears related to the social consequences of success such as peer rejection; relative cost can also be understood as the loss of time and energy for pursuing other activities. Relative cost simply refers to what individuals may need to give up in order to participate in particular tasks or activities, and the effort required to complete the tasks. Often individuals' choices are influenced by both positive and negative characteristics. In this study the role of relative cost is examined by referring to individuals' past experiences in IT-related learning at school, and the cost of participation which they associate with CS course pursuits.

In Eccles' (2004; 2005a) studies, students' choices of tertiary majors differed by gender, as women were found to possess better interpersonal skills and were more likely to pursue majors in fields other than maths or sciences, whilst men were more likely to major in math and science. The gendered characteristics suggest that differences in gendered beliefs about what individuals are good at, such as possessing good people skills, are also associated with a higher likelihood of females pursuing the social sciences and humanities, as they are able to utilise the skills they have particularly when anticipating a higher cost of participating in unknown or unfamiliar fields which are male dominated.

2.2 Conclusion

In this chapter the characteristics of the EVM are presented, as well as an overview of a number of empirical studies which adopted the EVM as the basis for their research, or modified the original EVM to suit their research purposes. The discussion of the components of the EVM as well as the studies which utilised the EVM further demonstrate the suitability of the EVM for examining gender differences in educational choices. Gender is socially constructed by cultural and historical processes and acquired by females and males through socialisation in the family, education and other agencies (van Zoonen, 1992). The EVM therefore serves as an appropriate model for this study as it explores the effect of the socialisation of gender roles, as well as the extent to which individuals' educational experiences and the values individuals assign to particular subject matters or tasks influence particular (possibly gendered) choices to pursue undergraduate CS or NCS courses.

Eccles' (2005b, 2011) discussions of the mediating roles of the STV component of the EVM further highlight the facilitating roles of the four different types of values individuals consciously or non-consciously attach to various subject matters, tasks or activities, which enable them to make particular educational and occupational decisions. The STVs also provide other ways of exploring how certain course choices result from the value of a "task" an individual perceives as interesting or enjoyable or important for short-term or long-term goals, as well as the usefulness or the cost of participation in such a course. They also help reveal the differences in the hierarchy of the values which males and females assign to the tasks to make particular behavioural and achievement-related choices in some fields of study but not in others.

This study examines the effect of the STVs individuals attached to particular studies or tasks which aided or deterred them from participating or not participating in undergraduate CS courses by gender. Factors such as previous achievement-related experiences, gender roles, expectations of success and STVs attached to IT-related subjects or activities are explored for the extent of their influence in participation or non-participation in CS, and to determine whether the factors and their influence are similar or different for males and females from two different educational contexts. A comparison chapter of factors accounting for participation in CS or NCS by educational context is also presented in Chapter 7 of the thesis.

The next chapter consists of literature with regard to females' participation in IT in general and in CS, and is framed in relation to the EVM in further exploring the influences of self efficacies, previous educational experiences, stereotypical images of IT (or CS) courses, socialisers and career knowledge on course pursuits by gender in both educational contexts.

Chapter 3. Literature Review

Over the past few decades the question regarding gender disparity in Information Technology (IT) remains: Why are women still so underrepresented in IT related studies and professions? Machina and Gokhale (2010) state that the pattern of this on-going female underrepresentation is largely due to the unequal opportunities within social structures which discourage females from participating in IT. The relative female underrepresentation in IT also highlights a potential lack of female perspectives and understanding of females' needs in the field of IT, and the likelihood it will remain male-oriented unless this changes.

This chapter draws on the previous chapter's discussion of the uses of the EVM to explore a range of key factors found in the literature to have contributed toward individuals' pursuit of IT (or CS) studies at the secondary and tertiary levels. This study explores factors affecting the participation and non-participation of females in IT and CS studies, examining the factors of self-efficacy beliefs, previous educational experiences, stereotypical perceptions of IT (or CS), socialisers, and career knowledge and aspirations and seeing how they influence individuals' subsequent course enrolment in undergraduate CS and NCS courses by gender across two different national educational contexts.

3.1 Females in IT and CS fields in general

The participation by females in IT and CS fields in general has always been lower than that of their male counterparts. One of the reasons accounting for this trend is argued by Messersmith et al. (2008) as possibly due to females' lack of computer access from an early age, which could result in a lower likelihood of them entering IT-related careers later. Her study also found 38% of the participants reported the feeling of intimidation of being in male-oriented classes or careers. The common reasons for females not to enter IT studies include the construction and delivery of the IT curriculum which did not appeal to females (Lewis et al., 2007), stereotypical images of the IT industry which did not create interest in females in wanting to pursue IT careers (Lewis et al., 2007; Newmarch et al., 2000), gender stereotyping about those who study and work in IT (Newmarch et al., 2000), and an inadequate knowledge of IT studies and professions (Redmond, 2006). If females can be shown how technology can make a difference in resolving critical issues and real-life problems, IT-related studies and careers would be more appealing to females' interests. This would be more effective in encouraging females' engagement than merely appealing to the notion that computers can be used for problem-solving (Murphy, 2006).

Leech (2007) also states that females who perceive IT in stereotypical manners, such as by associating IT with computer hardware and perceiving IT-related careers as involving the same routine tasks which they have to complete at school, are further discouraged from choosing IT-related courses such as CS at the tertiary level. While Moorman and Johnson (2003) found that both male and female students perceived CS as a primarily "male" field, Papastergiou's (2008) study revealed that high school females identified CS with hardware, algorithms and programming as well as perceiving it as difficult and requiring long hours on the computer. In the same study, high school males perceived CS as more human and application-oriented. These gendered differences in perceptions of CS may affect the subsequent pursuit of CS at the undergraduate level. Indeed, the inadequate knowledge of IT-related studies and professions discouraged many from studying IT-related courses (such as CS) at the undergraduate level (Craig, 2005). This highlights the importance of institutions and schools' provision of adequate information about the wider range of IT-related studies as well as the career prospects to students while they are at school, to encourage their subsequent participation in IT studies at the tertiary level.

It is important to note that all of the studies discussed thus far have been conducted in educational settings in predominantly Anglo-Saxon contexts with few or no comparable studies in English which report on the participation in IT studies in other national contexts, where attitudes and factors affecting females' decisions may conceivably differ from those that prevail in the contexts that have been studied.

The following sections present a range of key factors which in past research in these settings have accounted for females' participation and non-participation in IT (or CS) fields of studies at both the secondary and tertiary levels. Using EVM as the theoretical framework in this study, five main important factors are identified in the literature as influential in individuals' course participation by gender. The five key factors are self efficacies/expectation of success (i.e., beliefs in achieving success or the perceived skills required to achieve success in particular studies or activities), previous educational experiences (e.g., achievements or being unsuccessful in IT-related learning), stereotypes associated with IT (or CS) (e.g., images of IT and perceptions of IT studies and careers), the influence of socialisers' behaviours, attitudes and expectations (e.g., those of parents, teachers, role models), and individuals' course and/or career knowledge and aspirations which motivated or deterred individuals from pursuing IT (or CS) related courses at the undergraduate level.

3.1.1 Self-efficacy

Individuals' self-efficacy beliefs in science and mathematics-related fields can become more pessimistic as they progress along their academic paths (Larose et al., 2006). Bandura (1997) states that self-efficacy beliefs act as predictors of individual academic performances, which differ by gender: males often overestimate their abilities and when things do not turn out as anticipated, often blaming external factors. Females, in contrast, tend to underestimate their abilities and blame themselves first before external factors. If females believed they were not capable or did not have the skills to do well in IT, they would be less inclined to pursue IT related courses. Machina and Gokhale (2010) believe that the lack of female participation in the science and technology fields is not entirely due to the lack of self-efficacy, yet females' self-efficacy beliefs cannot be positively reinforced when subjected to gender-stereotyped treatments from parents and teachers. Negative expectations about their own abilities would in turn affect females' confidence in doing well in IT-related studies and related professions. Females were found to have a lower level of confidence in their own abilities to do IT prior to enrolling in university courses (Lewis et al., 2007). Stronger self-efficacy beliefs regarding IT (or CS) related learning during secondary schools are therefore encouraging factors in participation in IT-related courses such as CS.

The skills perceived to be important or essential for studying CS by individuals could often predict their participation in CS or NCS courses. Fan and Li (2002a) found that students' good performance in maths during the CEE and their belief that they possessed good maths skills were the two main reasons why they initially enrolled in CS courses. In addition to maths ability, Frieze et al. (2006) and Fan and Li (2002b) also found that females' liking for and perceived abilities in programming were related to their confidence levels.

In contrast, von Hellens, Nielsen and Beekhuyzen's (2003) study found that while females did not perceive themselves as possessing a high level of technical competence, they possessed a high level of confidence in their ability to succeed and saw no difference between themselves and male students. This again highlights the importance of confidence in studying IT, and the fact that this and the perceptions of the skills possessed for studying IT are encouraging factors for IT/CS participation. However, even more influential for course participation are previous successful experiences in the field. Previous experiences and achievements in maths and programming, as well as individuals' beliefs about their maths and programming abilities can affect subsequent participation in CS courses for all individuals, especially females (von Hellens et al., 2003).

Self-efficacy is important in individuals' educational choices as self-concepts of strong abilities and skills in IT often result in choices made in the field. Using the EVM and the literature, this study examines how individuals' self efficacy beliefs in IT and maths-related learning while at school encouraged or deterred them from studying CS courses, and whether self-efficacy beliefs in IT or maths varied greatly in males and female in both educational contexts.

3.1.2 Educational experiences

Single-sex school settings and the IT learning environments can form part of individuals' educational experiences prior to university which affect subsequent course choices. Several studies revealed that single-sex classes provided less stressful and more enjoyable learning environments for females in IT (Craig, 2005; Leech, 2007; Papastergiou, 2008; Redmond, 2006). Females who studied in single-sex schools had more positive attitudes towards IT and higher participation rates in IT-related activities due to the frequent uses of computer applications and better access to teachers (Scott, 1996). Craig's (2005) study revealed that the characteristics of single-sex learning settings include a greater access to computers, more female role models, and school curriculum which catered for females' learning needs, and that these characteristics encouraged higher proportions of female undergraduates to study IT-related courses. Similarly, single-sex IT classes which incorporated technical, communication and teamwork skills were found to make IT-related studies and careers more appealing to females (Craig, 2005; Leech, 2007; Redmond, 2006). Single-sex settings provide opportunities for females to learn IT in a more comfortable environment which could otherwise be dominated by their male counterparts. Gurer and Camp (2002) stated that male domination in IT classes can be unappealing to females and has caused both genders to perceive IT as a male domain.

The perception of IT as a male domain has long been present. Wajcman (2005) argues that the very technologies around us are socially shaped as masculine because over time the culture of masculinity has been coterminous with the culture of technology. The notion of IT as a male domain was also examined by Wasburn and Miller (2004), who found males were less inclined to work with females, females were assigned gender specific jobs, and that females were uncomfortable about males' attitudes. Gurer and Camp (2002) also found that females often felt isolated in IT learning environments, while Valian (1999) stated that females as the minority in the male-dominated IT field are likely to be judged for being different rather than being judged on their actual performances. The participation and gaining of achievements of females in a male-dominated field such as IT not only illustrate females' capabilities and potential success in pursing traditionally male dominated fields of study, but also challenge the gender stereotype that females cannot achieve in male fields. Miliszewska's (2006) study concluded that offering a more "female friendly" course content, building females' confidence in IT learning and providing better support would retain females already studying in the CS field. On the other hand the study noted that issues such as difficulty in understanding course material, concerns about job scarcity in the field, and constantly needing to keep up with new technologies made studying CS a difficult decision for females.

In contrast to single-sex school settings, the secondary school setting is often a complex environment where the quality of IT-related teaching and learning has varied for females. Female participants from Messersmith et al.'s (2008) study reported that their positive secondary IT experiences such as receiving good grades and possessing a high competence at completing computer tasks were the two main reasons why they made IT-related career choices. Experiences which accounted for the non-participation in—or at least the dropping out from—IT studies included difficult courses, falling behind on coursework, underprepared teachers, a lack of up-to-date curriculum content and the majority of the IT teaching staff being males (Clayton, 2006). Of particular concern was the underprepared teachers who have not been trained to teach IT as their first teaching preferences, and are often teaching IT in response to school needs (Clayton, 2004). In the same study Clayton argued that students taught by underprepared IT teachers with a disparate range of IT skills are more likely to engage with a disorganised and irrelevant curriculum, and are more likely to find IT studies uninteresting and not useful for future study and career goals.

Previous experience in the field was an underlying factor which can influence students' choice of an undergraduate CS major (McInerney et al., 2006). Individuals' previous successful experiences in maths and/or programming, and having an interest and a proficiency in programming, were their primary motivations for choosing CS (Margolis & Fisher, 2002). In contrast, experiences which discouraged females from pursuing undergraduate IT studies included narrow and technically posed programming classes (Clayton, 2005), and fewer programming experiences being available to females than to their male counterparts (Lewis et al., 2007). CS coursework experiences also varied by gender, as a lower proportion of females than males revealed they felt “confident about asking the lecturer for help in class”, while a higher proportion of females than males reported a heavier study load, too little time to understand work and feeling stressed with their coursework (Lewis, McKay, & Lang, 2006, pp. 5-6).

Both the literature and the EVM stated that previous achievement-related experiences affect individuals’ interpretations of experiences, subsequent study or career goals and the STVs attached to IT/CS, which ultimately results in certain educational choices being made. In line with the literature and the EVM, secondary IT- and maths-related learning experiences, the influence of socialisers (e.g., IT teachers) as well as the perceptions of the skills student participants believed they had (or did not have) to pursue CS courses, are examined in the present study for the extent of their influences in males’ and females’ pursuits and non-pursuits of CS courses in both educational contexts.

3.1.3 Stereotypical images associated with IT

Individuals’ stereotypical notions or images of IT (or CS) related courses and careers could be due to the sex role typing that occurs in all human societies, which causes males and females to conduct different tasks and be assigned different rights and privileges (Brown, Garavalia, Fritts, & Olson, 2006). Lemaku (1979) also states that cultural sex role demands influence females’ choice of non-traditional and traditional careers. Gender roles develop early in life and are a primary reason for individuals’ rejections of certain occupations (Trusty, Robinson, Plata, & Ng, 2000). Cohoon (2002) argued that as long as society portrays an image of computing as a male activity, fewer females will be likely to consider CS unless they are encouraged to do so.

In addition to sex role typing, the image of IT professionals working long hours in isolation is clearly not always a faithful reflection of reality, yet this stereotype is still prevalent (Thomas & Allen, 2006). Such stereotyped images and perceptions of IT may prevent many young females from entering the IT field. Images prevail of IT professionals as males who excel in IT and who are “geeks” or “nerds” who possess a lack of social skills (Stockdale & Stoney, 2007). Such adverse stereotypes associated with IT have discouraged many secondary students from entering IT and CS related fields (Jepson & Perl, 2002). Timms, Courtney and Anderson’s (2006) study found that 91% of female participants (Year 11 and 12) were “non-takers” of IT subjects and perceived IT subjects as “boring” and “irrelevant”, and as not providing adequate knowledge to study IT beyond secondary school. Secondary students may also not be aware that IT-related studies require a combination of both the technical skills and good interpersonal and team-working skills. Timms et al.’s (2006) survey found that students’ previous IT experiences such as dealing with frequent hardware and software problems, the unavailability of IT subjects and the experience of subjects taught by under-prepared teachers all contributed towards pessimistic notions about further pursuing IT-related courses in higher education (Timms et al., 2006).

Individuals’, and particularly females’ previous IT-related learning at school can result in stereotyping regarding IT course pursuits, and Clayton (2009) identified that gender stereotypes influenced individuals’ perceptions of the range of career alternatives, subjective task values, and expectations of success, and subsequently the selection of long-term goals and careers. Moreover, Clayton found that the undergraduate courses that students chose were most directly related to subsequent career choices. Barker and Aspray (2006) also state that gender roles of males and females with technology affect females' pursuits of IT studies.

Both the literature and the EVM have identified stereotypes regarding subject matter (e.g., in IT/CS courses) as affecting females' course pursuits in IT related fields. In this study, the two aspects of the EVM, "cultural stereotypes of subject matter and occupational characteristics" and an "individual's perception of activity stereotypes and task demands" (Eccles, 2011, p. 196) are used to examine the extent to which individuals' stereotyping of CS courses influences their CS course choices by gender in both educational contexts.

3.1.4 Influences of socialisers

Socialisers including parents, teachers and peers are stated by Eccles (2011) as playing an important role in individuals' educational and vocational choices. Individuals' perceptions of socialisers' beliefs, attitudes and behaviours can also affect their short and long term goals, self-concepts of abilities and personal and social identities. Jacobs and Eccles (2000) suggest that parents influence children's value of tasks in four main ways, by: 1) providing a socio-emotional climate; 2) providing specific valued experiences; 3) involving their children in valued activities; and 4) transmitting perceptions of abilities and expectations for performance. Children's early awareness of self-abilities and perceptions of tasks and their value are influenced by parents. When parents provide a safe and inviting environment and are able to demonstrate the value of skills and activities related to IT, then children are more likely to perceive studies in the IT field as relevant and important.

Similarly, Margolis and Fisher (2002) stated that parental support plays a key role in supporting female students' interest in IT subjects and careers. Mothers were also found to be the most influential persons in students' career decisions (Clayton, 2006). Similarly, Messersmith's (2008) study revealed that individuals' memories of parents working on computers and the guidance parents gave them on computer uses encouraged their early participation in uses of IT, stimulating their interest in IT and their desire to pursue IT as a career. Bandura (1997) believes that children are influenced by their parents to choose similar career paths as a way of imitating the work done by their fathers and mothers.

Other socialisers such as female role models in IT have been identified as important for encouraging females' participation in the field (Jepson & Perl, 2002; Stockdale & Stoney, 2007). Similarly, Wasburn and Miller (2004) highlighted the importance of female mentors as critical for female students' confidence and for providing them with appropriate support and guidance when required. Contributions from female teachers are required to address some of the persistent gender biases in IT, such as perceiving that educational and occupational opportunities in IT-related fields are only for males. Having more female socialisers would allow both male and female students to see and interact with female IT teachers or female professionals who can successfully perform IT-related tasks or apply IT-related skills in their roles. When children of both genders are exposed to computers and perform IT-related activities from as early as preschool, they are less likely to possess gender role stereotypes regarding IT as only for males (Gurer & Camp, 2002).

This study uses the EVM to further explore the influence of socialisers (e.g., teachers, parents and peers) in individuals' learning while at school, and to ascertain whether such influences contributed toward a liking or disliking for IT-related learning, and subsequent CS or NCS course pursuits by females in both educational contexts.

3.1.5 Career related knowledge, expectations and aspirations

Course and career related knowledge can affect individuals' eventual course pursuits at the tertiary level, as studies have found that those who had greater access to information related to IT studies during secondary school were more inclined to pursue IT related courses (Clayton, 2004, 2006). The lack of course information regarding tertiary education available to secondary students also meant they may not be aware of the fuller range of educational options available in IT-related fields. Also, students who possess a lack of understanding or inadequate knowledge about the range of occupation options associated with their tertiary courses are more likely to act upon outdated or incorrect IT subject information which in turn limits their course choices. Contrasting views regarding IT-professions by gender have been revealed: males perceived IT professions as more interesting, prestigious, creative and competitive, whereas females perceived IT careers as more difficult and programming oriented (Papastergiou, 2008). Students are the potential IT personnel of the future and if they are unable to make informed decisions regarding IT studies, the IT industry will lose a wealth of potential contributors.

Apart from a lack of course/career related knowledge, individuals' negative perceptions regarding IT-related careers (such as employment issues) do not attract or appeal to females to work in the industry. Young's (2003) study found that females' career ideals and aspirations valuing interesting work and working with people conflicted with their perceptions of IT careers, which seem highly technical and solitary. Similarly, Clayton's (2005) study revealed that interesting work, working with other people, earning a high salary, engaging in challenging work and creativity were the five most influential factors over students' careers choices, which may not be the characteristics highly associated with IT-related careers.

In contrast, females who perceive IT-related professions as solitary, lacking in interaction with people, and too competitive may be less likely to pursue IT-related studies at the tertiary level. The gendering of IT work, which requires females to "adapt" to a masculinised domain, and other discouraging factors for females in choosing IT related courses include: desire for a family-flexible job, long working hours, and a low interest—enjoyment value for physical sciences (Messersmith et al., 2008). The challenges of working in IT as reported by female IT professionals included long hours, pressure to meet deadlines, effects on social life, coping with family and work, as well as the difficulty in keeping up to date with new technologies, and these were seen as pressing factors which females consider prior to participating in IT-related studies at the tertiary level (Nielsen, von Hellens, & Beekhuyzen, 2004).

The extent of the course and career related knowledge that individuals possessed when choosing their undergraduate courses is explored in this study, to see if a good (or lack of) awareness of CS courses and associated career prospects may have encouraged or discouraged Australian and Taiwanese females from choosing CS courses.

3.2 Enhancing female participation in general IT and CS fields

Several initiatives can be implemented to address the issue of female underrepresentation in IT-related fields. However, initiatives implemented in schools aiming to encourage females to participate in IT often locate the problem in the females themselves, yet fail to address the processes by which males actively or sub-consciously exclude females from technology

(Wajcman, 2005). The need to reshape the IT field and the exclusionary culture may need further attention to attract more females to study in the field. A quick study of the Victorian syllabus found a strong focus on the teaching of technical skills with little emphasis on social and team activities which are also required in IT related careers, and these characteristics subconsciously exclude females (Thomas & Allen, 2006).

At the secondary level, IT curriculum needs to include more relevant learning material and more hands-on experiences for female students (Craig, 2005). Female students should also be equipped with knowledge regarding IT-related studies and professions, such as the possibilities of careers in fashion, medical research and games development roles (Carlson, 2006; Craig et al., 2008). Females are also more likely to consider studying IT related courses like CS at the tertiary level if they are equipped with positive IT experiences and more accurate perceptions of IT studies and careers from an early age (Redmond, 2006). Papastergiou (2008) suggests that female students could engage in collaborative projects aimed at the design and development of applications, to understand how these activities relate to people and to experience the collaborative efforts they entail and thus to develop an interest in CS activities, and consequently participate in CS courses at university.

Similarly, it is essential to consider all the possible factors in order to implement initiatives at the tertiary level to encourage more females to study IT-related courses such as CS. Improved classrooms with better resources, up to date curriculum and interesting activities can better cater for the different learning styles and needs of today’s youth. Such improvements can be facilitated by considering the social and cultural implications of gender in relation to the learning and uses of information technology. Addressing gender bias regarding IT-related studies and professions will appeal to females so they no longer perceive IT as a field appropriate for males only. This in turn will provide more educational and occupational opportunities for females who had not been able to consider this field of educational and vocational options available previously.

Examples of initiatives and programs to promote CS have been cited in the literature. They include “The Roadshow” (cited in Frieze, 2005) and “Females@SCS” (cited in Carlson, 2006). The Roadshow consists of a series of presentations by a group of female undergraduates and graduates from the School of Computer Science at Carnegie Mellon University who shared their experiences about studying in CS with secondary school students with the aim to encourage females’ interest in CS and to motivate them to study in the field (Frieze, 2005). The Roadshow presentations were aimed at challenging traditional stereotypes, providing role-models of females studying CS, as well as addressing stereotypical images of CS. Similarly, Females@SCS invited female speakers from the IT sector to serve as role models for female students studying IT-related studies at the tertiary level (Carlson, 2006). Females@SCS offered a mentor service which provided female students with support for coursework and the rigours of the CS courses. Tertiary courses need to be more accessible and interesting for both males and females, while at the same time it is important to retain females in the CS field, as the relative lack of female CS teachers may further reinforce students’ sex-stereotyped views of CS as male domains (Messersmith et al., 2008), and thus further reinforce the misconception that CS is only suitable for males.

3.3 Conclusion

Female underrepresentation in IT and CS fields in general has been an on-going trend for more than two decades. Studies from the literature highlight that factors such as self-efficacy beliefs, previous educational experiences, stereotyping, socialisers and course/career related knowledge in IT-related learning during secondary school are particularly influential in individuals', and particularly females' participation in IT-related courses such as CS. Using the EVM and the literature, self-efficacy beliefs in maths and IT-related learning, educational experiences (e.g., single-sex schooling, individuals' own IT-related learning achievements and the STVs attached to IT), stereotypical notions of IT-related studies and careers, the influence of socialisers, as well as career or course related knowledge are found as the main factors in individuals' achievement-related choices, either in the CS or NCS field.

This study explores into the complex range of factors involved during individuals' (particularly females') decision making processes regarding course participation in CS and NCS fields in the Australian and Taiwanese contexts. Using the EVM and the factors identified by studies in this chapter, this study uses survey and interview findings to determine which particular factors are the most influential in course participation by males and females in CS and NCS fields. Moreover, the study examines whether factors for CS and NCS participation differed by gender in each respective educational context (Australian and Taiwan), and if factors for female participation in CS differed by educational context.

By identifying the factors and the extent to which they influence females' participation and non-participation in CS courses from two educational contexts, a better understanding may be gained of the intricacies of factors, which may have different meanings or values for males and females, affecting decisions about whether to study or not to study CS. This, in conjunction with studying the differences in results between students educated under two different educational contexts can help in developing strategies to prevent the discouraging factors leading to non-participation in CS, and can help offer possible insights into dissolving the cycle of gender inequity in both educational contexts.

This chapter has presented a range of possible key factors which are mostly likely to influence individuals', particularly female undergraduates' participation in CS courses in general. The following chapter provides an account of the study design used to survey and interview undergraduates from the Australian and Taiwanese contexts, to identify the factors and how they influence individuals (particularly females) in making the CS or NCS course choices. Justification for the research design and sampling procedures employed, as well as the analysis procedures are outlined.

Chapter 4. Methodology

4.1 Introduction

Methodology examines critically the gaps in knowledge, listens to the “voices” of subjects, and reads into the adoption or rejection of existing knowledge (Clough & Nutbrown, 2002). A mixed methods approach is adopted by this study in an attempt to fill the gap in knowledge, as studies in the past have rarely compared participation by gender in CS courses in two distinctively different educational contexts. This study attempted to identify the key factors and how they influence undergraduates’ (particularly females’) participation and non-participation in CS courses in Australia and Taiwan.

To better understand the reasons accounting for the inequitable representation of females in tertiary CS courses in both educational contexts, perspectives from both males and females were obtained to avoid bias which may arise from females’ views alone. The findings of this study also add to existing knowledge which consists of mainly female perspectives within a homogenous context (e.g., Anglo Saxon educational context), by offering comparisons of findings by sex. This provided a better insight into why female underrepresentation is present in both educational contexts (e.g., similarities in factors), and what could have been the differences in factors which encouraged or discouraged Australian and Taiwanese females from pursuing CS courses. A greater understanding of the trend of gendered participation in CS is essential for breaking up the cycle of gender inequity in the field, to ensure females have more equitable access to educational and vocational options, choices and opportunities in CS in both contexts.

4.2 Research question

My aim in this study is to identify the key factors accounting for individuals’ and particularly females’ participation in CS and NCS courses at the undergraduate level in Australia and Taiwan. The literature has revealed an on-going female underrepresentation in CS at the tertiary level over the past decade. The use of Eccles et al. (2011) EVM was adopted to respond to the research question, “What are the factors, and how do they influence individuals’, particularly females’ participation and non-participation in CS courses in Australia and Taiwan?”, by closely examining the influences of social, cultural, educational, familial and peer factors over course participation. Moreover, by examining individuals’ course participation by Australian and Taiwanese educational contexts (not specifically outlined in the EVM), this study also sought to ascertain the role of “educational context” (or institutional factor) as another possible factor in individuals’ decisions to pursue CS or NCS courses at the undergraduate level. In particular, the research looked at the relationship between educational values and expectations held by individuals educated under the two different contexts, to identify similarities and differences in these. In order to examine the complexity of these factorial relationships, a two-phase approach (Phase 1: surveys; Phase 2: interviews) was chosen with the aim to provide more informed findings regarding course participation by individuals in both countries.

The following section outlines the research design of this study. A detailed break-down is presented of the use of mixed methods in this two-phase study to conduct research and to collect data.

4.3 Research design

Johnson and Christensen (2004) describe mixed methods as using the qualitative paradigm for one phase of a research study and the quantitative research paradigm for another phase of study. More specifically, Creswell and Plano Clark (2007) define mixed methods research as involving "philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of quantitative and qualitative data in a single study or series of studies" (p. 5). A mixed methods approach enables researcher to use a combination of quantitative and qualitative approaches, which can be conducted either concurrently or sequentially, to provide a better understanding of research problems than either approach alone. Johnson and Christensen (2004) also argue that a combination of two (or more) research methods such as in mixed methods addresses the weaknesses of using either method alone, while adding to the strengths of the collation of data. This study adopted a mixed methods approach by applying a quantitative approach in Phase 1 to identify trends and distinguish between significant and non-significant results through a statistical test such as chi-square to explore if there were differences by gender in survey responses. Phase 2 consisted of qualitative interviews which were conducted and analysed to further explain, add and triangulate the trends and significant/non-significant results identified in Phase 1. A mixed methods approach supported the thorough examination of the complexity and the interplay of factors accounting for individuals' participation and non-participation in CS in the two educational contexts.

The Explanatory Design is a two-phase mixed methods design, in which qualitative data explain or build upon initial quantitative results (Creswell & Plano Clark, 2007). Explanatory design procedures begin with the collection and analysis of quantitative data as the first phase (Phase 1), the results of which are followed up by the qualitative data collected and analysed in the second phase (Phase 2). The Explanatory Design has two variants: the Follow-up Explanatory Model and the Participant Selection Model (see Figure 2).

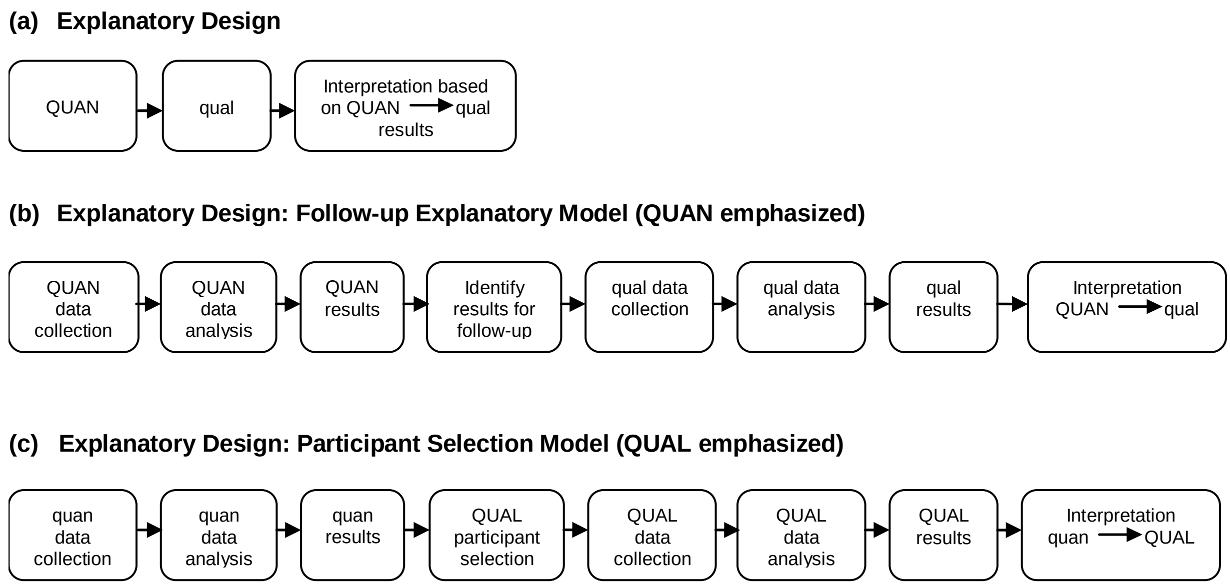

Figure 2. “The Explanatory Design” (Creswell & Plano Clark, 2007, p. 73)

Figure 2 shows a series of visual diagrams mapping the relationship between QUAN (quantitative) and QUAL (qualitative) components. The labels in upper case (i.e., QUAN, QUAL) indicate that weight or priority on quantitative or qualitative data are given priority over the types without capitalisation, namely, quan, or qual (Creswell, 2009; Creswell & Plano Clark, 2007; Teddlie & Tashakkori, 2009). The Follow-up Explanatory Model (see Figure 2b) can be used when a researcher needs qualitative data to explain or expand on quantitative results, to explain statistical differences among groups, individuals scores at extreme levels, or unexpected results; the emphasis is placed on quantitative aspects (Creswell & Plano Clark, 2007). The Participant Selection Model (see Figure 2c), in contrast, is used when a researcher needs quantitative information to identify and purposely select participants for a follow-up, in-depth qualitative study (Creswell & Plano Clark, 2007). This study adopted the Follow-up Explanatory Model (see Figure 2b).

Using the Follow-up Explanatory Model (see Figure 2b), this study commenced with a quantitative survey study to identify possible factors affecting the participation and non-participation in CS courses by gender in Australian and Taiwanese educational contexts. The results from the quantitative study in Phase 1 were then followed up with an in-depth qualitative study in Phase 2 to explain why these results occurred. This two-phase structure enabled one type of data to be collected at a time (1st phase: QUAN; 2nd phase: qual) in each educational context respectively. The research sites were an Australian tertiary institution based in Melbourne, as well as a top-ranking university in Taiwan. Both selected institutions provided undergraduate CS courses. Having two culturally different research sites used to account for educational participation by gender in different educational contexts, enabled a further interrogation of the factors and how they influence undergraduates', particularly females' participation and non-participation in CS courses in Australian and Taiwanese educational contexts.

The challenges of adopting a Follow-up Explanatory Model included its time-consuming nature (the collection of two different types of data in separate phases, as well as the time required to recruit participants), and the issues in deciding on the whether to include the same (or different) participants for both phases. However, this model is deemed appropriate for this study because it provided a more comprehensive insight into the factors accounting for the trend of gendered participation in CS courses in both contexts, and the extent to which the factors influenced females' course or non-course pursuits in CS.

The following section presents the quantitative approach used during Phase 1 of this study, and the statistical tests used to identify statistical differences by gender by group membership (CS and NCS) for the Australian and Taiwanese participants.

4.3.1 Phase 1: quantitative approach: surveys and chi-square tests

The purpose of using survey research in Phase 1 was to examine the range of social, psychological and motivational factors which influenced undergraduates' participation and non-participation in CS. The samples surveyed in Phase 1 were undergraduates who were studying Bachelor of Computer Science (CS) or a CS major (CS sample), and also undergraduates who were studying in disciplines other than CS (NCS sample), in Australia and Taiwan respectively. Surveys also enabled inferences to be drawn – via the defined samples (CS and NCS) – about the characteristics from the selected populations in Australia and Taiwan. Creswell (2009) stated that a survey design "provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population." (p. 145). Survey research allows a researcher to select a sample of respondents from a target population and administers a questionnaire to collect information on variables of interest.

The use of surveys as the data collection procedure for Phase 1 of this study was due to the economy of the design and rapid turnaround, since surveys could be administrated and data collected online, making data easily attainable (Best & Krueger, 2004). McMillan and Schumacher (2010) also advocated survey research in education for its versatility, efficiency, and generalisability. Credible information from a large population can be collected quickly and inexpensively. Moreover, small samples can be selected from larger populations in ways that permit generalisations to the population, concerning, for instance, a representative description of traits, beliefs, attitudes, and other characteristics of the population.

The surveys were cross-sectional, which means that the data were collected at one point in time (Creswell, 2009), prior to interviews being conducted in the subsequent phase (Phase 2). The use of a web-based survey data collection procedure enabled respondents to access the survey online. In this case, SurveyMonkey was used by this study for its ease of obtaining and generating survey data efficiently at any time from anywhere with internet access (De Vaus, 2002). This web-based tool provided a simple and straightforward data collection process, reducing time and cost because of its simple question construction and formatting capabilities, and its ability to gather quick responses as well as to follow-up and provide simple reporting of results. All that participants who used Survey Monkey had to do was to ensure that all relevant questions were answered before pressing the “submit” button.

Prior to participant selection, approval was obtained through the Ethics Committee at both institutions. In order to identify and select potential individuals in the populations, a letter was sent to the heads of IT faculties of the selected institutions in Australia and Taiwan. The letter to both institutions outlined the purpose of this study and requested permission to conduct research. An email was sent to Australian lecturers who were teaching core units of Computer Science, and another email was sent to Taiwanese lecturers who were teaching undergraduate CS programs in 2010. To further recruit participants, posters were posted on faculty and general noticeboards throughout the Australian and Taiwanese institutions. The poster contained a brief introduction of the nature of this research and tear-away strips outlining the full survey link for potential participants to access the site at their own convenience. Participants for Phase 1 from each institution voluntarily participated in the online survey, by first obtaining the survey link from the poster or by accessing the link forwarded by their lecturers. They were asked to read the explanatory statement placed at the beginning of the online survey before commencing the survey. Participants who were interested in participating in an interview (in Phase 2) regarding their participation in their respective CS and NCS courses indicated “Yes” and left their email addresses for the final question on the online survey. The following section outlines the sampling procedures involved in defining the participant groups for this study.

4.3.1.1 Sampling procedures

There are four participant groups in this study (see Table 7).

Table 7

Australian and Taiwanese Participant Groups

Group	Group membership
1	Australian CS undergraduates
2	Australian NCS undergraduates
3	Taiwanese CS undergraduates
4	Taiwanese NCS undergraduates

Participants included: students who study undergraduate CS (Group 1) and NCS courses (Group 2) in Australia, as well as students who study undergraduate CS (Group 3) and NCS courses (Group 4) in Taiwan. In addition to understanding the reasons for students’ CS participation, students who chose courses other than CS were also surveyed to see how their reasons for non-participation in CS varied from those of CS students. Male students’ opinions about the female representation in teaching and studying in IT-related fields (including CS) would also provide valuable male perspectives. Since past research mainly focused on gaining insights from females, this study attempted to incorporate both male and female perspectives from two different educational contexts to better understand the interplay of possible key factors and how they might influence course participation by gender in CS and NCS courses in Australia and Taiwan.

Completion of the online surveys administered and collected via SurveyMonkey was voluntary; 180 participants responded. This sampling size was deemed sufficient due to the small numbers of females studying CS at both the Australian (n=36) and Taiwanese (n=77) institutions at the time of data collection.

Phase 1 limited the survey sample to the selected Australian and Taiwanese tertiary institutions which offered undergraduate courses or a major in CS. Also, the targeted participants were students pursuing undergraduate courses, as undergraduates were deemed a potentially larger sample pool than postgraduates. The institutions sampled provided easy access to computer labs or public computers within faculties or libraries for potential participants when they were on campus and wished to participate in surveys. The format of the survey which was accessible over the web enabled participants to complete the survey when it was most convenient. Lastly, to reduce a potential confounding factor of different course content/criteria being studied by CS participants, invitations to participate were confined to students from a single tertiary institution in Australia and from one Taiwanese institution, whose CS curricula had been thoroughly examined for comparable content (see Chapter 1).

After applying the filters of location, educational level, ready computer access and a single research site in Australia and Taiwan respectively, the sample was limited to a manageable size, appropriate for a thorough study of individuals' reasons for participation and non-participation in CS for this study. A total of 44,853 undergraduates were enrolled in the Australian institution and 17,709 undergraduates enrolled in the Taiwanese institution in 2010. In the same year 2,021 undergraduates were enrolled in IT courses in the Australian institution; 760 undergraduates were enrolled in IT courses in the Taiwanese institution.

Stratified random sampling (McMillan & Schumacher, 2010) was employed in Phase 1 to divide the available Australian and Taiwanese population into subgroups of CS participants and NCS participants on the basis of educational level (undergraduate). Samples were drawn from each subgroup (CS and NCS) from the Australian and the Taiwanese populations. It was anticipated prior to the commencement of data collection that NCS participants would be proportionally more numerous than CS participants as a wider sample of NCS undergraduates were studying across all other disciplines than in CS in the Australian and Taiwanese institutions. The advantages of using a stratified random sampling approach in Phase 1 included: only a small number of subjects needed to be used; the researcher could identify the subgroups of interest then describe in detail the characteristics which were similar or different across the strata or subgroups, and using a stratified sample would result in less sampling error as long as the characteristics used to create the strata were related to the dependent variable (McMillan & Schumacher, 2010; Teddlie & Tashakkori, 2009).

The following table shows the number of Australian and Taiwanese undergraduates who participated in the online survey by sex and group membership (CS and NCS) (see Table 8).

Table 8

Australian and Taiwanese Undergraduate Population and Sample Sizes of Selected Research Universities, by Sex and Group Membership (CS and NCS)

	Australian university (AU)			Taiwanese university (TW)		
	Male N	Female N	Total N	Male N	Female N	Total N
Undergraduates enrolled in 2010	19918	24935	44853	9838	7871	17709
Numbers enrolled in IT courses	1643	378	2021	593	167	760
Stratified CS survey sample	21	11	32	29	12	41
Stratified NCS survey sample	23	51	74	4	7	11
N/A sample*	6	8	14	9	5	14
Total sample size	50	70	120	42	24	66
Total stratified sample size	**44**	**62**	**106**	**33**	**19**	**52**

Note. *N/A sample is the proportion of the survey sample who did not specify if they were studying CS or NCS courses (or majors) at the time of survey participation. The N/A sample was not included as part of the total stratified sample size.

Table 8 shows that a total of 186 undergraduates voluntarily participated in the online survey (AU=120, TW=66). There were 106 (M=44, F=62) Australian and 52 (M=33, F=19) Taiwanese participants who self-reported as studying CS and NCS courses. Stratified samples indicated there were 32 (M=21, F=11) Australian and 41 (M=29, F=12) Taiwanese participants studying CS courses (or majors), while 74 (M=23, F=51) Australian and 11 (M=4, F=7) Taiwanese participants were studying courses other than CS (NCS). “N/A sample” consisted of participants who did not indicate whether or not they were studying a CS course (Q.21a) or a CS major (Q.21b), and therefore were not included for analysis as it would not be possible to analyse data without group membership (CS and NCS). The following section describes the use of the survey instrument in Phase 1.

4.3.1.2 Instrumentation

An instrument is defined as any technique or tool that a researcher uses, such as a questionnaire or an interview (McMillan & Schumacher, 2010). The survey instrument used to collect data for Phase 1 of this research is a modified instrument based on an original survey instrument developed by the Women in ICT team as part of the Women in IT-Swinburne (WIT-S) project to investigate the decreasing number of women enrolled in IT courses at Swinburne University (Lang, McKay, & Lewis, 2006). The main author of the original instrument was contacted and granted permission for this study to use the survey instrument, on the basis that the authors’ names be referenced where the instrument is referred to. This study used a modified version of Lang et al.’s (2006) original survey by using most of the original components whilst incorporating several other components to ensure the modified survey was designed to answer the research question, which is “What are the factors, and how do they influence individuals’, particularly females’ participation and non-participation in CS courses in Australia and Taiwan?” The instrument validity and reliability are presented in the following sections.

Validity

In order to use an existing instrument, established validity (content validity, predictive validity and construct validity) and reliability of scores from past uses of the instrument must be established (Creswell, 2009; Teddlie & Tashakkori, 2009). Lang et al.’s (2006) WIT-S instrument was developed to investigate the decreasing number of women enrolled in IT courses at Swinburne University, by surveying undergraduate students on their IT experiences in both educational and social contexts, their perceptions of courses and career choices, as well as their university experiences. Content validity was established by demonstrating that the items were measuring the content, such as attitude or similar scales, as well as academic ability (Creswell, 2009; Teddlie & Tashakkori, 2009). For example, the results from the WIT-S survey revealed that a higher proportion of male and female students enrolled in the Faculty of Information and Communication Technology (FICT) were found to have completed IT at the senior secondary level in contrast to their non-FICT peers, and were more confident in their abilities to learn new skills on the computer. The WIT-S survey’s predictive validity was also ascertained when the survey correlated highly with the outcomes it was intended to predict in understanding the role of the backgrounds and experiences which students had had at school in their choice to study IT courses at the tertiary level. For example, a higher proportion of FICT females than non-FICT females believed they had the ability to learn programming. In other words, females who did not have a strong self-efficacy in their capabilities in programming-related learning may not have been as confident to pursue IT courses. Construct validity was demonstrated where the WIT-S items were found to have measured hypothetical constructs or concepts. For instance, students’ feelings of competency and efficacy in computer use were thought to have contributed toward their FICT participation, and the results reflected this assumption: FICT males and females had had more experiences with creating programs than non-FICT males and females.

In addition to establishing the validity of the use of an existing instrument, ascertaining its reliability is equally important and is presented in the following section.

Reliability

De Vaus (2002) states the importance of discussing whether scores resulting from past use of the instrument demonstrate reliability. Data reliability is the degree to which the results of a measurement consistently and accurately represent the true magnitude or “quality” of a construct, in this instance, the survey. Although test-retest correlations and consistency in test administration were not mentioned from the use of the survey by Lang et al.’s (2006) study, the item responses revealed a consistency in scores across the constructs. For instance, a higher proportion of FICT females than non-FICT females agreed to items related to attitude to IT (“I have a lot of ability to learn programming”), perception of skill (“I believe that programming is the most important component of studying IT”) and career aspiration (“I want to pursue a career in the IT industry”) (Lang et al., 2006, pp. 6-8). The scores obtained from FICT females’ responses to ability in programming, and to the perception of programming as a skill required in IT learning were nonetheless important measures which matched that of their career aspirations of pursuing IT related studies in the field. These responses also indicated there was in general a consistency of scores without errors caused by carelessness in administration or scoring.

The following section presents the major components of the actual instrument (modified version of the WIT-S survey) used in this study (see Appendix 2), as well as the pilot testing of the survey instrument.

4.3.1.3 Data collection: survey instrument

Surveys were chosen as the instrument for Phase 1of this mixed methods study. The survey (see Appendix 2) was created by adopting Eccles et al.'s Expectancy Value Model (EVM) (Eccles, 2005a), which examines the motivational factors underlying the educational choices by females, and in this study, females' choices and non-choices of CS undergraduate courses. In order to explore the psychological and social factors which influence course enrolment decisions, the questions were categorised into sections such as "Personal background", "Parents/guardians", "Tertiary education", "Educational decision-making", "Career aspiration" and "Personal opinion".

The surveys collected in the first phase of this research were questionnaires administered via SurveyMonkey, where students (CS and NCS) in Australia and Taiwan filled out the questions independently by either: a) typing the survey link provided on the tear-away strips of the recruitment poster into the address box of an internet browser to access the survey site, or by b) clicking on the survey link forwarded by their lecturers.

To encourage more open and honest responses, students were assured that their identities were to be kept anonymous, except for those who opted to attend the interview by having answered "yes" to Question 38 of the survey, since their anonymity could not be entirely ensured (as the email address provided may reveal their identities). However, participants were assured that the information they provided in the survey as well as during the interview would be kept confidential. During the process of survey modification, the wording of the survey questions was amended. A pilot administration of the draft questionnaire (in both English and Chinese) was undertaken with seven volunteers, who were asked to consider whether the wording of the questions was easily understandable. Feedback from the volunteer participants suggested that there were some grammatical errors with some of the questions. The survey instrument was subsequently revised. Each item in the draft questionnaire was reviewed once more with an eye to reducing vagueness. The result was an instrument with more clearly worded items without reducing the number of items.

The survey developed for Phase 1 of this study is a questionnaire consisting of 38 items for the Australian participants (see Appendix 2) and a translated version of the survey for the Taiwanese participants (see Appendix 5). In addition to the survey instrument, the letter of introduction (see Appendix 4), the explanatory statement (see Appendix 5), consent form as well as the interview questions (one set for CS and the other set for NCS students) (see Appendix 6) were all translated into Taiwanese by a NATII accredited translator (English to Chinese) prior to the collection of data in Taiwan. Participants were asked to answer closed-ended and open-ended questions, and to respond to some survey items based on a five-point Likert response format, indicating the extent to which they agreed with the statements shown in the items by selecting “strongly disagree” (score=1), “disagree” (score=2), “not sure” (score=3), “agree” (score=4) or “strongly agree” (score =5).

The first section of the questionnaire “Personal background” included items such as “age”, “sex”, “type of school attended” (government/catholic; co-educational/single-sex), which were retained from the original WIT-S survey. Participants’ responses about their backgrounds were used in the subsequent analyses, to see how their backgrounds may have directly or indirectly affected their decisions in educational choices. New questions such as "Did you study any senior secondary Mathematics subjects?" and "Did you study any IT or ICT or computer studies at senior secondary level?" were added to explore the possible correlation between prior IT and/or mathematics experiences during senior secondary schooling and subsequent participation in tertiary IT/CS courses. Individuals' expectancies for success and the values they placed on IT-related studies were deemed highly possible factors in course participation.

The second section, "Parents/guardians" contained items regarding parents' highest level of educational attainment, occupations and computer usage from the original survey instrument. These questions are aimed at exploring whether parents' educational attainment as well as occupations affected participants' choices of a particular undergraduate course. No new items were added to this section, as the one of the aims of the survey was to explore the effect of parents' computer uses and the encouragement they offer to individuals on subsequent CS or NCS course choices.

The third section "Tertiary education" consisted of original survey questions including "What is the full name of degree you are studying?" and asked whether participants' chosen courses were their first preferences. A new item added was "Where did you find the information about the course you are now enrolled in?", to examine the exposure participants had to information about the range of educational options available to them at the time, which assisted them to make their undergraduate course choices.

Section Four, “Educational decision-making” was a new section added without items from the WIT-S survey. Items included “Why did you choose your current course?”, “Who influenced you in choosing your current course?” as well as course features and skills required to study courses. These were in accordance with the EVM (2005a) and sought to examine how individuals’ anticipation of success and self-efficacy beliefs in CS/NCS fields motivated pursuits of courses in either fields.

The fifth section of the survey, “Career aspiration” asked participants questions including whether they had had any previous work experience in the IT industry, as well as “What type of career(s) do you intend to pursue once you have graduated from your current degree?” and “What are the important skills required to pursue your desired career(s)?” to explore participants’ understanding of the career options associated with their courses. No items from the WIT-S survey were used in this section.

Part A of “Personal opinion” examined the effects of participants’ opinions about studies and career aspirations which could have influenced their CS and NCS participation using five-point Likert items. Items from the original WITS-S survey including “I find the coursework difficult” and “I find the subjects I am studying interesting” were retained, while new items including “I am confident about asking lecturers/tutors for help”, “I need to be good at programming to achieve well” and “Do you think there is a gender imbalance in IT-related studies?” were added. The new items further cross-examined whether the responses from CS and NCS participants regarding the skills required to study CS and the gender representation in IT studies varied by males and females in both samples (CS and NCS) and by educational context (Australian or Taiwanese).

Part B of “Personal opinion” examined participants’ beliefs and perceptions regarding the career prospects as well as the career aspirations associated with their respective courses. Six original WIT-S items relating to career aspirations or opportunities were retained for their relevance to this study. The various STVs that individuals attached to IT (or CS) related courses and/or careers were affected by pre-tertiary studies and IT-related experiences. Individuals’ perceptions of the pay of future careers, and/or difficulty of obtaining jobs in the field, were based on their own understanding of careers in the field. When perceptions of careers in the CS field are not very positive, individuals are more likely to attach a higher relative cost attached to CS courses, which in this case may have made them less inclined to participate in the CS field of studies. Similarly, those who perceived CS careers as demanding and involving working long hours, yet prefer careers would enable them to balance a career with family, would therefore attach a stronger attainment value (e.g. personal importance) to courses other than CS. As for individuals who attached a strong utility value (e.g., perceived usefulness) to being able to apply skills learnt in CS coursework in their future CS careers, they may have been motivated by this value to pursue CS courses. Therefore, the STVs individuals attached to choosing CS courses were dependent upon their pre-tertiary perceptions about IT-related careers and courses such as CS, as well as their own IT-related experiences and exposure to professionals in the field, which facilitated the various STVs which they attached to CS courses, in turn motivating or discouraging CS course participation.

Overall, the survey used the EVM to explore the interplay of what factors were most influential over individuals’ course participation, and how the interplay of factors affected participants’ subsequent participation in an undergraduate CS or NCS course at the undergraduate level. The following section outlines how the surveys were analysed to obtain relevant and meaningful information about the CS and NCS samples in Australia and Taiwan.

4.3.1.4 Data analysis: surveys

Creswell (2009) explains that data analysis in a mixed methods approach occurs within both the quantitative and the qualitative approaches. One of the popular mixed methods data analysis approaches was the sequential QUAN → qual analysis, where an analysis of the quantitative data in the first phases can yield extreme or outlier cases, while follow-up qualitative interviews with these outlier cases can provide insight about why they diverged from the quantitative sample. Teddlie and Tashakkori (2009) also stated that studies which adopt the sequential QUAN → qual procedure can identify groups of people and form groups around attributes and themes based on the initial QUAN data then compare these groups or perform a follow-up with the groups to generate the qualitative data.

Outliers are observations that are numerically distant from the rest of the data in quantitative statistics (De Vaus, 2002). They can occur by chance in any distribution, but they are often indicative either of measurement error (e.g. faulty data, erroneous procedures), or that the population has a heavy-tailed distribution. By determining the outliers during the first phase, more accurate and secure data can be obtained. The use of qualitative data in the second phase of this study however provides more depth for non-outliers as well as outliers.

Creswell's (2009) recommendations for survey data analysis were used to determine the survey findings in Phase 1. The numbers of participants by group membership (CS and NCS) who completed or did not complete the surveys were reported. A descriptive analysis of participants by sex (male and female) and group membership (CS and NCS) was provided for responses to items such as level of education, subjects studied at school...etc. The statistics for responses to survey items were presented in the form of frequencies (and percentages) by sex and group membership, particularly when they revealed strong trends. SPSS was the statistical program used in this study to test for statistically significant differences by gender for all survey items (excluding items with text input-only). The survey results were presented in tables (or figures where appropriate).

Chi-square tests were employed to test for statistically significant differences by gender within groups (CS and NCS) in Australia and Taiwan, as the aim of this study is to examine the factors for the gendered participation in CS, and to see if the factors for participation were similar or different for participants from different educational contexts. Results from statistical tests were interpreted to determine if they were statistically significant and answered the research question.

The following sections present the case study approach used in Phase 2 of this study, followed by an outline of participant selection, as well as data collection and analysis procedures.

4.3.2 Phase 2: qualitative approach: case studies and interviews

A qualitative case studies approach was deemed appropriate for Phase 2 of this study, as it allowed more detailed accounts of cases to be gathered and explored in depth in relation to the processes, activities, and events of individuals (Creswell, 2009; Johnson & Christensen, 2008). Yin (2003) describes case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p. 13). The use of case studies also enabled detailed information about individuals to be collected. Phase 2 of this study adopts a multi-case design where each individual interviewed is treated as a single case, which allowed cases to be compared for similarities and/or differences by gender, by group membership (CS and NCS) and/or by educational context (Australian/Taiwanese). This study collected qualitative data using interviews at the selected institutions in Australia and Taiwan. These institutions provided ideal settings for obtaining in-depth, personal accounts as to why males and females chose CS or NCS courses, since the researcher could interact directly with interviewees face-to-face. The researcher in this instance acted as the “key instrument” (Creswell, 2009, p. 175), who collected data by interviewing participants using a protocol (in this case, a list of interview questions). This study focused on “participants’ meanings”, their own personal accounts of reasons for course participation. Interview questions varied at times and were worded slightly differently to cater for participants’ responses as well as to maintain the flow of conversations during the interviews.

The rich and varied data gathered from interviews also enabled inductive data analysis to be carried out, resulting in the formation of patterns, categories, and themes. The researcher was able to go back and forth through the recorded interviews, as well as the interview transcripts, to ascertain a comprehensive set of themes which emerged from the interviews. The qualitative approach used by Phase 2 of this study provides a more holistic picture than does the survey of the complex range of social, familial, personal and motivational factors contributing toward the gendered participation in IT-related fields of study such as CS. Multiple perspectives from participants from both CS and NCS fields of study offered comparable insights into the trend of female underrepresentation (or representation) in CS courses at the undergraduate level. The procedures used for selecting participants are outlined in the following section.

4.3.2.1 Participant selection

Prior to the commencement of interviews in Phase 2, approval was obtained through the Ethics Committees at both institutions. Participants for interviews were not restricted in number, yet the short timeframe for recruitment as well as the voluntary nature of the participation in interviews resulted in seven participants being interviewed in Australia and ten participants in Taiwan. The number of participants was deemed appropriate for this study, as the aim was to obtain detailed accounts of cases. Participants who completed online surveys in Phase 1 and who answered "yes" to Question 38 "Are you interested in participating in an interview in the future?" were all selected for Phase 2. These individuals were then contacted via the email addresses they provided. Appointments were made for face-to-face interviews with participants who were contacted by email by the researcher of this study, and who were still interested in participating in interviews. Teddlie and Tashakkori (2009) argue that purposive sampling is primarily used in qualitative studies, where particular persons are deliberately selected for the important information they can provide. The self-selection of individuals for Phase 2 of the proposed study – participants who expressed their interest in participating in interviews – ensured that only participants who had a high level of interest in sharing their personal experiences and their reasons for choosing CS and NCS courses were included. These participants were also deemed appropriate subjects for this study, as they could respond to the research question in a reflective manner, by providing personal accounts of the various reasons they considered prior to their course participation (CS and NCS).

Participants who voluntarily elected to participate in interviews were asked to read an explanatory statement prior to their interviews. A consent form was given to participants to obtain their consent to participate in the interview and their permission for the interview to be taped. The researcher ensured that all consent forms were received prior to conducting the interviews. Participants were assured that their participation in this research was voluntary and their identities would remain confidential, and any data from the interview would be deidentified.

4.3.2.2 Data collection: interview instrument

Interviews are one of the common types of data collection procedures in qualitative research (Creswell, 2009). Qualitative interviews in Phase 2 enabled the interviewer to obtain in-depth information about a participants' thoughts, beliefs and knowledge about a topic (Johnson & Christensen, 2008). The researcher was also able to conduct face-to-face interviews with participants at the two selected research sites. An interview guide approach (or referred to as semi-structured interviews) was adopted for the researcher to ask specific open-ended questions though not exactly in order (Creswell, 2009), and permitted exploration of specific topics regarding experiences and other factors in course choices which may not have been uncovered in surveys.

Moreover, the research question served as the starting point in designing appropriate and relevant interview questions concerning females' participation in CS:

- What are the factors, and how do they influence individuals', particularly females' participation and non-participation in CS courses in Australia and Taiwan?

The research question was intended to inform the construction of interview questions in conjunction with the use of the EVM (2011) to explore how social, psychological and motivational factors influence individuals', particularly females' educational choices at the undergraduate level. Interviews were conducted with individual participants in a quiet meeting room pre-booked at the two research sites.

Participants were provided with a list of interview questions prior to the commencement of each interview at both research sites. They were given ten minutes to read the interview questions, and were encouraged to clarify the questions if they were not sure. A more comprehensive list of interview questions for Australian CS and NCS participants (see Appendix 3) – as well as a translated copy of the interview questions for the Taiwanese participants – was provided (see Appendix 6) prior to the interviews. Participants were informed that they had the right not to respond to questions they perceived as confronting, offensive or sensitive. A set of questions for CS participants and another set of questions for NCS participants were provided, as participants from each group were likely to have different opinions. Both sets of the interview questions for CS and NCS participants were categorised into four sections, namely, "Secondary schooling", "Perceptions of study", "Opinions of study", and "Career aspirations". Each of these four sections was intended to explore a particular theme found by Phase 1 results. The survey findings highlighted that participants' IT-related experiences during secondary school, perceptions of CS as a study and/or career, the skills they perceived as necessary and their anticipation of success in the field were the main influences over their course pursuits.

The interviews began by the interviewer asking the broad question "Do you think there are very few females studying Computer Science, and why?" to stimulate opinions and responses.

Other sub questions including “What makes you want to study Computer Science?” and “What did you know about Computer Science before you commenced the study?” were asked to follow up responses to previous questions, or to follow up responses which were revealed to be central to the main research question. The sub-questions also generated more interest and discussions for participants as they did not have to respond to a fixed ordering of questions during the interview.

The interview questions for CS students included:

- “What could you tell me about your IT experiences in secondary school at the senior level?”;
- “What did you know about CS prior to studying this course?”; and
- “What were your reasons for choosing to study CS?”

Interview questions for NCS students included:

- “Did you think it was important to study IT in Year 12? Why?”;
- “What did you know about CS before choosing your current course?”; and
- “What are your reasons for not choosing to study CS?”

The questions were not asked in any particular order, as at times there was a need to restate the question with slightly altered wording as a prompt for participants to provide clearer and more detailed responses. In order to ensure the interview questions were all covered, participants were brought back to the topic if their responses became irrelevant or off-track.

The interviews were audio-taped and hand-written notes were jotted down during the interviews. Audio-taping of interviews enabled revisits back to the interview data to identify themes, and ensured the reliability of data. The audio taping of interviews was also done on a laptop in case of failure of the audio recording equipment. Interview questions were clarified by slightly rewording or explaining the questions when participants were unsure about the intent of the questions. The interview data were later transcribed and field notes used to develop an overall understanding. The Taiwanese participants were encouraged to respond to interview questions in English by their lecturers. All participants attempted to respond to all questions in English, and only answered or provided responses in Taiwanese with particular vocabulary or phrases which they did not know or were not sure about how to express in English. The Taiwanese interview data were transcribed professionally by a certified bilingual translator from Taiwanese to English, with the parts of the interviews which were spoken in English remaining as they were. Once the data were fully transcribed, they were analysed in full with the aid of the EVM to determine which factors influenced course participation by individuals, particularly by females in both Australia and Taiwan. The following section outlines the steps taken to analyse the interview data.

4.3.2.3 Data analysis: interviews

Teddlie and Tashakkori (2009) argue that the process of data analysis involves making sense out of text, gaining a deeper understanding of the data, representing the data and making an interpretation of the larger meaning of the data. Using a case study research approach in Phase 2 enabled a detailed description of the setting and individuals, and an analysis of the data to identify themes or issues. This study used the data analysis process suggested by Creswell (2009) as shown in Figure 3.

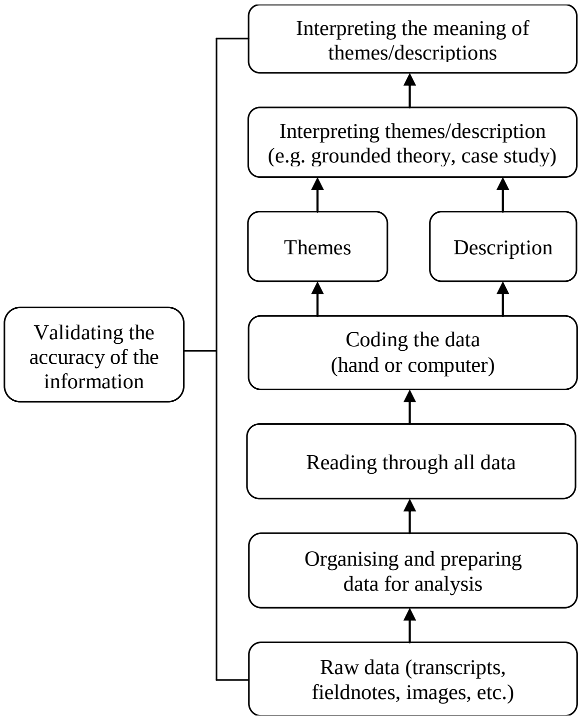

Figure 3. Data analysis in qualitative research (Source: Creswell, 2009, p. 185)

Figure 3 shows the interview data procedure applied to process the qualitative data in Phase 2. The stages of data analysis in qualitative research were interrelated and they were not always visited in the order presented in Figure 3. The interview data were analysed by:

1. transcribing and typing up field notes before they were sorted into different categories according to the sources of information;

2. reading through all data to obtain a general sense of the information;

3. commencing a detailed analysis with a coding process, by organising the material into segments of text before interpreting the meaning of the information, and ensuring that prior to Step 4, the codes were generated based on past literature, the research question, and the EVM. The codes were also developed based on information collected from participants, and predetermined codes were also used before fitting data to them. Some of the predetermined codes included "IT experiences", "stereotypes", "gender", "career goals" and "personal interest". Other codes derived from participants' responses included "prestige of institution" and "cost of participation". The codes were developed to address the larger theoretical perspective in the research,

such as “cost of participation’ (subjective task values), or referred to as STVs” and parental/personal influence (socialisers’ expectations). This study adopted the process of manually coding the qualitative transcripts to sort information into codes that would be useful in writing the qualitative study;

4. using the coding process to generate a description of the setting and people, as well as categories or themes;
5. utilising a narrative passage approach to convey the findings of the analysis, and making an interpretation of or stating the meaning of the data, including the researcher’s own interpretations of the findings, as well as the meaning derived from a comparison of the findings with information from the literature and theories.

The procedures for ensuring the reliability, validity and generalisability of qualitative data collected during Phase 2 are presented in the following section.

4.3.2.4 Qualitative reliability, validity and generalisability

Kvale (2007) explains that reliability refers to the consistency and trustworthiness of research findings. Other factors which affect qualitative reliability include whether interview subjects change their responses at the interview, and the transcription of interviews by different transcribers. I ensured the reliability of qualitative data collected and analysed in Phase 2 by:

1. Checking that transcripts did not contain obvious mistakes during transcription. The Australian interviews were transcribed by a professional transcriber, while the Taiwanese interviews were transcribed by a bilingual transcribing company in Taiwan. The analysis of the interview transcripts was done solely by the researcher of this study while listening to the recorded interviews and reading transcripts back and forth several times to ensure the interpretation of the main themes of the interview data were consistent. The field notes taken were also used and checked against the interview transcripts; and

2. Making sure that the definition of codes remained the same or similar, and the meaning of the codes did not change during the process of coding.

Qualitative validity is based on determining whether the accounts provided by the researchers and the participants were accurate, credible and could be trusted as accurate from the standpoint of the researcher, the participant or the readers (Creswell, 2009; Creswell & Plano Clark, 2007). Qualitative validity also means that the researcher checks the accuracy of the findings by employing certain procedures. This study utilised several validity strategies to assess the accuracy of findings by:

1. using open-ended responses from surveys in Phase 1 to triangulate with interview data in Phase 2. This comparison enabled cross-checking of similarities and/or differences of findings, by gender, group membership (CS and NCS) or educational context (Australian and Taiwanese). This also enabled a coherent justification for the themes established from the data, as well as from the perspectives of the participants;

2. using descriptions to convey findings to allow readers to gain a richer sense of the setting, providing a discussion of shared experiences;

3. clarifying any underlying bias possessed by the researcher towards the study through the researcher's self-reflections, and

4. presenting discrepant information which ran counter to the themes, by providing information which contradicted the general perspective on the theme. This allowed the accounts provided by participants to be more realistic and valid.

Qualitative generalisation is used sparingly in qualitative research, as this form of inquiry focuses on the particular descriptions and themes developed in the context of a specific site (Teddlie & Tashakkori, 2009). As Creswell (2009) stresses, "particularity" rather than generalisability is the hallmark of qualitative research. The generalisation occurs when qualitative researchers study additional cases and generalise findings to the new cases. In line with Creswell and Plano Clark’s (2007) suggestions for studies which adopt a mixed methods analysis adopting the Explanatory Design (Phase 1: QUAN=quantitative data; Phase 2: qual=qualitative data), this study analysed the QUAN findings and the qual findings as follows:

1. Stage 1: separate QUAN data analysis;
2. Stage 2: identify QUAN results to use; and
3. Stage 3: apply select QUAN results to qual phase.

This study adopted the Explanatory Design which considered the QUAN results (Phase 1) to be followed up in the qual phase (Phase 2), by selecting cases (e.g., males and females, CS and NCS students), providing demographics (e.g., type of schooling, subjects studied at secondary school), explaining results (e.g., significant-non-significant results) and comparing groups (e.g., factors for course participation by gender in the CS/NCS group in Australia/Taiwan). Significant results as well as non-significant results from the QUAN phase which showed strong trends or were contrary to expectations were followed up in the qual phase to gain a better understanding as to why these results occurred.

4.4 Ethical issues in research design

Prior to the commencement of the data collection for this study, participants were informed of the nature of the research so they could give informed consent. Participants’ consent was given before their responses from both surveys and interviews could be elicited and used for analysis in this study. Verbal and written consent was obtained prior to the commencement of both phases. A hard copy consent form was distributed to participants prior to participating in interviews. Participants were informed that they had the freedom to withdraw at any phase of this study, which ensured participants could withdraw at any time from this study without coercive pressure. As the researcher did not possess any teaching posts at either institution, nor was she personally known to students, there was no power relation over the participants.

Several strategies were implemented to protect participants from any mental or psychological stress as a result of participation in this research. In line with Babbie's (2005) views on confidentiality, the names of the institutions and the real names of participants were deidentified and pseudonyms were used where applicable. Anonymity was ensured for Phase 1 of this study as the surveys did not require participants' provision of names. All possible care was taken to ensure responses were not specifically linked to participants in findings to make them identifiable to others who may know them, and identifying information was removed after the completion of the interview transcription. All physical data (e.g. consent forms, interview transcripts) and responses collected online (i.e., the survey responses via SurveyMonkey) were either stored in locked cabinets or on a password-controlled computer to which only the researcher had the key or password for access. Only the researcher of this study had the knowledge of the details of participants in order to ensure the confidentiality of participants of this study.

4.5 Conclusion

This chapter has revisited the main research question of this study to explain the design of the study, justifying the use of a mixed methods research approach. The research was to gather the general characteristics of the undergraduates studying CS and NCS courses, exploring the main reasons for their course participation. Those who completed the survey were invited to share their personal experiences further, to enable the researcher to further respond to the research question. A justification for the Explanatory Design: Follow-up Explanatory model has been provided. Detailed explanations for the QUAN and qual phases adopted by this study, along with an outline of the sampling procedures and the procedures taken to ensure the validity and reliability of data were met in Phase 1 (surveys) and Phase 2 (interviews).

The findings and discussions of the QUAN and qual results are presented in the next three chapters according to the educational context (Australian context, Taiwanese context), with further break-downs by group membership (CS and NCS) and gender. Presenting the data in this way allows for greater clarity in understanding how factors influenced the participation and non-participation by gender in each educational context. The third results and discussions chapter is a comparison of the similarities and differences of factors affecting the choice of CS and NCS by gender across educational contexts. This enables a comparison of factors and themes to emerge across educational contexts, and also helps identify the influences in course participation by gender which, to the researcher's knowledge, have not yet been identified in previous research.

Chapter 5. Results and Discussion – Australian students

This chapter presents the survey responses of Australian undergraduate students who were enrolled in a Computer Science (CS) course or major, and undergraduates who were studying in other non Computer Science (NCS) disciplines. The interview findings acted in support or served as a contrast to the survey findings, or were used to provide important information and to add richness, which might not have been achieved in the surveys.

The Australian sample comprised 106 (M=44, F=62) participants with a survey completion rate of 79% (95 completed surveys). More than a quarter (32: 27%) of the sample were studying CS courses or were studying CS majors (CS participants), while close to two-thirds (74: 62%) of the sample identified themselves as studying courses or majors other than CS (NCS participants). The remaining (14: 12%) did not specify their courses and were excluded from the analysis as they could not be analysed by group membership (CS and NCS). Seven (M=3, F=4) participants voluntarily participated in 45-minute interviews, including three (M=1, F=2) CS participants and four (M=1, F=3) NCS participants.

Prior to proceeding to the fuller exploration of the results from surveys and interview findings, it must be noted that four survey items were excluded from the analysis:

- Q.15. Occupation of father/male guardian
- Q.16. Occupation of mother/female guardian
- Q.33. How often do you perform the following activities on the computer for study?
- Q.34. How often do you perform the following activities on the computer for leisure?

These four questions were originally included in the survey as it was assumed that parents' occupations and participants' previous IT-related activities for study or for leisure could affect their subsequent educational and career aspirations in the CS field. Parents' occupations (Q.15 and Q.16) were questions initially intended for providing a measure of socio-economic status (SES). However, it was later found that the sizes of the CS sample (32) and the NCS sample (74) were too small for conducting a multivariate analysis using SES as a variable. The other two excluded survey questions (Q.33 and 34) were later found to be not specific enough for examining whether study or leisure-related activities on the computer prior to or after enrolment directly affected subsequent participation or non-participation in CS studies.

This research adopted chi-square (X^2) tests to identify statistically significant differences by gender within each sample (CS sample and NCS sample), as the questionnaire used in this study contained mostly categorical data (Corder & Foreman, 2009). Yate's continuity correction was used for 2 by 2 contingency tables (i.e., each variable has only two categories) to avoid an overestimation of the chi-square value. The Sig. (p) value of .05 or smaller was set as the level of significance, which means that there is a 95% probability that any observed statistical difference is real and not due to chance. As this study consisted of a small CS sample (M=21, F=11) and NCS sample (M=23, F=51), significant differences could still occur. Therefore, effect size (ES), which is independent of sample sizes, was included when p was .05 or smaller to explain the degree of association between variables, using phi (ϕ) coefficients for 2 by 2 tables and Cramer's V (V) for larger tables (Corder & Foreman, 2009; Pallant, 2009). Cohen (1992a) defined the conventions for ES as: small = .10, medium = .30, and large = .50. In order to present a more robust description due to the small CS and NCS sample sizes, the frequencies (and percentages) of responses to all five-point Likert items in this study were collapsed down as follows: "SD/D" ("Strongly disagree" or "Disagree");

“A/SA” (“Agree” or “Strongly agree”), and “NS” (“Not sure”) remained unchanged. Also, due to the small sample sizes in this study, not many statistically significant differences occurred. However, strong trends (including high frequencies and percentages or unexpected outcomes) were observed.

The participants’ responses to the survey questions were divided into three main areas:

1. Prior to enrolment
2. Course-decision-making process
3. After enrolment

This chapter discusses each of these three areas: ‘Prior to enrolment’ presents results relating to individuals’ secondary schooling, maths and IT subjects studied and IT-related exposure. ‘Course decision-making process’ presents results of individuals’ perceptions of socialisers’ behaviours and attitudes (parents’ computer use and encouragement offered to children on developing computer skills), perceived skills required to achieve success in particular subject areas, individuals’ self-concept of their own abilities as well as the subjective task values attached to course-related choices. ‘After enrolment’ presents results of individuals’ interpretations of experience in their own courses or majors, as well as individuals' perceptions and opinions of cultural stereotypes of subject matter (current studies) and occupational characteristics (career-related aspirations).

Interview questions were used to explore the finer, more intricate accounts of individuals’ personal emotions, the values they attached to CS or NCS related studies, and activities or interests which could not be explained in depth in surveys. The interview questions were constructed around the four main areas derived from the survey findings that were found to be most influential in individuals' pursuits of CS and NCS courses, including: 'Secondary schooling', 'Perceptions of study', 'Opinions of study', and 'Career aspirations'. The interview findings were used to triangulate the survey findings in terms of some of the similarities, differences, overlapping themes or trends by gender within samples (CS and NCS) and by educational context (Australian and Taiwanese). They provided further information about the extent to which individuals' subsequent participation or non-participation in undergraduate CS courses were largely related to the four areas mentioned:

1. previous exposure to IT and previous successful or negative experiences with IT learning during secondary school (Secondary schooling);
2. an adequate or insufficient understanding of CS related careers or studies (Perceptions of study);
3. factors of personal interest, family influences, and the subjective task values attached to particular CS related studies or activities (Opinions of study), and
4. the strength of individuals' career aspirations as influences over course pursuits (Career aspirations).

A total of seven participants participated in the interview, including three CS participants (M=1, F=2) and four NCS participants (M=1, F=3). These participants were studying at a prestigious university located in suburban Melbourne, one of the Group of Eight leading tertiary institutions in Australia. They were all studying for their first undergraduate courses. They were all 21 years of age or under, with the exception of Kerryn (CS female) who is a mature aged student. All of the Australian participants interviewed expressed wanting to know the main factors contributing toward the gender inequity in Computer Science as the reason why they were involved in this study.

The following sections present survey and interview findings of personal backgrounds and educational experiences of the Australian undergraduates by group membership (CS and NCS), and a further breakdown by sex within each sample.

5.1 Prior to enrolment

5.1.1 Personal demographics

Demographic information is given by sex for the 32 (M=21, F=11) Australian participants who identified themselves as CS students and the 74 (M=23, F=51) participants who indicated being NCS students in the survey. In both CS and NCS samples, the frequencies (and percentages) of participants in age groups ranged from “Under 18” to “Over 25”. The CS sample consisted of one-third (7: 33%) of males who were 20 years of age, 19 years old (4: 19%), under 18 (3: 14%) or 18 (1: 5%); the remaining CS males (6: 29%) were 21 and older. More than half (6: 54%) of CS females were 21 years of age (3: 27%) or over 25 (3: 27%), and the remaining (5: 46%) were aged 22 (1: 9%), 24 (1: 9%) or younger (3: 27%). Approximately half of the CS sample were the eldest child in the family (M=11: 52%, F=5: 46%) and the remaining were not (M=10: 46%, F=6: 54%). Nine (43%) CS males indicated “school leaver” as their highest level of qualification while close to half of CS females (5: 46%) reported possessing an undergraduate degree.

The NCS sample consisted of males who were either 19 years old (5: 22%) or 20 years of age (5: 22%), followed by 18 years of age (3: 13%) or over 25 (3: 13%), and the remaining aged between 21 and 25 (7: 30%). A quarter of NCS females were over 25 years of age (13: 26%), close to a quarter of females were 21 (12: 24%) and 20% (10) were 20 years old. The remaining NCS females were 22 and older (5: 10%) or younger at 18 (4: 8%) and 19 (6:

12%). Over half of the NCS sample were the eldest children in the family (M=12: 52%, F=30: 59%) and the remaining were not (M=11: 48%, F=21: 41%). About half of the males (11: 48%) and one-third (19: 37%) of the females reported their highest level of qualification as “school leaver”.

5.1.2 Secondary schooling

The types of schools and senior secondary subjects studied formed part of Australian participants’ previous achievement-related experiences which could have possibly affected their subsequent participation or non-participation in undergraduate CS. The frequencies (and percentages) of responses to survey questions regarding senior secondary schooling (Year 11 and Year 12 in Victoria or equivalent), as well as the results of chi-square tests (to test if the frequency distributions of responses were statistically significantly different by gender) in both samples, are shown in Table 9. The level of significance (Sig.) was set at .05 ($p < .05$) for statistical tests performed on all survey items. All Sig. figures of .05 or smaller in Table 9 and in all other tables thereafter represent statistically significant differences. Also, due to the small sample sizes not many statistically significant differences occurred. However, strong trends shown in Table 9 as well as in any other tables are commented on or discussed where appropriate.

Table 9

Frequencies and Percentage Responses to Secondary Schooling Items by Sex and Group Membership (CS and NCS), and X^2 Significance Level

	CS Participants			NCS participants		
Secondary schooling	Male N (%)	Female N (%)	Sig. level*	Male N (%)	Female N (%)	Sig. level*
Q.5b Attended co-educational school	16 (76%)	7 (64%)	ns	20 (87%)	29 (57%)	.023
Q.6a Studied secondary maths	18 (86%)	9 (82%)	ns	21 (91%)	41 (80%)	ns
Single subject only:						
Further Maths (FM)	2 (11%)	2 (22%)		1 (5%)	6 (14%)	
Maths Methods (MM)	6 (33%)	1 (11%)		5 (24%)	17 (41%)	
Combination of subjects:						
FM & MM	5 (28%)	1 (11%)		1 (5%)	4 (10%)	
MM & Specialist Maths (SM)	5 (28%)	0 (0%)		11 (52%)	8 (19%)	
FM & MM & SM	0 (0%)	1 (11%)		1 (5%)	1 (2%)	
Studied maths overseas	0 (0%)	3 (33%)		1 (5%)	3 (7%)	
Studied maths intestate	0 (0%)	1 (11%)		1 (5%)	0 (0%)	
Studied IB maths	0 (0%)	0 (0%)		0 (0%)	2 (5%)	
Q.6c Studied university-level maths	1 (6%)	3 (33%)	ns	3 (14%)	2 (5%)	ns
Q.7 Studied senior secondary IT	9 (43%)	3 (27%)	ns	14 (61%)	9 (18%)	.001
Single subject only:						
IT Applications (ITA)	3 (33%)	3 (100%)		5 (36%)	4 (44%)	
Software Development (SD)	4 (44%)	0 (0%)		6 (43%)	1 (11%)	
Combination of subjects:						
ITA & SD	2 (22%)	0 (0%)		2 (14%)	1 (11%)	
Studied Year 11 IT only	0 (0%)	0 (0%)		0 (0%)	2 (22%)	
Studied IT overseas	0 (0%)	0 (0%)		1 (7%)	1 (11%)	

Note. *The level of significance is set at .05 ($p < .05$). ns = not significant.

Table 9 shows that the majority of the CS sample attended co-educational schools (M=11: 52%, F=7: 64%). A considerably higher proportion of NCS males (20: 87%) than NCS females (29: 57%) attended co-educational schools. A chi-square test (with Yates Continuity Correction) revealed a statistically significant difference in type of school attended by gender in the NCS sample, X^2 (1, n = 74) = 5.14, p = .02, ϕ = -.29. The measured effect size (ES) (ϕ) suggested a small association between co-educational schooling and gender in the NCS sample. It was interesting to observe that a high proportion of females studied CS despite attending co-educational schools, which contrasted with Craig's (2005) study which found that 90% of females studying IT courses at a selected university in Sydney attended single-sex schools.

The senior secondary maths studied by both genders in the CS and NCS samples did not differ significantly, or appear to have influenced CS participation. Chi-square tests (with Yates Continuity Correction) revealed no statistically significant differences by gender in having studied senior secondary maths or university-level maths in both samples. The majority of the CS sample (27: 84%) and NCS sample (62: 84%) studied senior secondary maths. While a higher proportion of males (8: 44%) than females (3: 33%) of the CS sample studied a single maths subject, they studied more advanced maths such as Maths Methods (M=6: 33%, F=1: 11%). It was also interesting to see that a higher proportion of females (3: 33%) than males of the CS sample (1: 6%) studied university-level maths. However, the CS female sample was too small to verify if having studied university level maths encouraged or prompted females' CS participation.

Having studied senior secondary IT had no particular influence on the pursuit of CS courses. Approximately 38% (12) of the CS sample and 31% (23) of the NCS sample (23: 31%) studied senior secondary IT. All CS females (3: 100%) and the majority of CS males (7: 77%) studied a single IT subject only (ITA or SD), yet no CS females studied SD. The majority of NCS males (11: 74%) and half of females (5: 55%) studied a single IT subject only, and only three participants studied ITA & SD (M=2: 14%, F=1: 11%). The survey findings revealed that senior secondary IT had little or no influence on females' pursuit of CS courses. CS course pursuit by females surveyed in this study could be due to other factors.

In addition to identification of the secondary level studies of IT subjects, the relationship between the gender of the teacher of IT and the type of IT subjects studied by participants was also observed; a marked relationship was found. For example, a high male to female ratio was observed in relation to secondary level IT teachers, where almost all CS participants (11:

92%) were taught by male IT teachers, except for one (8%) CS male who was taught by female teachers in both IT subjects. In the NCS sample, males who studied ITA only were taught by female teachers (3: 21%), yet those who studied SD only were taught by male teachers (5: 36%); females who studied ITA only were taught by male teachers (3: 33%) and the only female who studied SD only was taught by a female teacher (11%). The strong representation of male teachers in IT teaching also highlights that female students were less likely to be exposed to the teaching of female teachers during senior secondary school. This potentially means female students have generally had fewer opportunities to interact with female mentors or role models in IT, and thus may thus have found it difficult to envision themselves studying and/or working in the field. Other studies have also found that an overwhelming presence of male role models (male teachers) instead of female role models (female IT teachers, female IT professionals) has discouraged some females from participating in CS course (Clayton, 2006; Jepson & Perl, 2002; Stockdale & Stoney, 2007).

In summary, the noticeably higher proportions of males than females in student numbers and in teaching staff at the senior secondary IT level illustrates an inequitable female representation and paucity of female authority figures in the field, making male and female students likely to perceive IT related fields as more appropriate for males. Maths and IT subjects studied by participants did not seem particularly influential for females in making subsequent course (or major) choices in CS. However, it was noted while no CS females studied SD they still chose CS courses.

The following section presents individuals' IT-related exposure at school to help understand the differences in factors in CS and NCS participation by gender in both the CS and NCS samples.

5.1.3 IT-related exposure

5.1.3.1 IT experiences within schools

Since Eccles (2011) suggested that individuals' previous achievement-related experiences affect achievement-related choices and performance across time, individuals' IT-related exposure during secondary school can affect their subsequent CS participation. Only 16% (5: M=4, F=1) of the CS sample and 19% (14: M=8, F=6) of the NCS sample attended open days during senior secondary school. An even smaller proportion of the CS sample (M=3) and NCS sample (M=2, F=4) attended information sessions regarding IT-related courses or careers. In addition to the lack of open day or information session attendance, less than half (13: 41%) of the CS sample and 53% (39) of the NCS sample surveyed knew any computer professionals while at school, who were mainly male professionals (CS: M=8, F=4; NCS: M=11, F=23). Open days and information sessions, as well as knowing computing professionals seemed to have little or no influence on females' participation in CS courses. It can be argued that some participants did not perceive attending IT-related study and careers seminars as necessary as they had already decided to pursue courses in other fields.

Nevertheless, for the males and females in both samples surveyed who revealed knowing mainly male professionals only further illustrated that the IT industry is still over-dominated by "male" IT professionals. Other studies have also identified that a lack of exposure to female IT professionals discouraged many females from pursuing studies and careers in IT related fields (Jepson & Perl, 2002; Stockdale & Stoney, 2007). Therefore, female teachers as role models are critical for males and females to address the gender bias in IT, and for female students to feel supported in their IT learning (Wasburn & Miller, 2004).

Other IT-related exposure including computer access and teachers' encouragement in IT learning were examined for their potential influence in individuals' CS participation. The majority of the CS sample (M=18: 86%, F=8: 73%) and the NCS sample (M=21: 91%, F=37: 73%) surveyed had access to computers in their secondary classrooms. The high proportion of the NCS females who had access to computers was similar to Messersmith et al.'s (2008) study, which found that females' access to computers during school did not facilitate their participation in IT related studies. In contrast to computer access, an interesting difference by gender in teacher encouragement was observe in the CS sample (M=14: 67%, F=2: 18%). A chi-square test (with Yates Continuity Correction) revealed a statistically significant difference in receiving teachers' encouragement by gender, X^2 (1, n = 32) = 4.99, p = .03, ϕ = .46. CS males were more likely to have been encouraged by teachers to develop computing skills than CS females. Indeed, a higher proportion of CS males than CS females acknowledged receiving encouragement from teachers and still chose CS courses illustrated that other factors were more influential for their CS participation.

Four of the seven interviewees revealed that word-processing (CS: F=1; NCS: M=1, F=2) was the most common form of their IT learning experiences during Years 7 to 10. Word-processing was however not particularly exciting for Tess[1] (NCS female), who commented that "some [IT] classes I didn't enjoy that much because they were trying to teach from the basic, like doing internet searches… so they weren't that exciting". Zoe (NCS female) also thought that "IT was probably a bit dry...the way it was taught wasn't that engaging or exciting". Both Tess and Zoe show when IT learning was mainly confined to the uses of Word and PowerPoint or using the Internet to search for information, the IT curriculum then

[1] Pseudonyms are used for all participants.

became unappealing to female students, dissuading them from considering IT-related studies such as CS. The delivery of IT curriculum was also identified as an important factor by Newmarch et al. (2000) as influencing females' subsequent pursuit of IT related studies at the tertiary level. Similarly, Timms et al.'s (2006) study also found that females' decision to not study senior secondary IT (in Year 11 and 12) was due to their perceptions of IT subjects as boring. Previous secondary IT experiences are therefore shown to have influenced some females' non-participation in CS courses.

The positive secondary IT experiences for one CS female participant interviewed seemed to have motivated her CS course pursuit. Sinead's (CS female) interest—enjoyment in IT prompted her subsequent decision to pursue a CS major, "there were a lot of opportunities to use the computer…we did some basic web design, some computer animation...later I used the computer for sound and video editing in class, and in Year 11 I took a VCE VET IT[2] subject". Sinead's experiences illustrated a range of technological applications which increased the interest she attached to senior secondary IT learning and consequently motivated her participation in CS.

In contrast, Jarrad (CS male) commented that the secondary IT curriculum did not fully meet his expectations, "In my opinion the curriculum wasn't bad, but it wasn't anything advanced…the [IT] teacher was originally a PE teacher...he was a good teacher, but he wasn't experienced". Jarrad's critique of the senior secondary IT curriculum suggested his IT learning experiences were not entirely positive, due to his perceptions of the lack of quality in

[2] VCE VET (Vocational Education & Training) programs are approved by the Victorian Curriculum and Assessment Authority (VCAA) following consultation with schools, industry and training providers. VCE VET programs lead to nationally recognised qualifications, thereby offering students the opportunity to gain both the VCE and a VET qualification. IT is one of the VCE IT programs offered (Victorian Curriculum and Assessment Authority, 2012c)

the curriculum taught by his inexperienced IT teacher. The issue of teacher training compromising the quality of teaching and student learning was highlighted by Clayton's study (2004), which found teachers who were not originally trained to teach IT subjects were less familiar with the subject content, which resulted in students receiving an IT education which lacked depth and comprehensiveness, just as students like Jarrad found. Despite not being fully satisfied with his IT learning during senior secondary school, Jarrad still pursued a CS course. This suggests that a lack of satisfaction with previous IT-related learning at school does not necessarily lead to non-participation in IT-related fields like CS, especially when other factors outweighed the negative experiences.

In summary, the over-representation of male teachers teaching IT subjects at secondary schools highlights a need for more female teachers in the field. A statistical difference by gender in the CS sample regarding teachers' encouragement for developing computing skills further illustrates how the specific expectations and attitudes of teachers as socialisers in assigning the attributes of gender roles for male and female students can discourage some females from choosing CS courses. For the NCS females interviewed whose secondary IT experiences were deemed not exciting, this could have contributed toward their subsequent non-participation in CS, while CS females' experiences which were fun and enjoyable or useful could have resulted in these young women finding CS courses more appealing than their NCS counterparts.

The next section explores the influence of IT related experiences individuals have out of school that may have motivated or discouraged pursuit of courses in the CS field.

5.1.3.2 Out-of-school experiences

Individuals' IT experiences out of school such as types of computer use did not seem to affect their subsequent pursuit of undergraduate CS courses. "Internet" was the most common purpose for computer use prior to course enrolment for the CS sample (31: 97%) and the NCS sample (69: 93%) surveyed. The most enjoyable purpose for using the computer was "Games" for 65% (13) of males and 20% (2) of females in the CS sample surveyed; while the "Internet" (M=6: 30%, F=17: 35%) was the most enjoyable computer use for the NCS sample. Close to two-thirds of CS males and a small proportion of CS females surveyed nominated games as the most enjoyable activity on the computer, which suggests that a personal liking for interactivity and stimulation could have prompted them in choosing CS courses, yet a larger sample is needed to verify this. Another out-of-school experience such as individuals' IT work experiences was deemed to be likely to be influential in CS course participation, though this did not seem to be the case. Only 7 CS (M=5: 28%, F=2: 18%) and 7 NCS (M=4: 18%, F=3: 6%) participants surveyed revealed they had worked in the IT industry prior to course enrolment. This highlights that IT-related work experiences can be encouraging but do not constitute a strong influential factor in CS course participation in this study.

In summary, the STVs attached to IT related studies or activities by participants when out of school may have affected their subsequent participation in CS, depending on the strength of the STVs attached to particular IT-related activities, as well as the type of IT-related experiences they had had previously. The CS participants interviewed in this study also indicated that positive interpretations of IT-related experiences aided in CS participation, while previous experiences of IT-related learning such as the boring, routine tasks they had to perform, discouraged the NCS girls from studying CS. The other IT-related experiences such as playing games on the computer seemed to have provided enjoyment for a proportion of the CS sample surveyed, which could have led them to pursue CS courses. Previous IT work experiences on the other hand did not seem to be strongly influential in subsequent CS participation, as the majority of the CS sample surveyed revealed no previous work experience in the IT industry.

The following section presents discussions of a range of factors which could have influenced individuals' decisions for CS or NCS educational choices at the undergraduate level.

5.2 Course decision-making process

5.2.1 Influences of socialisers

Socialisers such as parents can exert certain influence on individuals in making particular course choices, and parents' educational backgrounds were one of the factors examined. Close to a quarter of CS males (5: 24%) reported that their fathers held TAFE qualification as the highest level of education completed, while only one CS female reported that her father had a TAFE qualification, and over half (6: 55%) of CS females indicated their fathers had completed primary school (2: 18%), secondary school (2: 18%) or a doctorate (2: 18%). Close to a quarter of CS males (5: 24%) reported secondary school as their mothers' highest level of education. In contrast only two (18%) CS females indicated their mothers had completed secondary school (as the highest qualification), while the remaining CS females reported their mothers possessing qualifications ranging from primary to doctoral qualifications. In the NCS sample, more than one-third of the NCS sample (M=8: 35%, F=20: 39%) revealed their fathers had completed undergraduate degrees. Approximately 39% (9) of NCS males revealed their mothers had completed secondary school while the mothers of one-third (17: 33%) of

NCS females possessed undergraduate degrees. Chi-square tests however found no statistically significant differences by gender in fathers' or mothers' highest level of educational qualification in both samples. This suggests parents' highest level of education obtained did not seem to affect CS course choices; other factors were the more likely influences which needed to be verified by larger samples.

One of the likely factors in mediating CS course participation could be parents' encouragement on attaining IT-related skills. Eccles (2011) stated that socialisers, particularly parents and teachers, mediate individuals' perceptions of their field of options in educational choices by providing or withholding support, which also means that such influences can encourage individuals to make particular course choices in certain fields. The frequencies (and percentages) of six survey items relating to socialisers, including parents' computer uses and the encouragement they provided to individuals on developing computing skills, as well as the representation of females in IT teaching and studies, are shown in Table 10.

Table 10

Frequency and Percentage Responses to Survey Items Regarding Socialisers' Influence

		CS participants		NCS participants	
		Male	Female	Male	Female
Survey items		N (%)	N (%)	N (%)	N (%)
Q.17 My father/male guardian uses a computer regularly.	Yes	17 (81%)	8 (73%)	18 (78%)	38 (75%)
	No	4 (19%)	3 (27%)	5 (22%)	13 (25%)
Q.18 My mother/female guardian uses a computer regularly.	Yes	10 (48%)	6 (55%)	16 (70%)	32 (63%)
	No	11 (52%)	5 (46%)	7 (30%)	19 (37%)
Q.19 My father/male guardian encouraged me to develop computer skills.	Yes	15 (71%)	7 (64%)	17 (74%)	32 (63%)
	No	6 (29%)	4 (36%)	6 (26%)	19 (37%)
Q.20 My mother/female guardian encouraged me to develop computer skills.	Yes	9 (43%)	7 (64%)	11 (48%)	26 (51%)
	No	12 (57%)	4 (36%)	12 (52%)	25 (49%)
Q.36a Do you think there are enough female lecturers or tutors teaching computing courses?	Yes	15 (83%)	6 (55%)	10 (46%)	13 (29%)
	No	3 (17%)	5 (46%)	12 (55%)	32 (71%)
Q.36b Do you think there is a gender imbalance among students in IT-related studies?	Yes	16 (89%)	11 (100%)	18 (82%)	39 (87%)
	No	2 (11%)	`0 (0%)	4 (18%)	6 (13%)

Note. Figures may not add up to the original number of participants in CS sample (M=21, F=11) and the NCS sample (M=23, F=51), due to participants' early withdrawal from the online survey.

Table 10 shows that parents' computer uses, particularly mother's regular computer uses, had no profound influence in CS course participation. A surprisingly higher proportion of NCS females (32: 63%) than CS females (6: 55%) surveyed perceived their mothers as regular computer users, yet it did not encourage them to choose CS courses. Parents' encouragement in developing computing skills could have encouraged CS females in studying in the field, as close to two-thirds of CS females surveyed reported receiving encouragement from both mothers (7: 64%) and fathers (7: 64%). While chi-square tests revealed no statistically significant differences by gender regarding fathers' or mothers' encouragement in both samples, mothers (or female guardians) could have been potentially influential in females' educational choices. For example, Kerryn (CS female) expressed during the interview that her mother thought it was great that she wanted to study CS, because she was so great at fixing the computer for them, and she considered her as a "computer guru". In this instance, mother's encouragement had some positive influence on Kerryn's subsequent participation in a CS course. Clayton's (2006) study identified that the mother was the most influential person in female students' educational and subsequent career decisions.

The influence of other socialisers, particularly female socialisers such as female IT lecturers and female students studying IT were also examined for their influence on females' CS course pursuits. Higher proportions of females (CS=5: 46%, NCS=32: 71%) than males in both samples (CS=3: 17%, NCS=12: 55%) surveyed indicated they did not think there were enough female lecturers or tutors teaching computing courses. The reason cited by the CS sample surveyed for the lack of female lecturers in IT was a lack of females studying IT (M=1, F=3), and other reasons included the field being perceived as "male-dominated" (F=2) "geeky" (M=2). The main reasons nominated by the NCS sample surveyed were "IT is technical" or "male-dominated" and "a lack of interest". Similarly, other studies have found that gendered occupational aspirations in traditionally male dominated fields encompassed aspects which females do not find ideal or interesting (Clayton, 2005; Frome, Alfred, Eccles, & Barber, 2006; Nielsen et al., 2004), therefore females would be less inclined to pursue fields which appear outside the parameters of their gender roles. Also, the "male dominance" of IT fields, such as that reported by both CS females and NCS females surveyed, further highlights the need for a greater representation of female teaching staff in the IT field overall and also in the CS field, as a better representation of females in IT teaching can address the gender bias of CS as an exclusively male domain (Messersmith et al., 2008).

The high proportion of the CS sample (M=16: 89%, F=11: 100%) and the NCS sample (M=18: 82%, F=39: 87%) surveyed believed there is a gender imbalance among students in IT-related studies. The proportion of CS sample surveyed (M=8, F=2) also believed that the gender imbalance was mainly attributed to the perception that "females have a lack of interest in IT or programming". Similarly, McInerney et al.'s (2006) study found that females were more likely to enter the CS field if they possessed an interest in the field and were proficient in programming. Other reasons CS participants surveyed believed as accounting for females' lack of participation in the IT field included IT being "male dominated" (F=3), its "nerdy image" (M=3), and the notion that females may suffer from "a lack of problem-solving skills or logical thinking" (F=2). Frieze et al.'s (2006) study also defined CS as predominantly to do with "problem-solving" and "ways of thinking", which coincided with the findings of this study. The results of this study illustrate how the perceived nature of the IT environment as "technical" or "male dominated" could have very likely discouraged some from pursuing IT-related studies such as CS.

A proportion of the NCS sample surveyed revealed reasons for gender imbalance in the IT field that are similar to the CS sample, which included “females’ lack of interest in IT” (M=8, F=12), “IT is an unappealing career for females” (M=4), and “IT is male dominated (F=8)”. Three of the four NCS participants interviewed also revealed that gender stereotypical characteristics associated with IT account for the gender imbalance in IT studies. For example, Tess (NCS female) stated “computers aren’t terribly popular with girls…you would have to be really nerdy to go into IT.” Ryan (NCS male), in contrast, highlighted the unappealing employment options associated with CS: “The employment that would lead you out of CS and into whatever career it leads to isn’t very exciting or isn’t very attractive”. Kira (NCS female) on the other hand believed that the lack of IT-related exposure that girls had from an early age accounted for their subsequent underrepresentation in CS, “Maybe girls aren’t encouraged to do it…maybe boys are doing more computer type of stuff from an early age and the girls come to it maybe a little bit later on”. While females’ lack of interest in IT was identified by NCS participants as the main reason behind the gender imbalance in IT-related studies, Gurer and Camp’s (2002) study found the lack of interest females have in IT was largely due to the stereotyped perceptions of CS as solitary. The perceptions of IT as entailing little human interaction and offering unappealing career options, were also factors found in Papastergiou’s (2008) study to have prevented many high school females from pursuing CS courses upon their entry to university.

In summary, while parents’ level of highest education did not seem to have a particular influence in participants’ subsequent CS and NCS pursuits, mothers’ encouragement for developing computer skills could have encouraged some CS females in choosing CS courses. This highlighted the potential importance of socialisers such as mothers in facilitating the educational decision making of individuals’ undergraduate studies. It was also revealed that

NCS females' stereotypical perceptions of CS studies, and labelling of those who study CS as "nerdy" and "computer-obsessed" could have discouraged them from participating in the CS field. The reasons provided by both the CS and NCS participants surveyed was that the male-dominated nature of the IT field was largely due to "females' lack of interest in IT", and that the nature of the IT environment discouraged many females from pursuing IT courses, which resulted in fewer female academics who are qualified to teach IT courses at the tertiary level. Males' and females' self-perceived efficacies in IT learning, skills needed for studying IT and overall in IT learning are examined for their influence in individuals' pursuits of CS or NCS courses.

5.2.2 Perceived self-efficacy and skills required for task demands

Individuals' self-efficacies are shown to lead directly to making educational choices in the EVM. It is essential to examine if individuals' self-efficacy beliefs in maths and/or in IT, as well as the skills they perceived as essential for achieving success in IT, influence their course participation. In this study participants' self-efficacy in IT learning was examined using six survey items based on a five-point Likert response format in the survey. In order to present a more robust description due to the small CS and NCS sample sizes, the frequencies (and percentages) of responses to all five-point Likert items in this study were collapsed down as follows: "SD/D" ("Strongly disagree" or "Disagree"); "A/SA" ("Agree" or "Strongly agree"); and "NS" ("Not sure") remained unchanged. Chi-square (X^2) tests were used to determine if the frequency distributions of the responses were statistically significantly different by gender in both samples (CS and NCS). Also, ES of Cramer's V (V) were included for p values of .05 or smaller (Corder & Foreman, 2009; Pallant, 2009).The responses to items in Q.12, as well as the outcomes (p) of the chi-square (X^2) tests are shown in Table 11.

Table 11

Frequency and Percentage Responses to Survey Items by Sex, Group Membership (CS and NCS), and X^2 Significance Levels

		Male N (%)			Female N (%)			Sig. level*
Q.12 items	Group	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I was good at learning IT-related skills at school	CS	2 (10%)	0 (0%)	19 (90%)	1 (9%)	2 (18%)	8 (73%)	ns
	NCS	1 (4%)	2 (9%)	20 (87%)	8 (16%)	10 (20%)	33 (64%)	ns
I was good at learning maths at school	CS	1 (5%)	1 (5%)	19 (90%)	2 (18%)	1 (9%)	8 (73%)	ns
	NCS	1 (4%)	2 (9%)	20 (87%)	8 (16%)	3 (6%)	40 (78%)	ns
I believe that good mathematical skills are essential to IT	CS	1 (5%)	2 (10%)	18 (85%)	3 (27%)	2 (18%)	6 (55%)	ns
	NCS	2 (9%)	1 (4%)	20 (87%)	3 (6%)	26 (51%)	22 (43%)	.001
I believe that good programming skills are essential to IT	CS	0 (0%)	2 (10%)	19 (90%)	1 (9%)	0 (0%)	10 (91%)	ns
	NCS	1 (4%)	3 (13%)	19 (83%)	3 (6%)	10 (20%)	38 (74%)	ns
I believe that logical thinking is important for studying IT	CS	0 (0%)	0 (0%)	21 (100%)	1 (9%)	2 (18%)	8 (73%)	ns
	NCS	1 (4%)	0 (0%)	22 (96%)	1 (2%)	9 (18%)	41 (80%)	.019
I am confident about my ability to learn new computer skills	CS	0 (%)	2 (10%)	19 (90%)	1 (9%)	0 (0%)	10 (91%)	ns
	NCS	0 (0%)	0 (0%)	23 (100%)	4 (8%)	10 (20%)	37 (72%)	.031

Note. *The level of significance is set at .05 ($p < .05$). ns = not significant.

In the subsequent discussion of the survey findings, all survey data referred to are the highest frequencies (and percentages) by sex in each sample (CS and NCS) for each survey item, which can be found in Table 11. To enable a better flow of discussion, survey responses of “agreed/strongly agreed” would be described as “agreed” and “disagreed/strongly disagreed” as “disagreed” for items based on the five-point Likert response format in the following sections and all other sections. It was highly possible that due to the relative small CS sample size, no statistically significant differences by gender were found. This then did not offer opportunities for discussion on statistically significant differences by gender in the CS sample. Since this research focuses on gaining an insight into the underrepresentation of females in the CS field, gendered differences found in the NCS sample were deemed as irrelevant, as the wording of the items were not related to their motives and reasons for non CS course pursuits. Therefore, the following sections present discussions (or comparisons) in terms of frequencies (and percentages) of survey responses by sex and/or by group membership (CS and NCS) where appropriate.

5.2.2.1 Individuals' perceptions of maths/IT learning at school

Individuals' perceptions of their maths and IT related learning at school were examined to see if previous achievements in one or both fields of learning prompted their CS participation. The majority of both samples agreed that while at school, they were good at learning IT-related skills (CS: M=19: 90%, F=8: 73%; NCS: M=20: 87%, F=33: 64%) and good at learning maths (CS: M=19: 90%, F=8: 73%; NCS: M=20: 87%, F=40: 78%). While it can be argued that for CS females self-perception as being good at learning IT or maths prompted their choices of CS courses, it was unclear as to why these two particular learning attributes did not encourage NCS females in choosing CS courses. Nevertheless, Margolis and Fisher's (2002) study also found that females who were highly successful in maths often did not venture into CS fields.

5.2.2.2 Individuals' perceptions of important skills for IT learning

Individuals' perceptions of the skills required to study IT were also explored. Perceptions of good mathematical skills as essential to IT did not vary by gender in the CS sample for those who agreed (M=18: 85%, F=6: 55%), yet responses by NCS participants differed: the majority of NCS males (20: 87%) agreed while half of the NCS females were not sure (26: 51%). For half of the CS females who believed good maths skills were essential to IT, this belief could have been a contributing factor in CS participation in comparison with their NCS counterparts. Fan and Li's (2002a) study found that females' perceptions of good maths abilities as essential for studying CS was one of the main reasons for their pursuit of undergraduate CS courses.

Perceptions of the other skills as essential for studying IT, including programming skills and logical thinking, were examined for their influence in CS course choices. It was observed that a higher proportion of CS females (10: 91%) than NCS females (38: 74%) agreed that good programming skills are essential to IT. McInerney et al.'s (2006) study also found that females who had an interest and a proficiency in programming were more likely to be motivated to study CS in higher education. Perceptions in logical thinking as important for studying IT did not differ statistically by gender in the CS sample (agreed: M=21: 100%, F=8: 73%), though a difference was evident in the NCS sample (agreed: M=22: 96%, F=41: 80%). A quick study of the proportional representation of females in the CS and the NCS samples found that, while high proportions of CS and NCS females agreed that logical thinking is important for studying IT, it did not seem to have an effect in motivating NCS females in pursuing CS, whereas it may have been encouraging for CS females in this study.

5.2.2.3 Individuals' confidence in IT learning

Individuals' confidence in learning new computing skills was deemed an encouraging factor in CS participation. The majority of the CS sample (M=19: 90%, F=10: 91%) and NCS sample surveyed (M=23: 100%, F=37: 72%) agreed they were confident in learning new computing skills, with a higher proportion of CS females than NCS females expressing this view. In contrast to Lewis et al.'s (2007) study which found that females are generally less confident than their male counterparts in their ability to do IT, no statistically significant differences were found in the CS sample, as was also demonstrated by the similar proportion of males and females who believed in their confidence in learning new computing skills.

In summary, high proportions of CS females and NCS females believed they were good at learning IT-related skills and maths when at school, yet self-efficacies in IT and maths learning did not necessarily lead females to choose CS courses. The perceptions of the need for maths and programming skills, as well as logical thinking did not differ by gender in the CS sample. It is worth noting that a noticeably higher proportion of CS females than NCS females was confident in learning new computer skills and believed that programming skills are essential to IT. The EVM also shows that individuals' self-concept of their own abilities, as well as their expectations of success will lead them into making educational choices in particular fields. In this instance, it appears that females' confidence (or lack of it) in learning new IT skills, and the skills they perceived to be needed to achieve in IT could have prompted or discouraged their participation in CS courses.

The following section presents the course knowledge that individuals possess which leads to their course participation.

5.2.3 Course knowledge

The sources from which participants gathered information about their courses are part of individuals' course knowledge which could lead to certain educational choices being made. The sources of course information are shown in Figure 4.

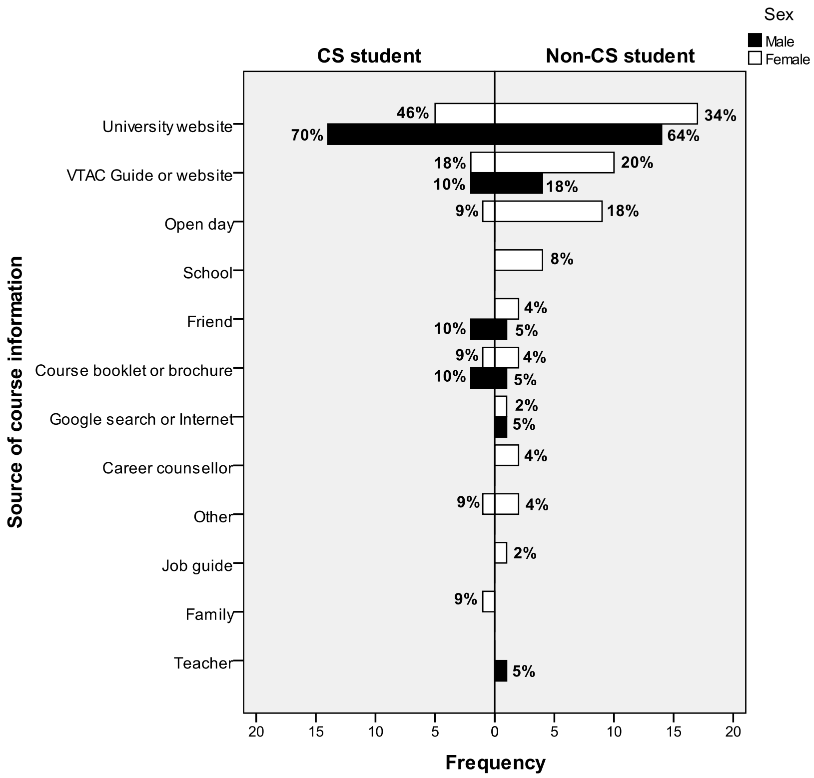

Figure 4. Source of course information (Q.24) by sex and by group membership (CS and NCS)

Figure 4 shows the most common source of course information was the university website for both the CS sample (M=14: 70%, F=5: 46%) and the NCS sample (M=14: 64%, F=17: 34%), followed by the Victorian Tertiary Admissions Centre (VTAC) guide (or website) (CS: M=2: 10%, F=2: 18%, NCS: M=4: 18%, F=10: 20%). A higher proportion of males than females from both samples used the university website to obtain information about their courses, while a higher proportion of females than males from both samples used the VTAC guide or website to learn about prospective course choices. Females, in general, seemed to have utilised a greater range of sources to learn about their courses than males.

Course features were another aspect of course related knowledge that was shown in the EVM as influencing individuals' course pursuits, as the understanding of the subject matter can lead to educational choices. "Programming" was the common feature of CS courses known by CS participants surveyed (M=7: 39%, F=8: 73%) and by two of the three CS participants interviewed (M=Jarrad, F=Sinead). Sinead (CS female) commented that the technical skills she would learn in CS would assist her in her science degree, "I knew how programming could be used for astrophysics or geographical mapping in my course…so I wanted to learn how to program properly". Jarrad also stated the technical aspects of CS such as "programming" were integral to CS. Programming was also found in other studies to be the most commonly known characteristic of CS (Lewis et al., 2007; Margolis & Fisher, 2002; Papastergiou, 2008). A noticeable gendered difference in Jarrad's and Sinead's responses was observed: while Jarrad explained quite a few things that he knew he would do when studying CS, Sinead, on the other hand, described herself as "knowing little about CS" prior to enrolment, yet then presented her understanding about the applicability of programming in astrophysics and geographical mapping for her own Science course. These findings suggest that while the perceived knowledge of course features may be similar between CS males and females, perceptions of how well they knew about the CS course varied somewhat. It was also evident that both Jarrad and Sinead's previous achievement-related experiences (e.g. having done well in senior secondary IT) and the subjective task values (such as interest-enjoyment value and utility value) attached to IT motivated them to participate in an IT related field of study such as CS at the undergraduate level.

In contrast, two of the four NCS participants interviewed (F=Zoe, Tess) revealed strong stereotypical notions attached to CS studies prior to enrolling in their own courses. For example, "The only [IT] exposure I had was the IT fix-it person who used to sit in the office and fix problems… It just didn't seem like a job I could imagine myself doing at all… it would be pretty boring". (Zoe, NCS female). Tess (NCS female) also raised perceptions that were similar to Zoe's, "I sort of knew CS was day-to-day computing things, so websites and software and a lot of programming". Zoe's and Tess's perceptions of CS as a study which involves a lot of programming or as boring professions, were examples of how individuals' stereotypical notions of the study and career tasks of CS discouraged career aspirations in the field. For Zoe, becoming a doctor strengthened her ideal goal of "helping more people" than a "boring" CS profession. As for Tess, becoming a robotics programmer fulfilled her long-term goal of "one day of building a robot" instead of CS careers which could require her to be "stuck to the computers all day". How stereotypical notions attached to IT could affect individuals' perceptions of other IT-related studies and professions was also highlighted by Redmond (2006), who suggested the gender imbalance in IT is largely due to a lack of understanding of IT studies and careers available. The EVM also highlights that individuals' stereotypes of the subject matter (e.g., CS courses) and occupational characteristics (e.g., CS related careers) could lead to non-choices in the field.

In contrast to the stereotypical notions possessed by Zoe and Tess, Ryan (NCS male) was able to discuss the actual task demands of CS (programming in theorems) and its applicability (being able to write C++ codes). Yet the stronger attainment value Ryan attached to physics and maths which he deemed as useful for pursuing engineering resulted in his non-pursuit of a CS course. NCS participants' responses in general illustrated how stereotypical perceptions could influence individuals, particularly females, not to pursue CS courses (or majors), and also showed that the lack of STVs individuals attached to IT (or CS) and previous IT related experiences contributed toward NCS participation.

In summary, course knowledge was important for participants to make informed choices about the possible range of educational options they could pursue at the undergraduate level. It was even more important to note that the university website was the most common source of course information, which highlighted the need for tertiary institutions to be sources of accurate and up-to-date details and information about the range of available courses, particularly a clear outline of the course features and electives individuals could study in CS courses or how they could pursue CS as a major in another course. “Programming” was nominated by a high proportion of CS participants surveyed and interviewed as one of the CS course features, yet participants’ responses also highlighted a need for high school graduates to gain a wider understanding of what CS studies entail prior to tertiary enrolment, and for them to understand the ways they could utilise what they learn in CS in conjunction with their interests. The CS participants interviewed revealed that an understanding of how they could utilise CS for future studies and for work were likely the reasons which encouraged their CS pursuits. On the contrary the stereotypical notions of CS held by NCS participants could have deterred them from pursuing it as a study or for future careers, as they did not possess an informed understanding of CS as a career or study to enable them to attach STVs to CS to make a relevant achievement-related choice (CS participation).

5.2.4 Reasons and influences over course choices

Eccles (2011) argues that gender differences in course enrolment in the physical sciences and engineering at the tertiary level are mediated by the relative STVs males and females attached to these fields compared to other fields. Only close to one-third of females (7: 64%) compared to males (17: 71%) in the CS sample surveyed revealed CS courses as their first preferences at the time they were admitted to university. Hence the reasons and influences accounting for males and females’ course choices are worth exploring. To enable a better flow of discussion, only the responses of the highest frequencies (and percentages) by males and females in both samples are presented. The frequencies (and percentages) of responses to the reasons for (Q.26a and 26b) and the influences (Q.28a and 28b) in their CS or NCS course participation are shown in Table 12.

Table 12

Frequency and Percentage Responses to Survey Items (Q.26 and Q.28) by Sex and Group Membership (CS and NCS)

		Q26a Why did you choose your current course? (You may choose one or more)		Q26b Which one of A to F was the most important reason?	
Item choice	Group	Male N (%)	Female N (%)	Male N (%)	Female N (%)
A. Challenging	CS	12 (67%)	5 (45%)	4 (22%)	0 (0%)
	NCS	**15 (68%)**	24 (49%)	6 (27%)	3 (6%)
B. Future income	CS	5 (28%)	4 (36%)	0 (0%)	0 (0%)
	NCS	9 (41%)	15 (31%)	1 (5%)	2 (4%)
C. Career prospects	CS	**13 (72%)**	**8 (73%)**	6 (33%)	**6 (55%)**
	NCS	13 (59%)	**35 (71%)**	4 (18%)	17 (35%)
D. Peer influence	CS	2 (11%)	1 (9%)	0 (0%)	0 (0%)
	NCS	0 (0%)	1 (2%)	0 (0%)	0 (0%)
E. Encouragement from family/friends	CS	2 (11%)	2 (18%)	1 (6%)	1 (9%)
	NCS	4 (18%)	16 (33%)	0 (0%)	2 (4%)
F. Personal interest	CS	4 (22%)	4 (36%)	**7 (39%)**	4 (36%)
	NCS	7 (32%)	23 (47%)	**11 (50%)**	**25 (51%)**
		Q28a Who influenced you in choosing your current course? (You may choose one or more)		Q28b Which one of A to H was the most influential?	
Item choice	Group	Male N (%)	Female N (%)	Male N (%)	Female N (%)
A. Father/male guardian	CS	3 (17%)	1 (9%)	0 (0%)	0 (0%)
	NCS	4 (18%)	17 (36%)	0 (0%)	2 (4%)
B. Mother/female guardian	CS	3 (17%)	2 (18%)	1 (6%)	1 (9%)
	NCS	5 (23%)	24 (51%)	2 (9%)	2 (4%)
C. Friends	CS	4 (22%)	1 (9%)	0 (0%)	1 (9%)
	NCS	5 (23%)	10 (21%)	0 (0%)	1 (2%)
D. Family members	CS	5 (28%)	4 (36%)	1 (6%)	2 (18%)
	NCS	4 (18%)	11 (23%)	2 (9%)	0 (0%)
E. Teachers	CS	3 (17%)	0 (0%)	0 (0%)	0 (0%)
	NCS	6 (27%)	13 (28%)	0 (0%)	0 (0%)
F. Career counsellors	CS	2 (11%)	0 (0%)	1 (6%)	0 (0%)
	NCS	5 (23%)	12 (26%)	2 (9%)	0 (0%)
G. Personal interest	CS	**16 (89%)**	**7 (64%)**	**13 (72%)**	**5 (46%)**
	NCS	**16 (73%)**	**45 (96%)**	**15 (68%)**	**40 (85%)**
H. Other people	CS	2 (11%)	2 (18%)	2 (11%)	2 (18%)
	NCS	1 (5%)	4 (9%)	1 (5%)	2 (4%)

Note. The figures in bold represent the highest frequencies (and percentages) of the responses to the survey items by sex in the CS sample and the NCS sample.

Table 12 shows that "career prospects" was the most common reason for course participation for the CS sample (M=13: 72%, F=8: 73%). In the NCS sample females also nominated "career prospects" (35: 71%) whereas it was "challenging" for 68% (15) of NCS males. CS participants interviewed (3: M=1, F=2) revealed that "career prospects" may not be the only motivating factor in CS course participation. Jarrad's (CS male) strong interest—enjoyment value attached to CS prompted his course change from materials engineering to CS, "I was first enrolled in materials engineering. I realised I didn't like it at all. So I switched back into something that I enjoyed". Sinead (CS female), in contrast, appeared to have attached a strong utility value for CS as it would enable her to advance in her course "I chose CS as it would support what I will later be learning in geodynamics." As opposed to the interest—enjoyment value and utility value that Jarrad and Sinead attached to CS, Kerryn (CS female) attached a stronger attainment value (personal importance) to studying CS and fulfilling her goals: "I could do a double-degree primary teaching and computer science". The CS interviewees revealed that the various STVs attached to CS courses due to personal interest (Jarrad), usefulness (Sinead) and career prospects (Kerryn) were motivating factors for pursuing CS courses. Without the aid of the STVs attached, the motivation for course enrolment in CS may not have been as strong.

In contrast, the NCS participants interviewed (3: M=1, F=2) did not consider studying CS due to the unappealing career choices or stereotypical perceptions about the course and associated careers. Ryan's (NCS male) response contrasted with the survey finding (NCS males chose courses because of the challenging nature), as he believed that "CS just didn't have an attractive end of career…I saw more attractive options with the course I currently chose". He reinforces the importance of interest in and perceptions about the career offered by CS as factors when choosing to study CS or not. As for Zoe (NCS female), the solitary nature of a CS profession did not appeal to her: "I was more interested in working with people. I think in CS, you probably don't work with people as much, it's more of a solo profession". Tess (NCS female) could not associate CS with her perception of a "more hands-on course" in contrast to her own course (Mechatronics): "it was taught a lot more—you learn this programming so you can get a robot to do this and that". NCS participants in general revealed they did not choose to study CS based on their perceptions that CS was not in accordance with their career aspirations. The perceived lack of career options (Ryan), the solitary nature of a CS profession (Zoe), and a not very hands-on course (Tess) highlighted NCS participants' perceptions and beliefs that the professions associated with possessing a CS qualification were "unappealing", "not sociable" and lacking in "practicality", offering these as the reasons they did not purse undergraduate CS studies.

The most important reason for participants' course participation was "personal interest" for CS males (7: 39%) and "career prospects" for CS females (6: 55%). The NCS sample chose "personal interest" (M=11: 50%, F=25: 51%). "Personal interest" was however dependent on participants' interpretation as revealed by the interviewees. Kerryn's (CS female) "liking for computer use" encouraged her CS participation and originated from her experiences of working with computers from an early age. Her parents' encouragement also nurtured her IT interests, further reinforcing her subsequent participation in a CS course. It was also Kerryn's goal of becoming a female computer scientist which further motivated her pursuit of a CS study. Sinead's (CS female) enjoyment of "programming" led her to pursue CS as a major. McInerney et al. (2006) also found that an interest and a proficiency in programming were the primary motivations for choosing to study CS. Jarrad's (CS male) perceived abilities and skills in IT ("I'm good at it") which resulted in "doing a course I enjoy" not only reflected a strong interest—enjoyment value attached to IT (or CS) but also highlighted his subsequent achievement-related choice (e.g. CS study). For Jarrad, a decision to study CS could be traced back to his previous successes in a VCE IT subject, which added to the positive IT experiences for him, and provided him with confidence in believing that success in the CS field was achievable, thereby encouraging his CS participation at the undergraduate level.

In contrast, two NCS females interviewed (F=Zoe, Tess) commented on the solitary nature and the routine of IT-related tasks performed at school, which deterred her from studying CS: "…being able to help people was important for me…At the time CS seemed like a study where you'd be stuck with computers all day". (Zoe, NCS female). Zoe also explained that the pursuit of her current study (medicine) was due to her career aspirations of "being able to help people"; CS was not aligned with this career goal. Zoe's perception of the nature of the CS profession (stuck with computers) discouraged her CS pursuit. Clayton's (2005) and Young's (2003) studies also found females tend to value working with people more than occupations which they considered as more technical and solitary; this could assist in explaining Zoe's eventual non-participation in CS. Tess's (NCS female) main reason for doing her Mechatronics course was to fulfil her interest-related goal of "I like the idea of one day being able to build a robot".

In addition to personal interest as an important reason in course participation, personal interest was also revealed to be the most common influence in the course choices of the CS sample (23: 72%) and the NCS sample (61: 82%). Personal interest was found to be the most influential factor in course selection for the majority of the NCS sample (M=15: 68%, M=40: 85%) and for the majority of CS males (13: 72%) and close to half (5: 46%) of CS females. A large Australian research study by Lyons et al. (2012) of 3500 first year undergraduates studying science, technology, engineering and maths (STEM) courses also found that around 86% of students considered personal interest to be important or very important in their STEM course choices. It was worth noting that no CS participants selected "father/male guardian" or "teachers" as most influential over their course participation. This highlighted the possibility of the more passive roles of fathers and also teachers in students' decision-making processes for IT-related pursuits such as CS at the tertiary level.

On the other hand, it was noted that personal interest in IT and/or CS related studies is related to previous educational experiences, and can be strengthened while individuals are still at school. All NCS participants interviewed (4: M=1, F=3) responded affirmatively that they would have considered choosing CS if IT was taught differently in secondary school. Ryan (NCS male) indicated that he would have preferred that his teachers "had come from a CS background" so it would be better for students like him to gain a "more accurate insight" into the IT or CS industry. This demonstrates the importance of providing students with more awareness of CS related studies and careers, which may assist in facilitating a greater likelihood of CS participation. For the NCS females interviewed (F=3), it was the perceived lack of utility value, interest—enjoyment value, and relative cost attached to IT-related learning or activities which deterred them from participating in senior secondary IT. Tess (NCS female) and Kira (NCS female) both commented on the unavailability of "programming" (Tess) and "IT subjects" (Kira) at school which failed to provide them with enough IT-related learning experiences for wanting to study CS at the undergraduate level. Zoe (NCS female), on the other hand, found it was her lack of exposure to the things that she found interesting and also the types of CS professions available that made her less inclined to want to study CS.

In summary, participants' responses to survey items regarding the reasons and influences for their CS and NCS participation at times contrasted with interview findings. While CS participants surveyed nominated career prospects as the most common reason for course choices, the CS participants interviewed indicated that an interest-enjoyment value attached to

IT or CS was more of the motivational factor which mediated CS pursuit. NCS females on the other hand nominated career prospects when surveyed and interviewed. “Personal interest” was perceived differently by CS and NCS sample interviewed as to why it was the most important reason for CS and NCS participation at the undergraduate level. CS participants explained that having an interest in computers or IT overall and gaining technical skills (e.g., programming) motivated their CS participation. In contrast NCS participants stated that the social aspects of careers such as working with people and applying skills in a “hands-on” manner were important. Personal interest was also found to be the most influential factor for course participation for both samples. Yet, the unavailability of IT-related studies at school, IT subjects being delivered by inexperienced IT teachers, and a lack of understanding of careers associated with CS could all have affected some females in this study to make NCS choices. Moreover, the NCS students interviewed also reported that a lack of accumulation of previous successful IT-related experiences during senior secondary school made it difficult for them to envision success in the CS field, thus making it less likely for them to want to pursue CS studies and professions. Therefore, improvements made on the IT curriculum and the way it is delivered can possibly provide more positive learning experiences for female students, which in turn promote a more positive outlook in choosing IT related studies such as CS.

5.3 After enrolment

5.3.1 Individuals’ perceptions of CS in general and coursework demands

Eccles’ (2011) EVM demonstrates that part of the achievement related choices is to do with the cultural milieu, where gender role stereotypes, as well as cultural stereotypes of subject matter can influence certain course choices. When CS participants were interviewed (3: M=1, F=2) about the kinds of gender stereotypes that were associated with CS, Kerryn (CS female) perceived CS as a study mainly for boys, “I expected mainly boys do the computer science type of thing and working on computers”. Associating males or assigning gender roles to CS became one of the stereotypical images of CS. Other studies have also found that males as “professionals” was a common gender stereotype associated with IT studies and professions (Craig, 2005; Stockdale & Stoney, 2007).

Sinead (CS female), on the other hand, regarded CS as gender neutral, with the exception of the examples used in her CS coursework that “were completely male-oriented” and “a bit sexist”. Sinead highlighted the seemingly gender-neutral characteristics of peers and educators in the CS classroom, yet found it hard to comprehend the predominantly male-oriented course content. Jarrad (CS male), in contrast, seemed more surprised that a female lecturer could teach and explain CS clearly, “She’s one of the best lecturers I have. But to be honest, I was really surprised to have a female lecturer in computer science…She’s clearly competent, but she’s very, very skilled at explaining things”. It can be inferred that Jarrad’s previous IT-related experiences perhaps did not enable him to associate female lecturers with possessing technical competency and good teaching skills. Jarrad’s example also illustrated that certain gender role stereotypes remained firmly associated with certain occupations, such as Jarrad’s expectations of socialisers (lecturers) being male. Yet when Jarrad encountered a female lecturer who was “competent” and “skilled at explaining things”, it destabilised his gendered perceptions that IT involved predominantly male-oriented activities.

Addressing the gender role stereotypes attached to CS courses and professions, such as by having (more) female lecturers teaching CS courses, can present a model of CS as a field of appropriate study for either sex, which can be a potentially positive influence for both male and female students. Other studies have also found that gender role stereotypes associated with IT-related studies such as CS were often due to a lack of female role models (Jepson & Perl, 2002; Stockdale & Stoney, 2007) and mentors (Wasburn & Miller, 2004).

All of the three NCS females interviewed revealed that "male-dominated" was the gender stereotype they associated with CS. Tess (NCS female) explained that the image of "a guy sitting alone and programmes always on a computer" just did not appeal to her. Zoe's (NCS female) image of "males who are into fixing their own computers" and "into gaming" again highlighted gender role stereotypes identified by the CS participants. Both Zoe and Tess associated gender role stereotypes with CS with images of a solitary male doing his own tasks. This is similar to Papastergiou's (2008) findings that females' misconceptions of CS consisted of little human interaction which further diminished their interest in CS related studies and professions. Kira (NCS female) discussed her perceptions of CS professionals as possessing "less of interaction with people and less creativity".

In contrast to stereotyping, all CS and NCS participants interviewed (regardless of gender) believed that it is important for individuals to participate in a course (or major) based on personal interests, and individuals should possess the freedom to choose what they want to study. In summary, CS and NCS females interviewed revealed that stereotyping (e.g. male-dominated, technical, solitary) associated with CS studies and professions was a mediating factor in the gendered participation in the CS environment. Both CS and NCS participants interviewed believed that males and females should not study courses deemed appropriate for their own gender to conform to societal beliefs and expectations.

A study of participants' understanding of the most important skills needed for their prospective courses revealed variations in responses by gender in the CS sample surveyed. Half of CS males (10: 56%) specified "logical reasoning" while close to two-thirds of CS females (7: 63%) nominated "good maths concepts". Other studies have also found that females who believed maths as important for IT learning and who have been successful in maths at secondary school were the ones who pursued CS courses in higher education (Margolis & Fisher, 2002; McInerney et al., 2006). CS participants' responses also highlighted that NCS participants who did not attach importance to the two skills (logical thinking and a good mathematical understanding) for studying and achieving well in CS could have been less inclined to pursue CS courses.

Participants' perceptions of coursework and of the classroom environment, as well as the skills required to be achieved in the course, were explored in an eleven-item survey question (Q.35). Chi-square (X^2) tests were used to explore whether statistically significant differences existed by gender in the CS sample. In line with the research question which is to identify the possible factors and how they influence females' participation and non-participation in CS courses, it was deemed appropriate to exclude NCS sample's responses to survey items in Q. 35 from the following table and in the subsequent discussions. The reason was that the survey items NCS participants responded to in Q.35 were not worded specifically to obtain their perceptions of the factors which may have discouraged their CS participation or what they think are the factors which influence CS participation. The frequencies (and percentages) of responses of the CS sample to the items in Q.35, as well as the outcomes (p) of the chi-square (X^2) tests are shown in Table 13.

Table 13

Frequency and Percentage Responses to Survey Items in Q.35 by Sex in the CS Sample, and X^2 Significance Levels

	CS survey sample						
	Male N (%)			Female N (%)			Sig. level*
Q.35 items	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I find the coursework time-consuming	4 (22%)	0 (0%)	14 (78%)	4 (36%)	0 (0%)	7 (64%)	ns
I find the coursework difficult	5 (28%)	4 (22%)	9 (50%)	1 (9%)	3 (27%)	7 (64%)	ns
The workload is heavier than I expected	10 (56%)	2 (11%)	6 (33%)	3 (27%)	2 (18%)	6 (55%)	ns
The coursework is too mathematical	12 (67%)	3 (17%)	3 (17%)	7 (64%)	1 (9%)	3 (27%)	ns
The coursework is technical	5 (28%)	0 (0%)	13 (72%)	2 (18%)	2 (18%)	7 (64%)	ns
I am considered "nerdy" for studying this course	1 (6%)	6 (33%)	11 (61%)	5 (46%)	2 (18%)	4 (36%)	ns
I find the subjects I am studying interesting	3 (17%)	2 (11%)	13 (72%)	0 (0%)	0 (0%)	11 (100%)	ns
The classroom environment is welcoming	2 (11%)	3 (17%)	13 (72%)	1 (9%)	5 (46%)	5 (46%)	ns
I am confident about asking lecturers/tutors for help	0 (0%)	4 (22%)	14 (78%)	1 (9%)	1 (9%)	9 (82%)	ns
I need to be good at mathematics to achieve well	3 (17%)	4 (22%)	11 (61%)	1 (9%)	1 (9%)	9 (82%)	ns
I need to be good at programming to achieve well	0 (0%)	0 (0%)	18 (100%)	0 (0%)	0 (0%)	11 (100%)	ns

Note. *The level of significance is set at .05 ($p < .05$). ns = not significant.

In the subsequent discussion of the findings, all survey data referred to can be found in Table 13.

5.3.1.1 Beliefs in skills required (or not required) to succeed in chosen courses

The perceptions of needing to be good at maths or programming to achieve well in CS were explored for their possible influence in individuals' CS course participation. The majority of the CS sample (M=11: 61%, F=9: 82%) surveyed agreed that they needed to be good at mathematics to achieve well. It is interesting to observe that a high proportion of CS females surveyed did not perceive (disagreed) their coursework as too mathematical (M=12: 67%, F=7: 64%). CS females surveyed not only revealed a difference in responses between perception and experience of the CS coursework, but they also provided an insightful perspective of the nature of CS courses for other females who may be considering of studies in the CS field.

Programming was another skill deemed by all CS participants surveyed (agreed) as necessary to achieve well (M=18: 100%, F=11: 100%). While chi-square tests found no statistically significant differences by gender in the perceptions of needing to be good at maths or good at programming to do well in CS courses, programming was certainly found to be a skill CS females attached to CS. This was similar to Frieze et al.'s (2006) study which also identified that females' confidence in programming greatly influenced their CS participation. The technical nature of CS courses did not seem to have discouraged females' choices of CS courses (M=13: 72%, F=7: 64%).

In summary, these findings show that although a higher proportion of CS males than CS females believed that good maths skills were essential for doing well in CS courses (or majors), chi-square tests did not indicate significant differences by gender in items previously mentioned. Programming skills were perceived as important for males and females in the CS sample, and CS participants' perceptions of the mathematical nature and technicality of their CS coursework also did not differ by gender.

5.3.1.2 Perceptions of socialisers and the CS learning environment

Individuals' perceptions of socialisers' (including peers', lecturers') were shown in the EVM as one of the contributing factors which lead to certain course choices. An interesting contrast was observed in the CS sample, where 61% (11) of CS males agreed they were nerdy for studying their courses, while close to half of CS females disagreed (5: 46%). CS females' responses, however, reflected what has been found in other studies: when females do not perceive CS as nerdy, they are more likely to pursue a CS study (Craig, 2005; Stockdale & Stoney, 2007). Interestingly, a higher proportion of CS males than females seemed to conform to the cultural stereotypes associated with the subject matter (CS course) by agreeing they were seen as "nerdy" for studying CS.

The classroom environment was thought to have affected individuals', particularly females' course participation in CS. The majority of CS males agreed that their classroom environments were welcoming (13: 72%) whereas CS females were either unsure (5: 46%) or agreed (5: 46%). To further examine the extent to which classroom environment affected CS participation, all CS participants interviewed (3: M=1, F=2) stated that their classrooms were "female-friendly". Sinead (CS female) did not believe gender was an issue, while Kerryn (CS female) commented on being the only girl in class yet having never been treated differently because of her gender; Jarrad (CS male) also felt that the classroom environment was as "friendly" as it could be. These findings were in contrast to a number of studies which found that females in IT fields reported feeling uncomfortable about males' attitudes (Gurer & Camp, 2002; Wasburn, 2004; Wasburn, 2007). Clearly the CS females interviewed (F=2) in this study were positive about their CS learning environments.

The influence of the CS classroom climate was examined more closely when all three CS participants interviewed (3: M=1, F=2) described their own experiences in the classroom as generally positive. Jarrad (CS male) found his CS experiences quite “enjoyable” and “constructive”; CS females reported feeling comfortable in the CS learning environment in general, with Kerryn (CS female) also commenting on seemingly different learning attitudes by gender: “some work was too basic for some boys so they mucked around a little…they probably didn’t take it as seriously as I was, and that was a bit annoying”. Kerryn’s experiences illustrated a potential gender gap in the CS learning context, due to females’ learning styles and paces of learning not being catered for. Lewis et al.’s (2006) study also highlighted that when females have very little time to understand work , they are less inclined to keep studying CS.

While Sinead’s (CS female) CS learning was also generally positive, she did find that when “people start taking about computer games, which some were really derogatory towards women” was the time when her CS learning environment felt like it was excluding females. Both CS females’ (Kerryn and Sinead) descriptions of their male counterparts’ behaviours in a CS learning context further illustrate the learning behaviours and attitudes are shaped by the CS culture which is constructed upon an array of patriarchal learning styles and course content. Similarly, Frieze et al.’s (2006) study identified that CS has little to do with gender but more to do with “culture”. It could be argued that the social identities in CS were governed by patriarchal parameters. This can have an effect on attracting females to study/work in CS, if the CS culture continues to define its content delivery and structure along exclusively male lines, and does not take females’ learning styles and needs into account.

Lecturers as one of the potential socialisers in influencing individuals' course participation were examined. The majority of the CS sample (M=14: 78%, F=9: 82%) surveyed agreed that they were confident about asking lecturers/tutors for help. All CS Students interviewed (3: M=1, F=2) appeared to be generally confident about asking for assistance from lecturers or tutors, however this was dependent on the attitudes and behaviours of the lecturers or tutors. Jarrad (CS male) and Kerryn (CS female) both explained that they would not find it difficult to ask for assistance due to the approachable attitudes displayed by their lecturers, yet Sinead (CS female) was more comfortable with asking for assistance from tutors than from lecturers. CS participants' responses also revealed that females would be more likely to study (or be retained) in CS with the support of socialisers (such as tutors, lecturers or parents).

It is evident that individuals' perceptions of socialisers' (lecturers/tutors/peers) attitudes toward them directly or indirectly affect their self-concept of ability in coursework; this in turn would affect their expectations of success in the CS field of studies. Participants' own experiences also demonstrated that lecturers' (or tutors') rapport and relationships with students are the key to prolonging and retaining participation in individuals' undergraduate CS studies. Other studies have also found that females' perceptions of socialisers (lecturers/tutors) as supportive of their studies motivated them to continue studying CS (Miliszewska et al., 2006; Wasburn & Miller, 2004).

In summary, the stereotypical images associated with CS related studies and professions may have discouraged some females from participating. While the classroom environment was deemed female friendly, Sinead (CS female) also highlighted aspects of the CS culture associated with male attitudes and behaviours which may make females within the environment uncomfortable, for example, when males talk about female characters in computer games in a derogatory manner. The majority of both CS males and females expressed their confidence in asking lecturers or tutors for assistance, yet this confidence was dependent on individuals' interpretation of socialisers' (lecturers'/tutors') attitudes and behaviours toward them; this may have some effect over retention or discontinuation in courses, particularly CS.

5.3.1.3 Interpretations of experiences with coursework

Individuals' interpretations of coursework experiences and perceptions of coursework demands can provide insightful perspectives for future females, in predicting the likelihood of females choosing studies in the CS field (Eccles, 2011). The majority of the CS sample agreed that their coursework was time-consuming (M=14: 78%, F=7: 64%) and difficult (M= 9: 50%, F=7: 64%). None of the CS participants interviewed (3: M=1, F=2) mentioned the time-consuming nature or the difficulty of their CS study experiences, but rather the "nerdy" aspect of CS for Sinead (CS female), "I thought it would be really difficult, it wasn't…however CS was even more nerdy than I anticipated…everybody was very focused on their computers and just typing away". Sinead's perception of people studying IT as nerds was also similar to factors found in other studies, which highlighted females' perceptions of those pursuing IT studies or careers as anti-social and lacking in social interaction, further deterring them from pursuing IT tertiary courses or careers such as CS (Craig, 2005; Lewis et al., 2007; Stockdale & Stoney, 2007; Timms et al., 2006). The females interviewed may have thought they did not need to study IT-related studies if they did not intend to work in the field.

Other aspects of the CS coursework including workload and subjects studied were also examined to provide a better indication of the relationship between coursework demands and subsequent CS participation. CS participants' responses to the workload being heavier than expected varied by gender: more than half of CS males (10: 56%) surveyed disagreed whereas more than half of the females (6: 55%) agreed. The gendered difference in perceived learning experiences within the CS sample was also similar to that found in Lewis et al.'s (2006) study, which revealed that a higher proportion of females than males reported experiencing a heavier workload in CS related studies. The perception of a heavier workload by females could dissuade some from continuing their CS course, or even discourage others who may be considering pursuing studies in the CS field. In terms of subjects studied in CS courses, the majority of the CS sample (M=13: 72%, F=11: 100%) agreed the subjects were interesting. A strong interest—enjoyment value attached to subjects studied in their CS courses was one of the robust factors in maintaining CS participation.

In summary, stereotypes such as the field being "male-dominated", "nerdy" or "anti-social" often accounted for females' decisions not to pursue CS related courses (and subsequently the professions in the field). Such stereotypical notions about CS related courses (or majors) and professions further illustrate a disconnection with females' self-schemata, or personal and social identities, as they could not foresee themselves working in solitary professions such as CS. Their perceptions of CS careers as requiring long working hours and revolving around computers rather than people were all examples of stereotypical notions attached to CS which further detracted from their interest in participating in the field. Moreover, the high proportion of CS females surveyed who believed that they needed to be good at maths and at programming in CS courses suggests that females who possess strong self-efficacies in these two skills are also more likely to enter the CS field. While CS participants interviewed (3: M=1, F=2) did reveal their classroom environment as generally welcoming, gendered differences in time required to understand course material, as well as the use of exclusively male examples were, at times, unappealing to female students in the CS classroom.

Participants from this study have illustrated that individuals' interpretations of experiences, cultural stereotypes of the subject matter (e.g., CS courses) and associated occupations (e.g., CS related studies and professions), perceived socialisers' (e.g., lecturers' and tutors') attitudes, as well as a range of STVs (interest-enjoyment value, attainment value, utility value and relative cost) contributed toward initial participation in CS or NCS courses. Regardless of participants' pursuits or non-pursuits of CS courses, stereotypical images and a lack of understanding of CS courses (or professions) was the recurring theme emerging from the survey and interview findings. Also, the STVs attached to IT (or CS), perceived activities associated (e.g., interesting subjects), as well as anticipation of success (e.g. obtaining good scores in chosen courses to fulfil study and/or career goals) were all motivational factors for individuals in making achievement-related choices (e.g. participation or non-participation in CS courses). An understanding of males' and females' CS coursework experiences provides a more gender balanced perspective into what it is like to study CS courses, which offers a more realistic overview of CS courses especially for secondary students who may be considering IT related courses such as CS at the tertiary level.

5.3.2 Cultural milieu: career related knowledge

The EVM shows cultural milieu as one of the factors which directly affects individuals' educational choices. In this study cultural milieu was examined in terms of the individuals' perceptions of the subject matter (e.g., courses) and occupational characteristics (e.g., career prospects, skills required for envisaged careers). A high proportion of the CS sample (M=16: 89%, F=9: 82%) and the NCS sample (M=20: 91%, F=42: 96%) surveyed knew the types of the careers associated with their courses. A proportion of CS participants surveyed indicated "programmer" (M=8: 44%, F=6: 55%) as the career they intended to pursue after the completion of their CS courses. CS Males identified “programming” (M=3: 38%) and CS females stated “logical thinking” (F=3: 50%) as important skills for working as a programmer. The perception of the skills needed in CS courses by CS males and females surveyed could have aided their participation in CS. Other studies have also found that a good understanding of the skills (e.g. programming, problem-solving skills) required to have a successful career are encouraging factors for females to want to study CS course (Frieze et al., 2006; Margolis & Fisher, 2002).

Participants’ perceptions of the occupational characteristics and work demands of their envisaged careers could have influenced their pursuit of CS or NCS studies. The following findings and discussion sections relate to participants’ career aspirations which could have affected their course choices upon entry to university. Similar to the format used to present survey responses for Q.35 (see Section 5.3.1), the survey responses provided by NCS participants for Q.37b are excluded. The researcher deemed this decision appropriate due to the items not having been worded specifically to ask for NCS participants’ opinions of how any of the items may have influenced their non-participation in CS courses. Thus the use of NCS participants’ responses for addressing the research question would have been irrelevant to the research question posed by this study.

Preconceived ideas and perceptions of careers were explored using survey question Q. 37b which contained eight items based on a five-point Likert response format. Chi-square (X^2) tests were used to explore if statistically significant differences existed by gender. The frequencies (and percentages) of responses to items in Q.37b, as well as the outcomes (p) of the chi-square (X^2) tests for the CS sample and the NCS sample are shown in Table 14.

Table 14

Frequency and Percentage Responses to Survey Items in Q.37b by Sex in the CS sample, and X^2 Significance Levels

	CS survey sample						
	Male N (%)			Female N (%)			Sig. level*
Q37b items	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I believe the pay will be high	4 (22%)	6 (33%)	8 (45%)	0 (0%)	7 (64%)	4 (36%)	ns
It will be difficult to balance a career with raising a family	7 (39%)	5 (28%)	6 (33%)	1 (9%)	2 (18%)	8 (73%)	ns
The career will require me to work long hours	4 (22%)	5 (28%)	9 (50%)	0 (0%)	4 (36%)	7 (64%)	ns
The workplace will discriminate against me	13 (72%)	4 (22%)	1 (6%)	6 (55%)	3 (27%)	2 (18%)	ns
Male colleagues will not welcome me	13 (72%)	4 (22%)	1 (6%)	6 (55%)	4 (36%)	1 (9%)	ns
I will have to sit in front of computers all day	3 (17%)	4 (22%)	11 (61%)	2 (18%)	0 (0%)	9 (82%)	ns
It will be difficult to get a job	4 (22%)	9 (50%)	5 (28%)	3 (27%)	5 (46%)	3 (27%)	ns
I will be able to transfer skills learnt in my course to the workplace	1 (6%)	4 (22%)	13 (72%)	0 (0%)	3 (27%)	8 (73%)	ns

Note. *The level of significance is set at .05 ($p < .05$). ns = not significant.

In the subsequent discussion of findings, all survey data referred to can be found in Table 14.

5.3.2.1 Career ideals and personal efficacy beliefs at work

The EVM (2011) shows that individuals' perceptions of demands of work can affect their goals and their abilities in achieving success in the field, which can affect subsequent CS course pursuit. The CS males (8: 45%) agreed while two-thirds (7: 64%) of CS females were unsure about the pay of their future careers being high. Chi-square tests however found no statistically significant differences by gender in perceptions of pay in the CS sample. CS females' responses contrast with Clayton's (2005) study, which found that optimism about a high salary motivated individuals' career choices, yet in this instance salary may not have been the most influential factor for CS females' participation.

The beliefs in the transferability of skills learnt in CS coursework to future workplaces were clearly strong, as the majority of the CS sample (M=13: 72%, F=8: 73%) agreed. The recurring use of words such as "useful", "valuable" and "specific" were in support of the survey finding, as all CS participants interviewed (3: M=1, F=2) reaffirmed their CS courses (or majors) as useful for preparing them for their future careers. CS participants' positive beliefs in the transferability of skills to future careers contrasted markedly with Miliszewska et al.'s (2006) study, which found CS students identified CS courses as impractical for adaptation in real careers. Clearly for the majority of the CS sample surveyed and participants interviewed, the CS coursework was found to be relevant and useful for future careers in the field.

In summary, gender role stereotypes, and particularly individuals' perceptions of gender roles attached to occupations which were traditional or non-traditional for either males or females, were identified by participants in this study as the reason why fewer females choose IT-related studies such as CS at the undergraduate level. Participants' expectations of pay (salary) revealed that a higher proportion of CS females were unsure (7: 64%) about the pay conditions of CS related professions than their male counterparts (6: 33%). The lack of understanding regarding pay conditions could have discouraged some of the females from gaining entry. On the other hand, the transferability of skills to the workplace was highly regarded by both males and females in the CS sample, and reveals that high proportions of CS males and females attached a high utility value to CS course participation and associated careers in the field.

5.3.2.2 Beliefs in colleagues' behaviours and attitudes in future workplace

Individuals' perceptions and beliefs about socialisers' (colleagues in this instance) behaviour and attitudes toward them at work could have encouraged or discouraged CS participation. A higher proportion of CS males than CS females disagreed that their workplaces would discriminate against them (M=13: 72%, F=6: 55%) and disagreed that male colleagues would not welcome them (M=13: 72%, F=6: 55%). It was interesting to observe that more than half of the CS females surveyed did not perceive that they would be intimidated by male colleagues at work, which is in contrast to Lewis et al.'s (2007) findings that anticipated discrimination may have a strong impact on females' course selections in choosing a male-oriented career field. This study has found that while more than half of the CS females surveyed were positive about their future work environments and treatment from male colleagues, females who were not sure or who believed they would be confronted with discrimination are likely to establish alternative study and/or career related goals in fields other than CS. It is therefore essential to a gain a better insight into how those females formed such perceptions about their envisaged work environment as possibly discriminating against them, in order to tackle the misconceptions to maintain as much as an equitable representation of females as possible in the CS field of studies and work.

5.3.2.3 Beliefs regarding work demands

Another belief deemed as influencing particular course pursuits by gender was about work and family balance. For example, Nielsen et al. (2004) revealed that IT female professionals found it harder to cope with family and work due to the long working hours and the associated challenges and task demands. A high proportion of CS females surveyed were also found to have agreed that it would be difficult to balance careers with raising a family (8:

73%) in contrast to their male counterparts who disagreed (7: 39%). Another perception that CS careers could hinder work-family balance was also revealed by a high proportion of CS females agreeing that their careers would require them to work long hours (F=7: 64%), in contrast to only half of CS males (M=9: 50%). Chi-square tests however found no statistically significant differences by gender in balancing family and working long hours in the CS sample. Participants' responses to another job-related demand, "sitting in front of computers all day", did not vary by gender with the majority of the CS sample surveyed agreeing (M=11: 61%, F=9: 82%). Two of the three CS participants (F=Sinead, Kerryn) and one of the four NCS (F=Kira) participants interviewed revealed the stereotypical images such as "sitting in front of the computer all day", "nerdy" and "anti-social" they associated with CS professionals. The stereotypical images of CS professionals and associated careers were known to both the CS and NCS females surveyed, yet the reasons why such images had not deterred the CS females interviewed in pursuing CS courses but discouraged the NCS females from choosing CS courses still requires further exploration.

5.3.2.4 Expectation of success in future careers

Frome et al. (2006) found that individuals' concerns regarding their employment prospects in IT had a profound impact on efforts to attract more individuals, particularly females, to work in the industry. Close to half of the CS sample was unsure (M=9: 50%, F=5, 46%) if it would be difficult to get a job. These findings revealed that the expectation of successfully obtaining jobs was low for the CS sample regardless of gender, yet the survey findings contrasted with that of those who were interviewed. Six of the seven participants interviewed indicated their intention to work after graduation, illustrating a difference in terms of the perceptions of the employment prospects between those surveyed and those who were interviewed. The provision of more information regarding the possible career paths in CS related fields can also act as a motivating factor in females' pursuit of courses in CS.

In summary, CS females' perceptions that they would not be discriminated against at work and that they would not experience unwelcoming attitudes by male colleagues further suggested that it was the perceived gender equity in the CS environment which did not prevent CS females from pursuing CS in the first place. CS females believed that it would be difficult to balance both work and family, and the perceptions of CS related professions as demanding, which could very likely discourage some females who may be seeking a more balanced work-family lifestyle. The stereotypical notion of "sitting in front of computers all day" that was perceived by CS females, also suggests that the perceived occupational characteristics of CS related careers could encourage females to make educational choices in fields other than CS. Also, the level of positive expectation of successfully gaining employment in CS fields could lead some females with low levels of expectation to pursue professions in NCS fields instead. An inadequate knowledge regarding the types of jobs available in the CS field could be a discouraging factor when females are making tertiary course choices.

It is therefore important that females' understanding of the pay conditions and the work environments expected in CS related fields be strengthened. Also, an understanding of the work demands from female CS professionals in the field is essential in motivating females' course pursuits in the field, especially so that high school females gain an accurate overview of the demands of CS courses and careers and thus not make course choices in NCS fields based on their stereotypical perceptions of CS.

5.4 Conclusion

Australian participants' secondary schooling experiences, formal and informal IT-related learning and IT-related exposure, both within and outside of school contexts, as well as influences of socialisers, expectations and perceptions of CS and NCS courses and careers were examined in this study to better identify the key factors and determine how they influenced individuals', particularly females' participation in CS and NCS courses (or majors) at the undergraduate level. Findings have identified that the gender imbalance in the IT as well as CS fields in general was seen to be mainly due to the noticeably higher proportion of males than females who chose to participate in IT courses. This then resulted in a higher proportion of males than females who ended up possessing the qualifications to teach IT-related studies at both the secondary and tertiary levels. CS participants interviewed revealed that an interest in the subject (IT or CS related studies), or a strong utility value attached to IT or CS motivated participants to choose CS courses. It was found that teachers' encouragement in developing computer skills differed by gender in the CS sample, as CS males were encouraged by their secondary teachers more than their CS female counterparts to develop computer skills. However, this study has found that while gender differences were noted in receiving teacher's encouragement on developing computing skills in the CS sample, the underlying factors for CS females in choosing CS courses would have outweighed secondary teachers' influence as a socialiser in their participation in CS courses.

The influences of socialisers in individuals' educational choices in CS revealed that individuals' perceptions of socialisers' (teachers') expectations and behaviours were encouraging or deterring factors in females' establishment of study and career goals in the CS field. A lack of "interest–enjoyment value" was therefore a discouraging factor for the NCS participants interviewed to pursue CS courses. NCS females' interpretations of previous achievement-related experiences of IT-related learning as unappealing therefore made participation in CS unlikely. Unappealing images of those who study and work in CS, such as perceiving them as “nerdy” and “computer-obsessed” deterred NCS females interviewed from pursuing CS. This presents as an interesting finding which highlights stereotypical images as one of the more influential factors which made CS courses an unappealing study or career choice for females.

A higher proportion of CS females than NCS females surveyed believed that they were good at learning IT-related skills at school, which further highlights the importance of previous positive IT learning experiences as motivational in females’ participation in CS. An understanding of the CS courses such as course features of CS and skills required prior to enrolment could have also contributed toward CS females in choosing CS. In addition to course knowledge, the “interest—enjoyment value” attached to IT-related learning (or studies) and/or activities while at school, as well as the utility value (or perceived usefulness) of CS were found to have greatly encouraged CS females’ pursuits. On the other hand, NCS females’ secondary IT-related learning experiences and the lack of understanding of the possible IT related studies and careers did not motivate them to pursue CS courses.

Gender stereotypes, such as CS studies and professions being seen as “male-dominated”, consisting of “male professionals” and “nerds” may have affected females’ NCS course choices. In addition to females’ perceptions of tasks associated with CS, the perception of the classroom environment as “female-friendly” and “welcoming” could be encouraging factors for making CS-related study choices, as a positive outlook on the classroom environment and the anticipated enjoyable learning experiences in CS were the reasons CS females chose CS courses initially.

Career-related perceptions, aspirations and misconceptions were often important factors which facilitated or discouraged CS participation. The transferability of skills to the workplace was found to be highly important for the majority of the CS sample, regardless of gender. A higher proportion of CS females than CS males believed that the difficulty of balancing work and family would potentially make it even more difficult for some females to decide to pursue CS courses. Lastly, career prospects and employment opportunities associated with CS were also found to be particularly important for individuals, particularly females, when deciding whether to pursue CS. It was found that females' perceptions of the likelihood of success at doing well in their intended courses and future professions were the most motivational factors in addition to the interest—enjoyment value and other STVs attached to the subject matter (course options). Regardless of participants' previous achievement-related experiences in IT-related studies (and/or activities), or the cultural stereotypes associated with the careers (particularly CS related) they intended to pursue, it appeared that females who placed stronger STVs (e.g., utility, attainment and/or interest—enjoyment value) on IT-related tasks or studies while at school seemed more inclined to pursue CS courses at the undergraduate level. The CS participants, both surveyed and interviewed, also revealed that their awareness of the demands of the CS coursework and CS related professions equipped them with adequate knowledge to pursue CS courses as their undergraduate studies.

The surveys and interviews conducted with males and females from the CS sample and the NCS sample revealed that secondary IT related experiences seemed to have contributed or discouraged participants in CS course participation. It was also found that STVs, such as a strong interest—enjoyment value that females attached to IT-related learning at school, and/or a strong interest in IT-related tasks or activities in out-of-school contexts prompted CS participation at the undergraduate level. Other STVs such as utility value were also found to constitute the second strongest factor after interest—enjoyment value. Females' perceived usefulness of courses for future careers (or future plans/goals) was also an important factor when deciding on whether or not to study CS courses. In contrast, stereotypical perceptions regarding CS related courses – rather than gender role stereotypes as previously assumed – were found to have possibly hindered NCS females' pursuits of CS courses. Furthermore, preconceived notions regarding CS related professions, and stereotypes regarding the demands of CS related careers may have prevented many females from participating in the CS field. Most importantly, the principal factor for course participation was revealed as being "personal interest" in IT-related learning (such as an interest in working with computers, in programming), and was powerful for CS participation, regardless of gender.

Similar to the reporting format of the survey and interview findings used in this chapter, the following chapter presents the findings from Taiwanese students and present survey and interview results on a range of key factors accounting for undergraduate course participation by gender and by group membership (CS and NCS).

Chapter 6. Results and discussion – Taiwanese students

The Taiwanese sample comprised 66 participants with a survey completion rate of 79% (52 completed surveys). There were 41 (62%) participants who identified themselves as studying a Bachelor of Computer Science (CS) or major, and 11 (17%) participants who identified themselves as studying a Bachelor's degree or major other than CS (NCS), while 21% (14) did not specify if they were a CS or a NCS student. Participants who did not complete Q.21a "What is the full name of the degree that you are currently studying?" or did not respond to Q.21b "Do you major in Computer Science?" (14: 21%) were excluded from the analysis, as these data could not be analysed by group membership (CS and NCS).

Similar to the reporting format used in the Australian chapter (see Chapter 5), four questions of the online survey were excluded from the analysis reported in this chapter (i.e., Q.15 and Q.16 regarding the occupation of father and mother; Q.33 and Q.34 regarding the regularity of performing a range of activities on the computer for leisure and for study). Also, the same statistical procedure (i.e., chi-square test) was used to examine if factors contributing toward course participation differed by gender in both samples (CS and NCS). The level of significance was also set at .05, and the effect size (ES) was provided when the *p* value was .05 or smaller (ϕ for 2 by 2 tables; *V* for larger tables), with reference to Cohen's (1992b) conventions for ES where small = .10, medium = .30, and large = .50.

In conjunction with survey findings, interview data were also gathered in response to some of the interesting findings from the surveys. This Taiwanese chapter adopted the same reporting format used in the Australian chapter, firstly presenting individuals' secondary schooling experiences and IT-related exposure in the "Prior to enrolment" section, followed by a section on the “Course decision-making process” which presents the effects (if any) of socialisers, and individuals’ perceptions and beliefs in skills required to achieve success in particular subject matters, as well as the role of subjective task values (STVs) attached to participation in particular studies or subject matters. The “After enrolment” section presents individuals’ interpretations of experiences of their own courses, as well as their perceptions of studies and prospective careers.

Ten participants who had fully completed the surveys volunteered to participate in a 45 minute interview (M=5, F=5), which consisted of eight participants (M=4, F=4) who were studying a CS course or major (CS students), and two participants (M=1, F=1) who were studying a course or major other than CS (NCS students). These participants were studying at the most prestigious university in Taiwan, a top-ranking tertiary institution located in central Taipei which is known for its reputation and status. All of the students interviewed were in their fourth year of undergraduate courses, and were aged between 21 and 22.

The personal demographics of the Taiwanese group and their secondary schooling experiences are presented in the following section.

6.1 Prior to enrolment

6.1.1 Participant demographics

Demographic information provided by the 41 (M=29, F=12) CS participants and 11 (M=4, F=7) NCS participants of the Taiwanese sample revealed that more than one-third of males (11: 38%) were 25 years of age or older, and the rest were 25 years old or younger (17: 62%) ;

a large proportion of CS females were 22 years of age (5: 42%), and the remaining were younger (4: 33%) or 23 and older (3: 25%). In the NCS sample, half of the males (2: 50%) were 20 years of age, and the remaining were 20 years of age (1: 33%) or over 25 (1: 33%). The age of NCS females varied, consisting of 6 (87%) females who were 21 (2: 29%), 22 (2: 29) or 23 years of age (2: 29%), and one (14%) aged 20. Approximately 12 (41%) males and 7 (58%) females of the CS sample and half of the NCS sample (M=2: 50%, F=4: 57%) identified themselves as the eldest child of their families. The majority of the CS sample (M=22: 76%, F=7: 58%) and the NCS sample (M=4: 100%, F=5: 71%) attended single-sex schools. Chi-square tests however found no statistically significant differences by gender in single-sex schooling in both samples. In this instance, single-sex schooling did not seem to have an effect on undergraduates' choices of CS courses as suggested by a number of researchers (Craig, 2005; Leech, 2007; Papastergiou, 2008; Redmond, 2006). In terms of educational backgrounds, approximately 12 (41%) CS males had an undergraduate degree with honours, while 7 (58%) CS females and half of the NCS sample (M=2: 50%, F=4: 57%) had an undergraduate degree as their highest level of qualification. More than a quarter of males (8: 28%) were enrolled in the fifth year while most females (5: 42%) of the CS sample were enrolled in the fourth year; all NCS males (4: 100%) were studying in the third year while most NCS females (3: 43%) were fourth year students.

6.1.2 Secondary schooling

The types of schools attended by participants, as well as their previous achievement-related experiences (e.g., subjects studied during senior secondary school) had been thought to be able to contribute toward participation or non-participation in CS. Also, the senior secondary maths subjects were checked for comparable similarities with the Australian senior secondary maths curriculum. In order to support meaningful discussion of the influence of final year secondary mathematics study on participation in CS, and to allow comparison between the two countries it is helpful to establish the parity and differences of content in the subjects offered. Thus, the final year (Year 12) senior secondary mathematics (maths) subjects offered in both Victoria Australia and Taiwan together with their content areas are shown in Table 15 (College Entrance Examination Center, 2010; Victorian Curriculum and Assessment Authority, 2010).

Table 15

Australian and Taiwanese Year 12 Mathematics Subject Content

Australian maths	Taiwanese maths
Further Mathematics (or equivalent) *Data analysis – core* • Presentation, summary, description and analysis of univariate and bivariate sample data *Applications – module* • Number patterns • Geometry and trigonometry • Graphs and relations • Business-related mathematics • Networks and decision mathematics • Matrices	General Maths I, II, III &IV • Number and expression • Polynomial function • Exponential, logarithmic functions • Sequence and series • Array and combination • Probability • Data analysis • Trigonometry • Line and circle • Plane vector • Space vector • Space plane and a straight line • Matrices
Mathematical Methods (or equivalent) • Functions and graphs • Algebra • Calculus • Probability	Mathematics B • Probability and Statistics II • Trigonometric functions • Limits and Function
Specialist Mathematics (or equivalent) • Functions, relations and graphs • Algebra • Calculus • Vectors • Mechanics	Mathematics A • Probability and Statistics II • Trigonometric functions • Limits and Function • Polynomial Calculus

Note. General maths I, II, III and IV are compulsory maths subjects for all Taiwanese senior secondary students in Year 10 and Year 11.

Table 15 shows that general maths I, II, III and IV are studied by all Taiwanese students in the first two years of senior high school (Maths I, II in Year 10; Maths III and IV in Year 11), before students choose either Maths A or Maths B in Year 12. Taiwanese students are tested on General Maths I & II, III & IV in conjunction with Maths A or Maths B as part of the college entrance examination (CEE) requirements (College Entrance Examination Center, 2009a; College Entrance Examination Center, 2009b). Mathematics A is considered more difficult than Mathematics B, and is recommended for those wishing to pursue Sciences, IT-related fields or engineering; Mathematics B is recommended for those wishing to undertake business, arts and humanities courses at university (College Entrance Examination Center, 2010). The content of Taiwanese maths subjects was found to be similar to the Victorian maths subjects after a careful examination. Taiwanese students who took Mathematics A studied probability, trigonometric functions, limits and functions and polynomial calculus, which were equivalent to Australian students who studied Mathematical Methods and Specialist Mathematics (MM & SM). Taiwanese students who studied Mathematics B studied probability and statistics, and trigonometric functions which were equivalent to the topics studied by Australian students who took Further Mathematics and Mathematical Methods (FM & MM). The senior secondary IT curriculum offered in Taiwan was also compared with the Australian IT curriculum (see Section 1.1.2.1) to enable comparable discussions in this chapter.

The frequencies (and percentages) of responses to survey items regarding senior secondary schooling, as well as chi-square test results, are shown in Table 16.

Table 16

Frequencies and Percentage Responses to Secondary Schooling Items by Sex and Group Membership (CS and NCS), and X^2 Significance Levels

Survey items	CS Participants Male N (%)	CS Participants Female N (%)	CS Participants Sig. level*	NCS participants Male N (%)	NCS participants Female N (%)	NCS participants Sig. level*
Q.5b Attended single-sex school	22 (76%)	8 (67%)	ns	4 (100%)	5 (71%)	ns
Q.6a Studied secondary maths	29 (100%)	12 (100%)	ns	4 (100%)	7 (100%)	ns
Maths B[a]	0 (0%)	0 (0%)	ns	0 (0%)	1 (14%)	ns
Maths A[b]	29 (100%)	12 (100%)	ns	4 (100%)	6 (86%)	ns
Q.6c Studied university-level maths	8 (28%)	1 (8%)	ns	1 (25%)	1 (14%)	ns
Q.7 Studied senior secondary IT	7 (24%)	2 (17%)	ns	0 (0%)	1 (14%)	ns
Single subject only:						
Introduction to Information Technology[c] (IIT)	1 (14%)	0 (0%)	ns	0 (0%)	0 (0%)	ns
Information Science[d] (IS)	6 (86%)	1 (50%)	ns	0 (0%)	0 (0%)	ns
Combination of subjects:						
IIT & IS	0 (0%)	1 (50%)	ns	0 (0%)	1 (100%)	ns

Note. [a]equivalent to Further Maths and Maths Methods; [b]equivalent to Maths Methods and Specialist Maths; [c]equivalent to IT Applications; [d]equivalent to Software Development.
*The level of significance is set at .05 ($p < .05$). ns = not significant.

Table 16 shows that the majority of the CS sample (M=22: 76%, F=8: 67%) and the NCS sample (M=4: 100%, F=5: 71%) attended single-sex schools. Craig (2005) suggested girls who attended single-sex school have more positive attitudes toward computing, thus would be more likely to study IT-related courses at university. All participants studied senior secondary maths (CS= 41: 100%, NCS= 11: 100%). Taiwanese participants were required to study "Maths A" or "Maths B" during senior secondary school. Students wishing to pursue IT, Computer Science or engineering-related courses at the tertiary level were advised to study Mathematics A (College Entrance Examination Center, 2010). For instance, Maths A was a prerequisite for admission into the Department of Computer Science and Information Engineering at National Taiwan University, "Students must have studied Chinese, English, Mathematics A, Physics and Chemistry." (National Taiwan University, 2010a). Similarly, to study for the Bachelor of Computer Science at Monash University in Australia, students needed to have obtained scores of at least 20 in mathematical methods (either) or specialist mathematics, or at least a score of 35 in further mathematics" (Monash University, 2011).

Individuals' previous educational experiences including senior secondary maths and IT subjects studied were examined for their roles in mediating CS or NCS participation. The whole CS sample (41: 100%) and NCS sample (11: 100%) surveyed studied senior secondary mathematics. All CS participants and the majority of the NCS sample (10: 91%) surveyed studied Maths A, except for a female student from the NCS sample who studied Maths B. Only a small proportion of the CS sample (M=8: 28%, F=1: 8%) and the NCS sample (M=1: 25%, F=1: 14%) studied university-level mathematics in Year 12. The high maths scores required to study CS related courses at many universities (College Entrance Examination Board, 1994) could have hindered some females from pursuing CS courses. For example, some of the NCS females may have been very interested in IT at the senior secondary level and have wanted to pursue CS study at the tertiary level (i.e., they attached a strong interest value to CS), yet they may not have been able to study CS courses (or majors) due to insufficient maths and CEE scores to satisfy the requirements set by many Taiwanese CS courses.

Senior secondary IT learning experiences were also examined for their influence on individuals' CS pursuit. Only 9 (M=7: 24%, F=2: 17%) CS students had studied IT at senior secondary school level. The majority of the CS participants (M=6: 86%, F=1: 50%) who had studied senior secondary IT had studied a single IT subject only (IS); only two females (CS: 1, NCS: 1) studied both IIT & IS. In the final year of secondary school, the majority of CS males (5: 71%) were taught by male teachers (IIT=1: 14%, IS=4: 57%) rather than by female teachers (IS=2: 29%), whereas CS females were taught by female teachers only (IS=1: 50%, IIT & IS=1: 50%). The exposure to female IT teachers during senior secondary school could have exerted a positive influence on female students' interest in academic and career pursuits in IT-related fields such as CS. However, one NCS female surveyed studied both IIT and IS, both of which were taught by male IT teachers. The exposure to male teachers may have reinforced the stereotype of IT as a subject where males excel (Stockdale & Stoney, 2007), which has often impeded secondary students from entering CS fields (Jepson & Perl, 2002). A larger female sample size is needed to validate the assumption of male or female socialisers' influence in the participation by gender in the CS sample further.

In summary, responses from both CS and NCS participants surveyed and interviewed indicated that high proportions of both males and females had studied advanced senior secondary maths such as Maths A (MM & SM or equivalent). This indicates that a strong attainment value was possibly placed on studying advanced maths in order to keep course options open at the undergraduate level. The underlying importance of having studied advanced maths was also highlighted by the fact that all CS participants surveyed had studied Maths A. On the other hand, participation in senior secondary IT did not seem particularly appealing or to have been perceived as a favourable subject to the majority of CS and NCS participants surveyed, as demonstrated by the very small proportion of both CS and NCS participation in IT at the senior secondary level. These Taiwanese findings contrasted with those predicted by Eccles et al.'s (2011) expectancy value model (EVM), which suggests that previous achievement experiences (e.g., IT or maths related learning at the secondary level) affect individuals' interpretations of experience and the values they attached to subject matters (e.g. CS) for making course choices. Taiwanese CS participants in this study have demonstrated that a stronger personal importance (e.g., attainment value) and/or utility value attached to studying Maths A than to senior secondary IT subjects (such as IIT or IS) was possibly a motivational factor in their CS course pursuits. Taiwanese participants in this study have also shown that even without previous participation in senior secondary IT, the pursuit of CS courses at the undergraduate level was considered more appealing and/or appropriate than studying IT at the senior secondary level.

6.1.3 IT-related exposure

The IT-related learning which individuals experience at the senior secondary level, particularly previous successes or enjoyment gained from IT-related activities could have, in effect, increased their likelihood of tertiary CS participation. When individuals interpreted IT-related experiences in a positive manner, the STVs (such as interest—enjoyment value) attached to IT-related courses such as CS would have been stronger, which would make individuals more motivated to pursue CS courses. It can also be argued that successful IT-related experiences may have promoted (or increased) self-confidence, which can strengthen the interest—enjoyment value attached to IT (or CS), which in turn increases individuals' expectations of success in the CS field.

The following sections present participants' pre-university IT-related experiences both within the school context and out of the school context.

6.1.3.1 IT experiences within schools

The EVM (2011) outlines that individuals' achievement-related choices (e.g., course choices) can be traced back to their previous achievement related experiences (e.g., successes in fields related to subsequent course choices) or their interpretations of such experiences. In this study individuals' IT-related experiences within schools were examined. Only two (CS: M=1: 3%, NCS: F=1: 14%) participants attended open days regarding IT-related courses or careers during senior secondary school. Three (10%) CS males but no NCS participants attended information sessions. The survey responses revealed that the majority of CS participants who did not attend open days or information sessions still pursued undergraduate CS courses. This also highlights that open days and information sessions have no apparent influence on CS course participation.

A trend emerged in that male IT professionals were known to both samples, which could have discouraged some females' CS participation. The survey findings revealed that a higher proportion of males than females in the CS sample (M=4: 14%, F=1: 8%) and the NCS sample (M=2: 50%, F=2: 29%) knew computer professionals when at school, and all knew male professionals only, except for one CS male who knew a female computer professional. A lack of female IT professionals not only reinforces some females' stereotypical notions of IT professionals as "males" only, but could also have made it difficult for them to understand what it would be like to work in IT-related fields. Other studies have also found that a lack of female role models in IT made female students less inclined to want to pursue CS related studies or careers (Jepson & Perl, 2002; Stockdale & Stoney, 2007). Individuals' stereotypes of CS courses and the work demands associated with CS careers could have deterred females from entering the CS field.

Other forms of IT-related exposure including computer access and teachers' encouragement were explored for their roles in mediating individuals' course choices. The access to computers in class did not vary for the majority of the NCS sample (M=4: 100%, F=6: 86%) surveyed, yet a chi-square test (with Yates Continuity Correction) revealed a statistically significant difference by gender in the CS sample, X^2 (1, n = 41) = 6.07, p = .01, ϕ = .44.

The measured ES ($\phi = .44$) also suggested a medium level of association between computer access and gender in the CS sample. CS males (23: 79%) had greater access to computers than CS females (4: 33%) while at school. It was shown that only a small proportion of CS females surveyed had computer access, yet this did not seem to have discouraged those without access from pursuing courses in the field.

On the other hand, socialisers' (teachers') behaviour toward individuals' acquisition of computer-related skills were perceived differently by males and females. In the CS sample surveyed, a higher proportion of males (12: 41%) than females (2: 17%) in contrast to a higher proportion of NCS females (4: 57%) than NCS males (1: 25%) believed their secondary school teachers encouraged them to develop computing skills. However, no statistically significant differences by gender were found in either of the samples regarding the effect of participants' perceptions of socialisers on course pursuits; there was no apparent effect for participants across course type or gender.

In summary, although a considerably smaller proportion of females of the CS sample had access to computers in the classroom, it did not seem to be a discouraging factor in CS participation, nor did access seem to have encouraged NCS females to pursue CS courses. While a relatively higher proportion of CS males than CS females reported having received teachers' encouragement on developing computing skills, it is still of concern to note the dominance of males in the teaching of IT and in the industry. A persistent exposure to mainly male IT teachers and male IT professionals may represent IT-related courses or careers as male-exclusive, which could make females feel unwelcomed and become less inclined to pursue courses or careers in the field.

Computer games constituted the most common form of IT experience at secondary school for 7 of the 8 CS participants interviewed (7: M=3, F=4), followed by simple programming skills (e.g. "using html commands to create webpages") (CS: M=1, F=3; NCS: M=1). The NCS male interviewed had some programming experiences while the NCS female interviewed commented on having used flash to create animation. It appears that regardless of group membership (CS and NCS), some participants appeared to have enjoyed IT-related learning, since they attached a certain degree of interest—enjoyment value to IT via interaction with games, while others had acquired and applied simple programming skills which formed part of their earlier IT-related experiences. Participants' successful experiences from their previous achievements in IT-related learning may have reinforced their belief in obtaining success in a similar course (or career) to IT, such as CS. CS females' (F=3) interpretation of games as "fun" or "enjoyable" further reinforce the view that enjoyable IT-related activities at school are essential not only for females but for both sexes to ensure positive, enjoyable and flexible learning occurs in the uses of IT. This would also make IT-related fields of study and professions more appealing, interesting and enjoyable for both sexes when they consider educational and occupational choices in the CS field.

Game playing constituted a large proportion of IT classes during secondary school for the two CS females interviewed (Li-Wen and Wei-Yin). A combination of enjoyment gained from games, as well as a lack of attainment value attached to secondary IT learning, made IT classes seem to lack in utility value: "it didn't really matter at all whether or not I attended IT classes...I mean, the school didn't really expect us to pay much attention in computer classes anyway" (Li-Wen, CS female). A relative lack of personal importance attached to IT-related learning at the secondary level was again illustrated by Li-Wen, whose beliefs and attitudes towards the relative unimportance of IT learning at school can serve as a reflection of not only the lack of attainment value attached to IT learning personally, but also of another facet of the strong educational and cultural stereotypes regarding studying IT during senior secondary school.

However, participants' lack of attainment value (or perceived importance) attached to senior secondary IT participation did not necessarily result in non-IT related course pursuits at the undergraduate level. It is interesting to observe how the attainment value and/or utility value attached to IT-related study pursuits could be totally reversed when Taiwanese students make educational choices at the undergraduate level: IT-related learning seems to have been more favoured and perceived as more worthwhile at tertiary level than it is at the secondary level.

NCS participants, in contrast, did not study senior secondary IT due to either a strong interest—enjoyment value attached to fields other than IT, or a lack of enjoyment in IT-related learning. For example, An-Chang (NCS male) found he had a stronger interest in maths, while Yu-Ju (NCS female) found her IT classes "quite boring", and always about learning "simple things" like word-processing or how to use the MS software. Similarly, Leech (2007) also states when individuals' previous IT experiences consisted of mainly routine tasks, such experiences can result in pursuing courses other than CS. NCS participants interviewed also revealed that in addition to the STVs individuals attached to secondary IT-learning, individuals' perceptions of the activity (i.e., IT-learning), stereotypes of the demands of the IT subject (i.e., programming/routine tasks), as well as their interpretations of experiences, were the three factors which may have affected their subsequent non-participation in CS courses.

The next section presents individuals' IT-related experiences outside of the school context, and how those experiences may (or may not) affected their subsequent CS course choices.

6.1.3.2 Out-of-school experiences

"Internet" was the most common purpose for using the computer prior to participants' course commencement for the CS sample (38: 93%) and the NCS sample (11: 100%) surveyed. The strong interest—enjoyment value individuals attached to using the "Internet" was evident, with higher proportions of females than males in the CS sample (M=12: 41%, F=9: 75%) and in the NCS sample (M=2: 50%, F=4: 57%) surveyed revealing the Internet as the most enjoyable computer use. Yet though the internet was the most enjoyable computer use, this enjoyment did not seem to play mediating roles in subsequent course pursuits by males and females in both samples. Previous work experience was the other IT-related exposure examined for its influence in motivating individuals' participation in CS courses. Six CS (M=5: 19%, F=1: 8%) participants surveyed indicated having worked in IT prior to studying CS compared to none from the NCS sample. Previous IT-related work experiences could have very little or no influence in individuals' CS course choices, as the survey revealed the majority of the CS participants (33: 85%) still pursued CS courses despite having no previous work experience in IT-related fields. There were no statistically significant differences by gender in relation to the influence of previous work experiences in the CS sample.

In summary, computer games constituted part of the enjoyable IT-related experiences of some of the participants interviewed. It seems that successful (or enjoyable) achievements gained from game-playing formed some participants' positive memories about IT-related learning, while for some the acquisition of simple programming skills reaffirmed their sense of self-efficacy in IT-related skills and related learning. This could have motivated their subsequent pursuits of IT-related courses (such as CS) at the undergraduate level. When individuals' expectations of success are high (particularly in the field of CS), educational (and achievement-related) choices of CS courses become more likely.

NCS participants interviewed revealed that for them there was a lack of attainment value and/or utility value attached to secondary IT-learning, which could have affected their decision not to pursue CS courses at the undergraduate level. Nevertheless, an interesting yet conflicting finding was that, despite the absence of STVs attached to senior secondary IT participation by CS and NCS participants, the pattern seems to be in reverse after leaving school, with CS becoming a favourable course choice. A possible reason for this reverse trend could be that senior secondary IT is not one of the core exam subjects from which subject scores could contribute significantly toward the overall CEE scores. Paradoxically, the high CEE scores required by many CS courses and the highly-valued skills (e.g., good maths and programming skills) for technical disciplines of study such as CS, could have been strong factors which appealed to those who believed they possess the skills and are capable of succeeding in CS at the tertiary level.

IT-related experiences out of school revealed for both the CS and the NCS samples surveyed revealed that using the Internet was the most commonly performed and the most enjoyable activity on the computer. The capacity of the Internet in fulfilling a range of individual needs, including searching for (or acquiring new) information, and performing activities which are only accessible or possible via the Internet made it a common and popular activity on the computer. Work-related experiences did not seem to have an overwhelming influence on participants' course pursuits, as only a small proportion of the CS sample and none from the NCS sample surveyed had worked in the IT industry prior to the commencement of their courses. Nevertheless, for the small proportion of the CS sample with previous work experiences in the IT industry, such experience could have prompted their participation in the field. However this needs to be further validated with more findings.

To this point, participants' secondary learning and IT-related learning experiences prior to their course enrolment have been examined to determine the extent to which their previous educational achievement and experiences may have affected their subsequent pursuits and non-pursuits of CS courses. It is equally important then to examine the possible factors involved during individuals' course decision-making processes, as such processes directly affect the course pursuits of males and females in the CS field or in other fields.

6.2 Course decision-making process

6.2.1 Influences of socialisers

The influences of socialisers including parents and teachers are examined in this and the following sections. Parents' educational backgrounds seemed to vary by gender in the CS sample. The highest level of educational qualifications obtained by the fathers of over half (16: 56%) of the CS males were secondary school qualifications (8: 28%) or undergraduate degrees (8: 28%); half of CS females reported their fathers as possessing TAFE qualifications (6: 50%). A high proportion of CS males indicated their mothers had completed undergraduate degrees (12: 41%) as their highest level of qualifications, whereas CS females reported mothers possessing TAFE qualifications (5: 42%). A similar trend is observed in the highest level of qualification possessed by the fathers and mothers of the NCS sample, which was found to be undergraduate degrees or above: fathers of half of the NCS males completed undergraduate degrees with honours (2: 50%), and a substantial proportion of fathers of the NCS females possessed undergraduate qualifications (3: 43%); mothers of the majority of NCS males possessed an undergraduate degree with honours (3: 75%), and mothers of almost half of the NCS females had completed undergraduate degrees (3: 43%). Chi-square tests revealed no statistically significant differences by gender in fathers' or mothers' educational qualifications in the CS sample and NCS sample.

Parents' computer uses, encouragement offered to participants, as well as individuals' perceptions of the representation of other socialisers such as female lecturers and females studying in IT-related studies, could have encouraged or discouraged their interest in pursuing CS courses. The frequencies (and percentages) of survey items relating to the (possible) influences of parents and lecturers are presented in Table 17.

Table 17

Frequency and Percentage Responses to Survey Items Regarding Parents' Influence by Sex and Group Membership (CS and NCS)

		CS participants		NCS participants	
		Male	Female	Male	Female
Survey items		N (%)	N (%)	N (%)	N (%)
Q.17 My father/male guardian uses a computer regularly.	Yes	12 (41%)	6 (50%)	4 (100%)	5 (71%)
	No	17 (59%)	6 (50%)	0 (0%)	2 (29%)
Q.18 My mother/female guardian uses a computer regularly.	Yes	12 (41%)	5 (42%)	3 (75%)	4 (57%)
	No	17 (59%)	7 (58%)	1 (25%)	3 (43%)
Q.19 My father/male guardian encouraged me to develop computer skills.	Yes	17 (59%)	6 (50%)	3 (75%)	3 (43%)
	No	12 (41%)	6 (50%)	1 (25%)	4 (57%)
Q.20 My mother/female guardian encouraged me to develop computer skills.	Yes	16 (55%)	5 (42%)	3 (75%)	4 (57%)
	No	13 (45%)	7 (58%)	1 (25%)	3 (43%)
Q.36a Do you think there are enough female lecturers or tutors teaching computing courses?	Yes	13 (48%)	5 (42%)	1 (33%)	3 (60%)
	No	14 (52%)	7 (58%)	2 (67%)	2 (40%)
Q.36b Do you think there is a gender imbalance among students in IT-related studies?	Yes	24 (89%)	10 (83%)	2 (67%)	3 (60%)
	No	3 (11%)	2 (17%)	1 (33%)	2 (40%)

Note. Due to some participants' early withdrawal from the online survey, figures may not add up to the original number of participants in the CS sample (M=29, F=12) and the NCS sample (M=4, F=7).

Table 17 shows that close to half of the CS sample (M=12: 41%, F=6: 50%) and the majority of the NCS sample (M=4: 100%, F=5: 71%) revealed their fathers (or male guardians) used computers regularly. The majority of the NCS sample (M=3: 75%, F=4: 57%) in contrast to less than half of the CS sample (M=12: 41%, F=5: 42%) reported their mothers (or female guardians) as regular computer users. It was noted that a higher proportion of males than females in the NCS sample perceived their fathers and mothers as regular computer users. Chi-square tests revealed no statistically significant differences in fathers' or mothers' computer uses by gender in both samples.

No noticeable differences by gender were observed in the CS sample regarding fathers' (or male guardians') encouragement for developing computing skills (M=17: 59%, F=16: 55%), or mothers' encouragement (M=16: 55%, F=5: 42%). A noticeably higher proportion of NCS males (3: 75%) than NCS females (3: 43%) indicated their fathers, as well as their mothers (M=16: 55%, F=5: 42%) encouraged them to develop computer skills. However, a higher proportion of males than females in both samples received encouragement for developing computer skills from fathers and mothers. Nevertheless, chi-square tests revealed no statistically significant differences by gender in parents' (fathers' or mothers') encouragement in both samples. Similarly, Bandura (1997) has suggested that parents' expectations of their children could differ due to their sex, which may be why the encouragement received by males and females from mothers or fathers varied in both samples.

Nevertheless, only one of the eight Taiwanese CS participants interviewed (F=Da-Bin) revealed her CS course pursuit was due to parental influence. Da-Bin's (CS female) father was very impressed with her CEE score, yet he had some concerns that she might not be able to use her creative skills in CS courses: "my dad did say that I can apply my creativity to CS once I've learnt all the fundamental background knowledge about CS". This shows that the support Da-Bin received from her father was what encouraged her CS pursuit, rather than previous achievement-related experiences in IT or programming. Individuals' perception of socialisers' (e.g., fathers') expectations and attitudes can encourage or discourage educational choices at the undergraduate level. The mothers of CS females who exhibited regular computer use and offered encouragement for computing skills development may have motivated CS females to study an IT-related course such as CS, which did not occur with NCS females. Clayton (2006) also found mothers were the most influential people in individuals' career-related decisions. Nevertheless, the influence of socialisers in individuals' course participation needs further exploration.

Individuals' perceptions of other socialisers which could have led toward their course choices were also explored. Over half of the CS sample (M=14: 52%, F=7: 58%) and a proportion of the NCS sample (M=2: 67%, F=2: 40%) surveyed did not believe there were enough female lecturers or tutors teaching computing courses. While a high proportion of CS females perceived that there were few females teaching IT, it did not seem to have affected their pursuit of CS courses. This contrasts with studies which found that a lack of female role models discouraged females' participation in IT (Jepson & Perl, 2002; Stockdale & Stoney, 2007). CS participants surveyed revealed that the main reasons accounting for the lack of females teaching IT were that "there are always more males than females in IT" (M=4: 29%, F=4: 57%) and "fewer females studying IT means fewer female lecturers" (M=3: 21%). CS males and CS females both believed that a higher representation of males than females in IT resulted in fewer numbers of females pursuing IT teaching roles in higher education. This further highlights the complacency regarding gender inequity in IT-related fields including CS, in which female representation is often simply characterised as being caused by the inadequate number of females studying in the field. There seems to be little curiosity about the key reasons behind their (possible) reluctance to enter the field.

The NCS sample surveyed revealed reasons different from those of the CS sample, stating that the underrepresentation of female academics was due to "females' lack of interest in IT" (M=1, F=1), and "societal expectations of men rather than women to teach IT" (M=1). NCS participants revealed that females' lack of interest in IT, as well as societal expectations and stereotypical images of IT could further widen the gender gap in IT-related fields such as CS. Da-Bin (CS female) provided an example of the expectations of females in the Taiwanese society: "A female often sacrifices many things in order to obtain a doctorate in CS, which does not measure up to the things she has sacrificed for" (Da-Bin, CS female). Da-Bin's comments shows that females' expectations can cause a conflict of interest, between her own individual interests and her (societally determined) ideal self – between becoming an academic in the CS field and society's expectations that a female should balance work and (potentially) family. Similarly, Nielsen et al. (2004) (2004) found that one of the core challenges of working in the field for IT female professionals was coping with family and work.

As with the case of female underrepresentation among CS academics, the representation of females in IT-related studies was perceived as low by males and females in both samples. The majority of the CS sample (M=24: 89%, F=10: 83%) and NCS sample (M=2: 67%, F=3: 60%) surveyed believed there is a gender imbalance among students. CS participants surveyed explained that the reasons for the gender imbalance in the field were possibly due to there being more males than females in the field (M=5: 21%), females holding stereotypical images of IT as nerdy or male-dominated (M=5: 21%, F=3: 30%), and a lack of interest in IT

(F=4: 40%). NCS participants surveyed revealed parent's expectations (F=2) and traditional stereotypes (M=1, F=1) were the two main reasons for the gender imbalance in IT. Yu-Ju (NCS female) further added in an interview that males usually study in Group 2 (sciences/engineering) from the second year of senior secondary school (Year 11 in Victoria, Australia). Females who are not as confident in maths are more likely to study in Group 1 (arts/humanities) instead. Some who do well in college entrance exams may never consider studying CS if they could get into 'better' courses.

Conversely, some people who are interested in CS may not be able to, so they end up studying humanities or other studies instead. Yu-Ju then concluded by stating "CEE scores can dictate individuals' course preferences". Yu-Ju thus highlighted how CEE scores and most importantly, the prestige of institutions, can influence Taiwanese students' pre-college course decision-making. An-Chang (NCS male) further pointed out that if very few females study in Group 2, then they are less likely to pursue CS courses which require a high level of maths and sciences. The course choices imposed upon Taiwanese students were often dependent on the groups they belonged to during senior secondary schools and the subjects they studied. It is clear that the inflexibility of the Taiwanese educational system can potentially hinder individuals' course choices at the undergraduate level, and foster a potentially widening gender imbalance in the CS field.

In summary, socialisers did not seem to be influential for the CS and NCS participants surveyed and interviewed. No statistically significant differences by gender were observed in parents' (fathers' or mothers') encouragement on developing computing skills. Neither were males' and females' (in both samples) responses found to be statistically significantly different in perceptions of the gender imbalance in IT-related studies or the representation of female lecturers teaching computing courses. While no statistically significant differences were found by gender in the samples, some interesting trends were observed. A higher proportion of NCS males than NCS females reported both parents (fathers and mothers) as regular computer users, and a noticeably higher proportion of NCS males than NCS females felt they received encouragement from both parents on developing computing skills. These trends indicate that a lack of encouragement offered by parents to NCS females in this study could have been why they did not choose CS courses subsequently.

CS males interviewed revealed that societal expectations as well as a possible attachment or emphasis on enrolling in the best courses offered by the top universities in Taiwan was the most influential factor in course choices by Taiwanese school leavers in this study. CS females interviewed revealed that their peers often perceived them as being able to resolve all of their computer issues, and also saw them as intelligent and having the technical capabilities to be able to study CS courses. In contrast, NCS participants interviewed revealed more stereotypical images associated with those who study CS, such as thinking students would be programming all day, while the NCS female interviewed revealed a more positive perception of CS females as "smart" in comparison to CS males, whom she saw as likely to "play games all the time". NCS individuals perceived males and females who study CS differently.

In terms of female representation in the IT-related field of teaching as well as in IT-related studies, the presence of fewer females was also acknowledged by both CS and NCS participants surveyed. The common reasons voiced by both groups were that there are fewer females studying IT (often due to a lack of interest in IT), which is likely to result in fewer females being qualified to teach computing courses. The perceptions of gender imbalance in IT-related studies seemed to vary by CS and NCS participants surveyed. While CS participants believed stereotypical images of IT caused the gender imbalance, NCS participants surveyed commented on parents' expectations. Also, NCS participants interviewed further illustrated previous findings and confirmed that the prestige of the tertiary institution (e.g. attainment value attached) outweighed personal interests in regards to course selection.

6.2.2 Perceived self-efficacy and skills required for task demands

Individuals' beliefs and perceptions about IT-related tasks could lead to subsequent CS course pursuits, as the EVM illustrates self-efficacy beliefs in certain fields result in educational choices in those fields. In this study participants' self-efficacy beliefs in IT and maths learning at school, as well as the skills they perceived as essential for IT, were explored in a survey question (Q.12) which consisted of six items based on a five-point Likert response format. Participants needed to provide a score ranging from 1 (strongly disagree) to a score of 5 (strongly agree) for each item. Due to the small CS and NCS sample sizes, a more robust description was needed. This was achieved by collapsing down the frequencies (and percentages) of responses to all five-point Likert items, yielding the following three categories: "SD/D" ("Strongly disagree" or "Disagree"); "A/SA" ("Agree" or "Strongly agree"); and "NS" ("Not sure", which remained unchanged). Chi-square (X^2) tests were used to determine if the frequency distributions of the responses were statistically significantly different by gender in both samples (CS and NCS). Also, ES of Cramer's V (V) were included for p values of .05 or smaller (Corder & Foreman, 2009; Pallant, 2009). The responses to items in Q.12, as well as the outcomes (p) of the chi-square (X^2) tests are shown in Table 18.

Table 18

Frequency and Percentage Responses to Survey Items by Sex, Group Membership (CS and NCS), and X^2 Significance Levels

		Male N (%)			Female N (%)			Sig. level*
Q.12 items	Group	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I was good at learning IT-related skills at school	CS	8 (28%)	6 (21%)	15 (52%)	7 (58%)	4 (33%)	1 (8%)	ns
	NCS	2 (0%)	3 (75%)	1 (25%)	2 (29%)	3 (43%)	2 (29%)	ns
I was good at learning maths at school	CS	4 (14%)	4 (14%)	21 (72%)	1 (8%)	0 (0%)	11 (92%)	ns
	NCS	1 (25%)	0 (0%)	3 (75%)	1 (14%)	3 (43%)	3 (43%)	ns
I believe that good mathematical skills are essential to IT	CS	1 (3%)	4 (14%)	24 (83%)	1 (8%)	0 (0%)	11 (92%)	.01
	NCS	1 (25%)	0 (0%)	3 (75%)	0 (0%)	2 (29%)	5 (71%)	ns
I believe that good programming skills are essential to IT	CS	2 (7%)	1 (3%)	26 (90%)	1 (8%)	0 (0%)	11 (92%)	ns
	NCS	1 (25%)	0 (0%)	3 (75%)	0 (0%)	1 (14%)	6 (86%)	ns
I believe that logical thinking is important for studying IT	CS	2 (7%)	0 (0%)	27 (93%)	1 (8%)	0 (0%)	11 (92%)	ns
	NCS	1 (25%)	0 (0%)	3 (75%)	0 (0%)	0 (0%)	7 (100%)	ns
I am confident about my ability to learn new computer skills	CS	2 (7%)	5 (17%)	22 (76%)	2 (17%)	7 (58%)	3 (25%)	.02
	NCS	1 (25%)	1 (25%)	2 (50%)	2 (29%)	1 (14%)	4 (57%)	.ns

Note. *The level of significance is set at .05 ($p < .05$); *p* values are rounded off to two decimal places due to small sample sizes; ns = not significant.

In the subsequent discussion of the findings, all survey data referred to can be found in Table 18. Also, to enable a better flow of discussion, all survey responses of "agreed/strongly agreed" are described as "agreed" and disagreed/strongly disagreed" as "disagreed".

6.2.2.1 Individuals' perceptions of maths/IT learning at school

Individuals' perceptions of their maths and IT-related learning were examined for their influence on participants' CS or NCS course pursuits. The responses regarding being good at learning IT-related skills at school varied by gender in the CS sample: the majority of CS males (15: 52%) agreed in contrast to more than half (7: 58%) of CS females disagreeing, whereas a high proportion of the NCS sample were unsure (M=3: 75%, F=3: 43%). Chi-square tests however revealed no statistically significant differences by gender in self-perceptions of IT-related learning in both samples. Interestingly, more than half the CS females surveyed did not believe they were good at learning IT-related skills, yet still chose CS courses. This also suggests that for half of the CS females surveyed, perceptions of a lack of ability in IT-related learning at school did not mean they perceived themselves as unable to pursue IT-related courses (such as CS) at the undergraduate level.

Maths related learning at school did not differ by gender in the CS sample (agreed: M=21: 72%, F=11: 92%) while the responses varied by gender in the NCS sample: males (3: 75%) agreed while NCS females agreed (3: 43%) or were unsure (3: 43%). Although a higher proportion of CS females than CS males believed in their maths learning abilities, chi-square tests revealed no statistically significant differences by gender in the CS sample. Other factors such as the perceived abilities in maths learning could have motivated their CS course choices and require further exploration. The relatively high proportion of CS females over NCS females who perceived themselves as good at learning maths while at school contrasted with Margolis and Fisher's (2002) finding that females who were highly successful in maths often did not venture into CS fields.

6.2.2.2 Individuals' perceptions of important skills for IT learning

Individuals' perceptions of skills required for studying IT could have been one of the contributing factors for CS (or NCS) course pursuits. No noticeable differences by gender were observed in either sample. Good mathematical skills were perceived by the majority of the CS sample (agreed: M=24: 83%, F=11: 92%) and the NCS sample (agreed: M=3: 75%, F=5: 71%) as essential to IT. Programming skills were another skill perceived as essential to

IT by the majority of the CS sample (agreed: M=26: 90%, F=11: 92%) and also the NCS sample (agreed: M=3: 75%, F=6: 86%) surveyed. Although a high proportion of males and females in the NCS sample agreed that good maths and programming skills are essential, the NCS females had not chosen CS course or majors. Chi-square tests also did not reveal statistically significant differences by gender in the NCS sample. However, a statistically significant difference by gender was observed in the CS sample; CS females were more likely than CS males to believe in good maths skills as essential to IT, X^2 (3, n = 41) = 10.86, p = .01, V = .52.

The perception among a higher proportion of CS females (92%) than NCS females (71%) that maths skills are essential to IT may have provided them with the confidence to pursue CS courses. Similarly Fan and Li (2002a) argue that individuals who have a higher level of confidence in maths are more likely to pursue CS related studies at the tertiary level. A higher proportion of CS females than NCS females believed in programming skills as essential to IT, and this could have been one of the encouraging factors for choosing CS courses. McInerney (2006) also states that individuals (and particularly females) who are highly confident of their programming skills are more likely to choose CS related studies. Logical thinking was another skill in addition to maths and programming that was agreed to be important for studying IT by the majority of the CS sample (M=27: 93%, F=11: 92%) and the NCS sample (M=3: 75%, F=7: 100%) surveyed.

6.2.2.3 Individuals' confidence in IT learning

Individuals' confidence in learning new computing skills was examined in relation to their subsequent pursuit of CS. The responses did not vary in the NCS sample (agreed: M=2: 50%, F=4: 57%), whereas in the CS sample, the majority of the CS males (22: 76%) agreed while more than half of CS females (7: 58%) were unsure about learning new computing skills. Chi-square tests revealed no statistically significant differences by gender in the NCS sample but a statistically significant difference by gender in the CS sample, X^2 (4, n = 41) = 12.31, p = .02, V = .55. CS males were more confident than CS females in their own abilities in learning new computer skills. Similarly, Lewis et al. (2007) also found that females are generally less confident than their male counterparts in their ability to do IT. In this study it appears that for the CS females (unsure= 7: 58%), their doubts about learning new IT skills did not necessarily result in NCS course pursuit, when other factors could have been more motivational for CS pursuits. In contrast, half of the NCS females (4: 57%) indicated they were confident about learning computing skills yet did not pursue CS courses. This also illustrates that individuals' confidence (and possibly good self-efficacies in IT-related learning) do not always encourage the pursuit of IT (or CS related) courses.

In summary, although not all survey items in Q.12 reveal statistically significant difference by gender, some interesting trends were observed. More than half of CS females did not believe (disagreed) they were good at learning IT-related skills while at school, yet they still ended up pursuing CS courses at the undergraduate level. Also, the high proportion of CS females who believed (agreed) they were good at maths learning at school shows that this confidence in maths could have also been one of the motivational factors in CS courses pursuit. It was also found that the perceptions of having the skills required for studying CS courses, such as programming skills, could have motivated CS females more than NCS females to pursue CS courses, as NCS females could either have not perceived themselves as possessing the abilities or were not interested in learning programming to do CS.

On the other hand, the statistically significant difference by gender found in the CS sample regarding perceptions of maths skills as essential to IT suggests that females who possessed highly developed maths skills were more likely to envision the applicability of their maths skills in CS courses. At the same time their belief in the utility value (i.e., usefulness) of their maths abilities would enable them to achieve and perform well in CS courses. The EVM also shows that individuals' concepts of their own abilities are likely to strengthen the STVs (i.e., attainment value, utility value) attached to educationally or occupationally-related activities, which in turn result in educational choices which could allow them to demonstrate their achievements in their chosen fields.

It was equally interesting to note that while perceptions of self confidence in learning new computing skills differed statistically by gender in the CS sample, CS females were found to be "unsure" rather than disbelieving in their abilities. CS females' lack of confidence could also be due to a lack of belief in their abilities, as Bandura (1997) found that individuals' self-efficacy in IT-related learning often differs by gender; he argues that females often underestimate their abilities in contrast to their male peers who often overestimate their abilities. In this instance, it appears that despite the statistical difference, a lack of certainty in acquiring new computing skills did not seem to have profound effects on CS females in respect of pursuing CS courses.

6.2.3 Course knowledge

Clayton (2006) proposed that students often possess inadequate information regarding IT-related studies, which subsequently affects their non-pursuit of tertiary IT studies. The sources of course information accessed by participants appear in Figure 5.

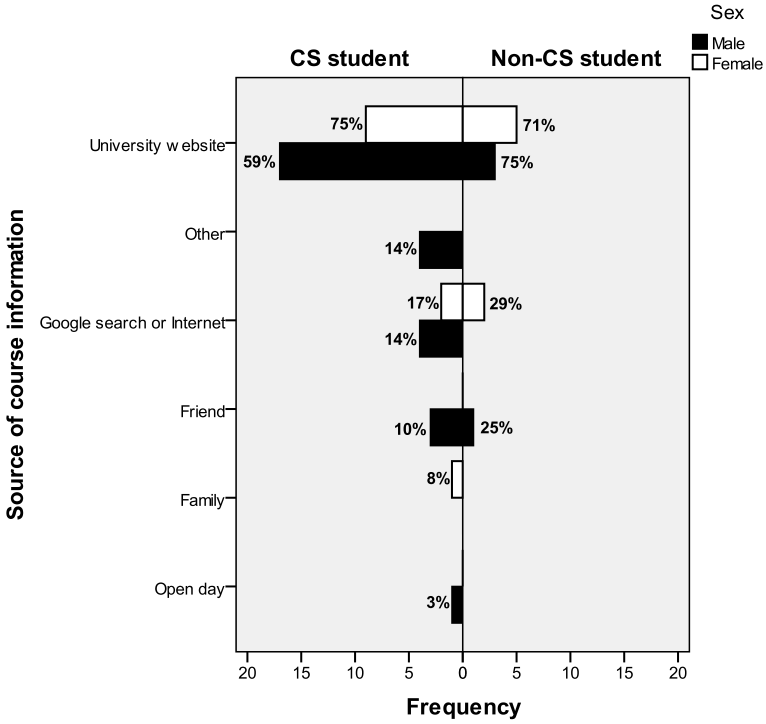

Figure 5. Source of course information by sex and group membership (CS and NCS)

Figure 5 shows that the majority of the CS sample (M=17: 59%, F=9: 75%) and the NCS sample (M=3: 75%, F=5: 71%) surveyed obtained information about the course (or major) via the university website. “Google search/Internet” (4: 14%) was used by some CS males and NCS females (F=2: 29%). Interestingly, relative to their female counterparts, males in both samples seemed to have used more of other sources including Google, a friend, open days or other sources. Chi-square tests however revealed no statistically significant differences by gender in the uses of course information sources in both samples. The trend could only suggest that females surveyed in this study were either not aware of, or simply did not know, the other sources of information available to assist them in making the decision to participate or not participate in CS courses.

Redmond (2006) stated that a lack of understanding of available courses and related careers in IT largely explains why there are relatively fewer females pursuing tertiary IT studies. “Programming” was the most commonly known feature of CS courses prior to enrolment by the CS participants (M=12: 44%, F=4: 33%) surveyed, followed by “mathematical skills” (M=1; F=2), “logical thinking” (F=1) and “challenging” (M=1). Similarly, programming was also noted to be the most commonly identified characteristic of CS (Lewis et al., 2007; Papastergiou, 2008). CS participants in general identified the skills required to study CS courses, but otherwise appeared to have limited understanding about the other aspects of CS courses prior to enrolment. Rung-Reng (CS male) perceived CS courses to be interesting, mainly based on his previous experiences with game-playing and his personal interest and enjoyment attached to computer games. It was likely that Rung-Ren’s previous successful experiences, as well as an interest in utilising successes achieved in IT-related activities (e.g., computer games) would serve to ensure he could gain more advanced, specific skills “to make better games for myself as well as others to enjoy”. Da-Bin (CS female), in contrast, admitted to knowing very little about CS courses, except that they “probably involves a lot of programming”. Nevertheless, Da-Bin’s apparent lack of understanding did not discourage her subsequent pursuit of a CS course, which serves as a contrast to Redmond’s (2006) finding that the inadequate understanding of the skills required in IT courses results in females’ non-IT course pursuits. In Da-Bin’s case, it seems other factors are stronger; possibly, her self-concept regarding her own abilities (such as being good at maths) which she deemed valuable and useful to advance in a field such as CS, gave her the confidence to take the course.

Hong-Bin (CS male), a mature-age student in his mid-thirties, commented on his non-participation in senior secondary IT subjects which resulted in his lack of exposure to CS related courses. Yet Hong-Bin's perceived confidence in logical skills, as well as "some coding experience", made him believe that he should be able to perform well in his CS course. In general, while CS participants seemed to have little understanding about the CS courses except that programming was a feature of CS courses, their responses reaffirm that cultural stereotypes (and perceptions) of CS courses maintain the perception of programming as the main skill of CS courses (Papastergiou, 2008) or task associated with CS courses (Weng, Cheong, & Cheong, 2009). Individuals, in particular females, who did not find programming appealing or interesting, or who perceived programming as the main aspect of CS courses, would be unlikely to attach (or not attach) any STVs (such as interest-enjoyment value, utility value) to CS courses; this is likely to result in their non-participation in the field.

While CS participants mentioned programming as one of the main features of CS, the NCS participants interviewed thought those who were able to pursue CS courses must have done well in the CEE. For example, Yu-Ju (NCS female) stated: "I feel only clever students can learn CS... people who wanted to go into CS studies would probably have learnt or acquired some programming skills beforehand". Yu-Ju's association of "programming" and the labelling of CS students as "clever" also coincide with the common perceptions of CS courses identified by CS participants surveyed. An-Chang (NCS male) perceived his maths background may not be useful (i.e., lack of utility value attached to CS), which resulted in his decision not to pursue a CS course, but he later found that "CS is very similar to some of the maths that I study." An-Chang's comment suggests that individuals' understanding of the characteristics of possible educational choices (such as CS courses) could affect their later course choices; the CS participants surveyed revealed "maths skills" as one of the perceived features of CS courses, which could have prompted some of them to pursue CS courses. Had An-Chang been more aware of his maths abilities or had greater self-efficacy in maths before selecting a course, he might have selected CS at university and achieved well in the course. Yu-Ju and An-Chang's comments both illustrate how individuals' own perceptions of activity stereotypes and task demands – particularly if they did not possess strong self-concepts (or perceived efficacies) in CS related skills such as programming (and/or maths) – would lead to the failure to attach attainment value (personal importance) and other STVs including interest-enjoyment and utility value to CS courses. In the absence of positive STVs, they would not anticipate success in the field, and consequently their pursuit of CS courses would have been unlikely.

In summary, the fact that university websites were identified as the main source of course information highlights the need for universities to constantly update and provide accurate and detailed information regarding the courses they offer. Informative university (or faculty) websites enable individuals to make more informed decisions about studying CS courses (or other courses), as they are able to take into consideration their skills, abilities, interests and career aspirations before making their course choices. On the other hand, the minimal use of sources of information other than university websites also emphasises the need for schools and teachers to suggest other venues for students to gain more information regarding the range of courses they may be interested in studying in order to maximise their knowledge about courses which cater for their interests and needs. As one of the most commonly identified characteristics associated with CS courses, "programming", seemed to be seen as one of the important skills required for studying CS. However, those who are not interested in programming or those who perceive themselves as inept in learning to program could also be discouraged from considering CS courses. Therefore, it is important to inform students that

CS courses require individuals to possess and develop both technical and soft (e.g., interpersonal, collaboration) skills (Brown et al., 2006).

While it is not surprising to see that CS males were more likely than CS females to pursue CS courses, it was still unclear as to what other stronger factors prompted females not to choose CS courses. The following section examines the most common reasons and influences, as well as the most important reason and influence in individuals' course choices by gender in the CS sample and the NCS sample.

6.2.4 Reasons and influences over course choices

Participation in certain courses or majors was often due to a range of social, psychological and motivational reasons, as well as intrinsic and extrinsic influences. The frequencies (and percentages) of responses to reason(s) (Q.26a and 26b) and influence(s) (Q.28a and 28b) accounting for participants' course participation are shown in Table 19.

Table 19

Frequency and Percentage Responses to Survey Items (Q.26 and Q.28) by Sex and Group Membership (CS and NCS)

		Q26a Why did you choose your current course? (You may choose one or more)		Q26b Which one of A to F was the most important reason?	
Item choice	Group	Male N (%)	Female N (%)	Male N (%)	Female N (%)
A. Challenging	CS	9 (33%)	4 (33%)	1 (4%)	2 (17%)
	NCS	1 (33%)	2 (33%)	0 (0%)	0 (0%)
B. Future income	CS	13 (48%)	**9 (75%)**	5 (19%)	3 (25%)
	NCS	0 (0%)	1 (17%)	0 (0%)	0 (0%)
C. Career prospects	CS	**18 (59%)**	6 (50%)	3 (11%)	2 (17%)
	NCS	**2 (67%)**	**5 (83%)**	1 (33%)	**3 (50%)**
D. Peer influence	CS	6 (22%)	3 (25%)	1 (4%)	0 (0%)
	NCS	0 (0%)	0 (0%)	0 (0%)	0 (0%)
E. Encouragement from family/friends	CS	5 (19%)	6 (50%)	1 (4%)	1 (8%)
	NCS	1 (33%)	2 (33%)	0 (0%)	2 (33%)
F. Personal interest	CS	15 (56%)	5 (42%)	**16 (59%)**	**4 (33%)**
	NCS	**2 (67%)**	2 (33%)	**2 (67%)**	1 (17%)
		Q28a Who influenced you in choosing your current course? (You may choose one or more)		Q28b Which one of A to H was the most influential?	
Item choice	Group	Male N (%)	Female N (%)	Male N (%)	Female N (%)
A. Father/male guardian	CS	7 (26%)	3 (27%)	1 (4%)	3 (27%)
	NCS	**2 (67%)**	**3 (50%)**	1 (33%)	1 (17%)
B. Mother/female guardian	CS	7 (26%)	0 (0%)	1 (4%)	0 (0%)
	NCS	1 (33%)	1 (17%)	0 (0%)	1 (17%)
C. Friends	CS	11 (41%)	**7 (64%)**	2 (7%)	2 (18%)
	NCS	1 (33%)	1 (17%)	0 (0%)	1 (17%)
D. Family members	CS	2 (7%)	2 (18%)	0 (0%)	0 (0%)
	NCS	0 (0%)	0 (0%)	0 (0%)	0 (0%)
E. Teachers	CS	7 (26%)	**7 (64%)**	0 (0%)	1 (9%)
	NCS	0 (0%)	2 (33%)	0 (0%)	1 (17%)
F. Career counsellors	CS	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	NCS	0 (0%)	0 (0%)	0 (0%)	0 (0%)
G. Personal interest	CS	**23 (85%)**	**7 (64%)**	**21 (78%)**	**5 (46%)**
	NCS	**2 (67%)**	**3 (50%)**	**2 (67%)**	**2 (33%)**
H. Other people	CS	0 (0%)	0 (0%)	2 (7%)	0 (0%)
	NCS	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Note. The figures in bold represent the highest frequencies (and percentages) of the responses to the survey items by sex in the CS sample and the NCS sample.

Table 19 shows that "career prospects" (18: 59%) was the most common reason among CS males surveyed for choosing CS courses while for CS females it was "future income" (9: 75%); similar to CS males, NCS males considered "career prospects" (2: 67%) and also "personal interest" (2: 67%), while NCS females selected "career prospects" (5: 83%).

Half of the CS participants (4: M=2, F=2) interviewed indicated that they first decided to enrol in CS after having obtained their CEE scores. For instance, Hong-Bin (CS male) and Pei-Chen (CS female) had wanted to enrol in another course (Electrical Engineering) yet their CEE scores only enabled them to choose the alternative option (CS courses). Hong Bin and Pei-Chen's motivation for their CS pursuits are in accordance with what Eccles (2011) proposes, that individuals simply cannot pursue all of the available (educational/vocational) options available to them, and must make choices based on a variety of factors. In this instance, factors such as CEE scores and the desire to be associated with a particular institution by both Hong-Bin and Pei-Chen meant that CS courses were the best course choices available to them at the time. Wei-Yin (CS female) in addition used the CEE score as a guide for selecting a CS course.

In contrast, personal interest was the most encouraging factor for Rung-Ren, whose interest in wanting to "design computer games" led him to consider CS as a good course pursuit. Rung-Ren's interest—enjoyment value attached to IT-related activities (i.e., games) prior to enrolment seemed to encourage his pursuit of CS. For Rung-Ren, his CEE score could have indirectly or directly affected his pursuit of a CS course, yet it was also the strong personal importance he attached to attending the best university in Taiwan, which motivated his participation in the CS field.

Similarly, NCS participants interviewed (M=1, F=1) revealed the CEE score as the reason why they did not pursue CS courses. Yet upon closer inspection it was the prestige of the institution that was also revealed by the CS interviewees to have constituted the main consideration for course choices. For example, Yu-Ju (NCS female) had originally wanted to study CS at her current institution, yet because she could not be admitted into the CS course at her preferred institution, she decided to study another course instead, then reapply the following year for a course transfer. Yu-Ju's reason for selecting her NCS course was in a way similar to why Pei-Chen (CS female) selected CS courses: both chose their courses as they could not pursue their first preferences (electrical engineering for Pei-Chen, and CS for Ju-Yu), so they then turned to courses which had a lower cost of participation (in this case, courses requiring lower CEE scores). An-Chang (NCS male), in contrast, was unfamiliar with the subject matter, and therefore decided not to pursue CS courses as he was unsure if he could do well. This illustrates that when individuals do not have strong self-concepts of their own abilities in CS, this can affect their expectations of success in the field, which then results in non-CS participation.

Personal interest appears to be the most important reason for course participation for the majority of CS males (16: 59%) and NCS males (2: 67%), as well as for one-third of CS females (4:33%) surveyed; half of the NCS females (3: 50%) however chose "career prospects" as the principal reason. Chi-square tests revealed no statistically significant differences by gender in either sample. When interviewed, Hong-Bin (CS male) and Yu-Ju (NCS female) both nominated their CEE scores as the main reason for their respective course (or major) participation. These are examples of how previous achievement related experiences (i.e., CEE scores) became a determinant of achievement-related choices and performances (i.e., CS study pursuits). Jia-Rong (CS male) and Rung-Ren's (CS male) reasons, illustrated how their liking for computer games prompted their subsequent CS pursuits; this also highlights that when a stronger STV value such as an enjoyment—interest value is attached to IT-related activities, it strengthens individuals' self-efficacies in IT-related learning, which in turn means they become confident enough to pursue IT-related courses such as CS. Jia-Rong's (CS male) experience of using the university website eventually prompted him to make his final decision to pursue a CS course. On the website he could see a detailed description of the course to be learnt over the four years, and the careers associated with CS after graduation. This provided him with a fuller awareness of IT (or CS) related studies and associated careers. Jia-Rong’s example highlights that university websites (or faculty websites) were able to provide individuals like Jia-Rong with a better understanding of CS courses and related career prospects, and could have been a powerful medium for clarifying the misconceptions and stereotypes regarding the CS field of study. A number of studies have also found that stereotypical images (or misunderstandings) of IT (or CS) related studies and careers often impede females from participating in the field (Clayton, 2006; Jepson & Perl, 2002; Leech, 2007; Newmarch et al., 2000; Papastergiou, 2008; Redmond, 2006; Stockdale & Stoney, 2007; Timms et al., 2006). Both this and other studies clearly indicate the importance of well-developed website information on courses. Nevertheless, it is equally important to make attempts to avoid stereotypical images, examples and emphases in such information.

At interview, both Sheng-Yao (CS male) and Pei-Chen (CS female) revealed that their maths and physics abilities prompted their CS pursuits, which in other words also means that when individuals perceive maths or/and physics as the skills essential for them to study CS, they may be motivated to participate in CS courses; other individuals who did not perceive these skills as important, or did not perceive themselves to be highly capable in maths or physics, may have been less likely to pursue CS courses. Similarly, Fan and Li (2002a) found that maths ability correlated highly with tertiary CS performances.

In addition to personal interest, socialisers (e.g., parents, family members) also served as another motivational factor for two CS participants interviewed. Sheng-Yao’s (CS male) pursuit of a CS course was due to the good career prospects associated with CS courses on which he was advised by his father, while Wei-Yin's (CS female) decision to study CS was highly influenced by her uncle's encouragement. Encouragement from socialisers, however was not the only motivational factor for Wei-Yin, whose own perception of herself as possessing good logical and reasoning skills could have heightened her own expectation of success in the fields, as she deemed those two skills as essential for studying CS, which could have prompted her CS course pursuit (an achievement-related choice). Similarly Bandura (1997) states that self-efficacy beliefs predict individual academic performance and choices, and thus it can be suggested that when females possess strong self-efficacy beliefs in science and technology (Machina & Gokhale, 2010), they will be more likely to participate in IT-related fields of study such as CS.

In addition to reasons for course participation, the influences in course pursuits were also examined. "Personal interest" was the most common influence in course pursuit by CS males (23: 85%) surveyed, while for CS females the influences included "teachers" (7: 64%), "friends" (7: 64%) and "personal interest" (7: 64%). The NCS sample indicated that "personal interest" (M=2: 67%, F=3: 50%) and "father/male guardian" (M=2: 67%, F=3: 50%) were the two most common influences. Yet for the most influential factor in participants' course pursuits was "personal interest" for the CS sample (M=21: 78%, F=5: 46%) and the NCS sample (M=2: 67%, F=2: 33%) surveyed. CS females' responses also highlighted the vital importance of female role models stated in some studies (Jepson & Perl, 2002; Stockdale & Stoney, 2007; Wasburn & Miller, 2004) which found such models to be encouraging factors for young females to pursue non-traditional fields including CS.

In summary, while personal interest was the most important reason for course (or major) participation as revealed by survey responses, both CS and NCS participants interviewed indicated that CEE scores facilitate (and at times, hinder) course choices for many individuals, and often outweighed their personal interest in a course (or major) itself. Four of the eight CS participants interviewed revealed that CS course choices were made after they had obtained their CEE scores. Most importantly, Taiwanese participants in this study have illustrated the importance of the prestige of the institution, which often outweighed their intention to pursue CS courses. Indeed, studying at the best university in Taiwan meant they may not always be studying their preferred courses, but instead would establish their personal and social profiles of being associated with excellence, elite characteristics that are perceived by the Taiwanese society as valuable. It appeared that the CEE score had an impact on participants' course preferences, whether or not in the CS field.

The following section outlines the possible effects of course or study related experiences, and career-related knowledge which could have prompted the participants surveyed (and/or interviewed) to pursue CS courses at the undergraduate level, or have discouraged them from doing so.

6.3 After enrolment

6.3.1 Individuals' perceptions of CS in general and coursework demands

Individuals' perceptions or pre-conceived ideas about particular fields of study can affect subsequent participation in those fields (Eccles, 2005b, 2011). The "stereotypes" attached to CS as revealed by the CS participants interviewed included: a) "dress sense"; b) cultural stereotypes of the subject matter of the CS study or profession (e.g., "social isolation"); c) perceptions of gender roles (i.e., "masculine characteristics"), and d) participants' own perceptions of task demands (i.e., "good at programming"). These stereotypes that are associated with CS could have discouraged some individuals, particularly females, from pursuing CS courses. Six of the eight CS participants interviewed (M=3, F=3) revealed some common gender stereotypes associated with CS that were shared both males and females. Hong-Bin (CS male) and Li-Wen (CS female) both stated that the common perceptions among individuals in society are that fewer girls tend to want to pursue CS courses, and instead females are more likely to pursue studies in humanities fields. Sheng-Yao (CS male) and Wei-Yin (CS female) stated that most CS people do not know how to dress appropriately or they simply sit in front of computers all day. Pei-Chen (CS female) in contrast mentioned the masculine characteristics attached to girls studying CS as “tomboys”. Rung-Ren (CS male) highlighted the common perceptions of CS students and professionals as being good at solving both software and hardware issues.

Similarly, the two NCS participants interviewed (M=An-Chang, F=Yu-Ju) perceived CS as being “for boys” and “less sociable”. Nevertheless, An-Chang (NCS male) perceived CS people as “programming and debugging all day”, while Yu-Ju (NCS female) on the other hand thought CS females are “very smart to be able to study CS”, whilst she perceived CS males as “liking to play computer games”. Both NCS participants interviewed seemed to perceive individuals who study CS as solitary, while it was interesting to observe how Yu-Ju’s perceptions of CS males and CS females differed, as her perceptions of CS females appeared to be more positive than of CS males. A noticeable difference in beliefs about whether individuals should pursue courses in accordance to their sex is evident in the contrast between An-Chang’s (NCS male) firm belief that individuals should choose courses “according to their personal interests”, and the belief Yu-Ju (NCS female) revealed her mother had expressed, namely that “engineering professions are too demanding for girls, especially once they are married and have kids”. Yu-Ju’s case has highlighted the potential influence of socialisers (e.g. parents') beliefs and expectations which can influence individuals' – in particular females' – pursuit of CS courses. Yet since Yu-Ju had set a short-term goal of transferring to CS the following year, the influence of her mother on her course pursuits was not as strong as her goal of studying in CS. Gender role stereotypes of females in non-traditional fields like CS could undermine females' interest and potential in the field, and hence serve as obstacles to opportunities for females to be exposed to a wider range of educational and vocational opportunities in the CS field.

Individuals' understanding of the skills required to achieve success in their chosen fields were explored for their potential in influencing course participation. CS participants surveyed (M=27, F=11) revealed "programming skills" (M=3: 11%, F=7: 64%) and "good maths skills" (M=6: 22%, F=1: 11%) as the two most important skills for pursuing CS courses, followed by "logical thinking" (M=4: 15%, F=1: 9%) and being "hard working" (M=3: 11%, F=1: 9%). In addition, other studies also identified programming and logical thinking as essential to CS (Frieze et al., 2006; Margolis & Fisher, 2002; Papastergiou, 2008).

In summary, the stereotypes, such as CS students and professionals being "shabby", "nerdy" or females seeming more "tomboyish", were perceived by CS participants prior to enrolling in CS courses, while for NCS participants CS was perceived as "anti-social" and "for boys". Nevertheless, the seemingly stereotypical notions attached to CS courses did not seem to be particularly discouraging for CS participants; indeed, their awareness or acceptance of those stereotypes attached to CS courses possibly made them aware of the unavoidable labelling of such stereotypes associated with their courses. This shows that an understanding of the stereotypical notions attached to the CS field by females would not always discourage the pursuit of CS courses.

It was important to note that the NCS female (Yu-Ju) interviewed pointed to the underlying importance of socialisers' (such as mothers') beliefs about the "appropriate" courses and careers for females. On the other hand it can be seen that Yu-Ju's goal of wanting to study the CS course at her chosen institution in the following year was a stronger, motivating factor than the influence of a socialiser. Therefore, the influence of socialisers on course pursuit was limited for Yu-Ju, while for Wei-Yin (CS female) and Sheng-Yao (CS male) socialisers (father, family members) may have partially influenced or motivated their subsequent decision to enrol in CS courses. The revelation by the CS participants surveyed that programming and good maths skills were important for studying CS courses also highlights that an understanding of the demands or skill sets required by CS courses, as well as being willing and prepared to further acquire and develop such skills, could have also motivated them to study CS courses in comparison with their NCS peers.

The other characteristics and perceptions of CS courses as well as the demands of the CS coursework were further explored using Q.35 of the online survey. Question 35 consisted of eleven items based on a five-point Likert response format for which participants needed to provide a score ranging from 1 (strongly disagree) to 5 (strongly agree) to indicate the extent to which they agreed with each item regarding their courses. Chi-square (X^2) tests instead of T-tests or ANOVA were used to explore statistically significant differences by gender (if any). However, due to the small CS and NCS sample sizes, and collapsed categories (e.g., agreed or strongly agreed, disagreed or strongly disagreed), X^2 tests were used to ascertain statistical differences. Also, in line with the research question seeking to identify the factors and to what extent they influenced the participation and non-participation by females in CS courses, the responses to items by the NCS sample surveyed (which were later found to be not specifically asking for their opinions on what encouraged or discouraged individuals' CS participation), were removed from the following table and were not used in the following discussions. The frequencies (and percentages) of responses to items in Q.35, as well as the outcomes (p) of the X^2 tests are shown in Table 20.

Table 20

Frequency and Percentage Responses to Survey Items in Q.35 by Sex in the CS Sample, and X^2 Significance Levels

	Male N (%)			Female N (%)			Sig. level*
Q.35 items	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I find the coursework time-consuming	8 (30%)	4 (15%)	15 (55%)	1 (8%)	2 (17%)	9 (75%)	ns
I find the coursework difficult	8 (30%)	8 (30%)	11 (40%)	1 (8%)	3 (25%)	8 (67%)	ns
The workload is heavier than I expected	8 (30%)	6 (22%)	13 (48%)	2 (16%)	5 (42%)	5 (42%)	ns
The coursework is too mathematical	8 (30%)	10 (37%)	9 (33%)	3 (25%)	6 (50%)	3 (25%)	ns
The coursework is technical	10 (37%)	9 (33%)	8 (30%)	4 (33%)	7 (58%)	1 (8%)	ns
I am considered "nerdy" for studying this course	20 (74%)	5 (19%)	2 (7%)	9 (75%)	1 (8%)	2 (17%)	ns
I find the subjects I am studying interesting	1 (4%)	6 (22%)	20 (74%)	1 (8%)	5 (42%)	6 (50%)	ns
The classroom environment is welcoming	3 (11%)	7 (26%)	17 (82%)	3 (25%)	3 (25%)	6 (50%)	ns
I am confident about asking lecturers/ tutors for help	2 (7%)	6 (22%)	16 (70%)	1 (8%)	5 (42%)	6 (50%)	ns
I need to be good at mathematics to achieve well	1 (4%)	7 (26%)	19 (70%)	2 (17%)	4 (33%)	6 (50%)	ns
I need to be good at programming to achieve well	3 (11%)	5 (19%)	19 (70%)	1 (8%)	3 (25%)	8 (67%)	ns

Note. *The level of significance is set at .05 ($p < .05$). ns = not significant.

In the subsequent discussion of the findings, all survey data referred to can be found in Table 20.

6.3.1.1 Beliefs in skills required (or not required) to succeed in chosen courses

The perceptions of the skills including maths and/or programming required to achieve success in CS courses were examined in relation to individuals' subsequent CS course pursuits. The majority of the CS sample agreed (M=19: 70%, F=6: 50%) that they needed to be good at maths to achieve well. Another set of skills for achieving well in CS courses by the CS sample surveyed was programming skills (agreed: M=19: 70%, F=8: 61%). Chi-square tests however revealed no statistically significant differences by gender in perceptions of maths or programming to achieve well in their courses in the CS sample. The high proportion of CS females who perceived programming as essential in CS courses could indicate that involvement in programming could have motivated their CS participation, as Frieze et al. (2006) also found that females' confidence in programming encouraged CS participation. Also, participants who attached stronger STVs such as utility value or attainment value to maths and or programming skills as essential for studying CS were more likely to participate in CS courses. For instance, five out of eight CS students interviewed revealed their expectations of "learning to program" as part of their prior expectations before enrolling in CS courses. What was more, four out of the five CS participants interviewed who felt learning programming was part of studying CS also revealed that they had been surprised to realise that they had to learn a lot of maths.

In addition to individuals' perceptions of the skills as necessary for the CS coursework, coursework experiences were also explored to provide a glimpse into the nature of coursework. A higher proportion of CS females than CS males was unsure about their courses being too mathematical (M=10: 37%, F=6: 50%). Over half (7: 58%) of CS females were also unsure that their coursework was technical, in contrast to more than one-third (10: 37%) of CS males who disagreed. Chi-square tests however revealed no statistically significant differences by gender in perceptions of the coursework being too mathematical or technical in the CS sample. The survey responses revealing that half of the CS females surveyed had doubts about the CS coursework as too mathematical or technical suggest that they may have a good self-concept of their own maths or technical skills to do well.

In summary, while chi-square tests revealed no statistically significant difference by gender regarding the skills (i.e., maths, programming) required or perceptions regarding the coursework as mathematical or technical, participants' responses seemed to show a few possible trends. For example, when participants were interviewed about their coursework experiences they revealed that while their experiences might have been different to their previous expectations, a high proportion of the CS sample surveyed revealed programming and good maths skills were the two characteristics (or skills) they needed in order to study CS courses, and this could also serve as an indication of their self-concepts regarding their own abilities. It is evident that an awareness of the course demands and the possible tasks and skills required by CS courses prepared participants to pursue CS courses.

On the other hand, when members of the CS sample surveyed were asked how technical and mathematically oriented their coursework was, they indicated that it was neither too mathematical nor technical. This could have been linked to their participation in CS. Pre-entry perceptions that the course would be both highly technical and mathematical made participation in CS courses less confronting for CS participants, who might have perceived themselves as capable of handling the mathematical and technical related learning of the CS coursework, or have possessed sufficient self-efficacy in either maths or technical skills (or both) to envision themselves succeeding in the field.

6.3.1.2 Perceptions of socialisers and the CS learning environment

Individuals' perceptions of the CS coursework and the learning environment were explored for their likely influence in facilitating CS course participation. The majority of the CS sample (M=20: 74%, F=9: 75%) disagreed that they were considered nerdy for studying CS courses. The noticeably high proportion of CS females surveyed who did not perceive themselves as nerdy indicates that this perception could have been a motivational factor in CS participation, as Craig (2005) also found that females who pursue CS courses do not perceive their CS participation as "nerdy".

The majority of the CS sample surveyed agreed (M=17: 82%, F=6: 50%) that the classroom environment was welcoming. All CS participants interviewed (8: M=4, F=4) also believed that their classrooms were female-friendly. Hong-Bin, Jia-Rong and Li-Wen stated that they believed the classroom environment was female friendly due to their perceptions that females were treated fairly and equally to males in the classroom (M=2, F=1). Da-Bin and Wei-Yin, on the other hand, highlighted the gender differences in social characteristics in the CS field, "I think in the beginning they (boys) are shy so I should try to invite them to be my friends first" (Da-Bin, CS female) and "I do think there's a difference in terms of conversations, like they [boys] always talk about computer games" (Wei-Yin, CS female). Sheng-Yao (CS male) gave credit to the lecturers in the faculty for maintaining a "gender-neutral environment" for those studying CS courses, "I think because most of my lecturers were educated abroad, so they're accustomed to use female-friendly language". It is clear that both CS male and female participants interviewed perceived their CS learning environment as mainly gender neutral, and Sheng-Yao also illustrates the importance of socialisers' (teachers') attitudes and behaviours which can be encouraging factors for the pursuit of CS.

In commenting on the effect of learning settings further, all CS participants interviewed (8: M=4, F=4) found their overall experiences in the classroom to be generally positive, and three (M=2, F=1) CS interviewees shared their experiences. Da-Bin (CS female) pointed to not receiving any special treatment for being one of the few females studying CS. Sheng-Yao (CS male) commented on the pressure CS females may experience when studying in a male-dominated CS field: “Females have too much pressure in this sort of environment. My female mentor used to say that boys would just stare at her as she walked past”. This not only illustrated the seemingly high male to female ratio in the CS learning environment, but also the social issues females tend to face, such as social isolation due to the lack of female presence in the CS field. In contrast to Sheng-Yao’s illustration of the social identity issues females may confront within the CS field, Hong-Bin (CS male) described the perceived characteristics of females who chose to study CS: “they must be top students who get really good grades...I think if CS is something they enjoy doing, then they’d manage their learning easily, even if they’re studying in a male-dominated field such as CS”. It is evident that the self-concept of females’ own abilities in CS learning, as well as an “interest—enjoyment value” attached to CS learning were deemed important factors for achieving success in the CS field of learning at the undergraduate level.

Individuals’ perception of socialisers (e.g., lecturers) within the CS learning environment was examined for their influence in CS course participation. The majority of the CS sample (M=16: 70%, F=6: 50%) agreed they were confident about asking lecturers/tutors for help. Chi-square tests however revealed no statistically significant differences by gender in confidence in asking for assistance in the CS sample. While half (6: 50%) of the CS females surveyed were confident in asking for assistance from lecturers, only one of the four CS females interviewed was confident in asking for assistance; while for the other three CS females interviewed felt that their readiness to seek assistance was dependent on lecturers' (or tutors') attitudes. Lecturers of the units were defined by 8 of the 10 participants interviewed as the last people they would seek assistance from (CS: M=4, F=2; NCS: M=1, F=1), due to the main perception that they are busy all the time, yet participants also stated they would only approach lecturers if they appeared friendly. This highlights that an individual's perception of lecturers' (or TAs') attitudes and behaviours facilitate and/or encourage both males' and females' anticipation of achieving success in the CS field, which could further increase their likelihood of continuous participation (retention) in CS courses. Other studies have also identified that females' perceptions of socialisers such as lecturers' (or tutors') support of their learning can encourage or motivate them to continue studying their CS courses (Miliszewska et al., 2006; Wasburn & Miller, 2004).

In summary, no significant differences by gender were observed in the CS sample being perceived as "nerdy" for studying their courses, or perceptions of their classrooms as welcoming and having confidence in asking for assistance. The majority of the CS sample surveyed and interviewed confirmed that their CS learning environment was generally positive, although the issue of female underrepresentation was repeatedly mentioned throughout the interviews by CS males and females. While Hong-Bin (CS males) acknowledged that females must have been pretty good in order to pursue CS courses, he emphasised the importance of the "interest—enjoyment value" attached to CS as the key to wanting to pursue the study in the first place, which in turn can motivate individuals to work hard to achieve success in the field (Eccles, 1994, 2005a, 2005b, 2011). This further reinforces the importance of Eccles' (2011) STV component of the EVM, where the interest value is critical for a long-term, consistent participation in a particular field (such as CS courses), which also increases individuals' likelihood of choosing CS courses (and/or related professions). A contrast was seen in the high proportion of the CS sample surveyed who revealed they were confident in asking for assistance from lecturers (or tutors) whereas CS participants interviewed revealed that socialisers' (lecturers' or tutors') attitudes and behaviours contributed partly toward their experiences of CS coursework. Most importantly, socialisers who appear friendly and have times where participants could visit them during breaks or after class were perceived as helpful, and enabled students to feel they were supported and have a better chance at succeeding in their CS courses as they were able to receive timely assistance on their conceptual understanding.

6.3.1.3 Interpretations of experiences with coursework

Individuals', and particularly females' CS coursework experiences, can affect females' consideration of subsequent study pursuits in the field. The CS sample agreed that the coursework was time consuming (M=15: 55%, F=9:75%) and difficult (M=11: 40%, F=8: 67%). Chi-square tests however revealed no statistically significant differences by gender in perceptions of the coursework as time-consuming or difficult in the CS sample. Despite the lack of significant differentiation, a higher proportion of CS females than CS males found the CS coursework difficult. Whether the (perceived) difficulty of the CS coursework may discourage females from pursuing CS courses would require further validation with larger samples. Miliszewska et al. (2006) also found CS students reported the course material as often difficult to understand.

Females' perceptions of the workload and subjects studied in their CS courses were examined for how perceptions of course demands can potentially affect the pursuit of CS courses. Close to half of the CS males (13: 48%) agreed that the workload was heavier than expected; CS females agreed (5: 42%) or were not sure (5: 42%). In terms of the subjects studied, the majority of the CS sample (M=20: 74%, F=6: 50%) surveyed agreed the subjects were interesting. Chi-square tests however revealed no statistically significant differences by gender in perceptions of workload or whether subjects were interesting in the CS sample. Nevertheless, CS females surveyed seemed to have more varied opinions regarding the CS workload and subjects studied than their male counterparts.

In summary, there were no statistically significant differences by gender in terms of the perceptions of the coursework as time-consuming, heavy coursework and also whether the subjects were interesting. Of particular note was the fact that about half of the CS females surveyed revealed they found the subjects they were studying in their CS courses interesting. The importance of an interest—enjoyment value attached to subjects studied in CS courses could have been a motivating factor in retaining CS females in the field, yet other factors affecting their on-going participation also need to be explored. The following section presents the survey and interview findings of the influences of individuals' career related knowledge, perceptions (and aspirations) of future careers which may have facilitated their pursuit of CS courses.

6.3.2 Cultural milieu: career related knowledge

Individuals' career related knowledge (including knowing the careers associated with their courses) is a cultural milieu factor outlined in the EVM which can influence individuals' subsequent course pursuits. The majority of the CS sample (M=22: 85%, F=10: 83%) and the NCS sample (M=3: 100%, F=3: 75%) surveyed revealed they knew the types of careers associated with their courses. Other studies have indicated that an inadequate understanding of the careers available in IT discourages females from pursuing IT-related courses (Frome et al., 2006; Papastergiou, 2008; Redmond, 2006; Thomas & Allen, 2006; Young, 2003). CS participants' understanding of the occupational characteristics and task demands associated with CS courses (or majors) were explored during surveys. In the CS sample (M=26, F=13), close to a quarter of males (6: 23%) stated that "programming skills" are required to "work in the IT industry", while more than half (7: 54%) of CS females listed "programmers" require "programming skills" (n=4) or "communication skills" (n=3) to succeed. This also highlights that for participants in this study, their basic understanding of the skills required to work in the CS field could have partially informed their CS course pursuits.

Other than individuals' understanding of the careers associated with CS courses and the skills required to work in the field, other aspects of career-related perceptions were explored in survey question Q.37b (consisting of eight items). CS participants responded to each item based on a five-point Likert response format. For the chi-square tests that were used to identify statistically significant differences by gender, categories were again collapsed. Similar to the format used to present survey responses for Q.35 (see section 6.3.1.1), NCS participants' responses were excluded from the following table and subsequent discussions, as their responses were irrelevant to perceptions of CS career prospects and work demands. The frequencies (and percentages) of responses to items in Q.37b, as well as the outcomes of the chi-square tests for both samples are shown in Table 21.

Table 21

Frequency and Percentage Responses to Survey Items in Q.37b by Sex in the CS Sample, and X^2 Significance Levels

	Male			Female			Sig. Level*
Q37b items	SD/D	NS	A/SA	SD/D	NS	A/SA	*p*
I believe the pay will be high	3 (12%)	9 (35%)	14 (53%)	3 (25%)	4 (33%)	5 (42%)	ns
It will be difficult to balance a career with raising a family	3 (12%)	7 (27%)	16 (61%)	3 (25%)	1 (8%)	8 (67%)	ns
The career will require me to work long hours	2 (8%)	3 (12%)	21 (80%)	2 (17%)	0 (0%)	10 (83%)	ns
The workplace will discriminate against me	9 (35%)	16 (61%)	1 (4%)	3 (25%)	6 (50%)	3 (25%)	ns
Male colleagues will not welcome me	16 (62%)	8 (31%)	2 (8%)	6 (50%)	6 (50%)	0 (0%)	ns
I will have to sit in front of computers all day	3 (12%)	3 (12%)	20 (77%)	2 (17%)	0 (0%)	10 (83%)	ns
It will be difficult to get a job	16 (62%)	7 (27%)	3 (11%)	6 (50%)	3 (25%)	3 (25%)	ns
I will be able to transfer skills learnt in my course to the workplace	3 (12%)	6 (23%)	17 (65%)	2 (17%)	5 (42%)	5 (41%)	ns

Note. The level of significance is set at .05 ($p < .05$). ns = not significant.

In the subsequent discussions of the findings, all survey data referred to can be found in Table 21.

6.3.2.1 Career ideals and personal efficacy beliefs at work

Individuals' perceptions of work demands can potentially influence their choices of courses in particular fields. In this study CS participants' expectations of future ideal careers did not differ by gender in terms of the anticipation of high pay (agreed: M=14: 53%, F=5: 42%). Similarly, Clayton (2005) identified high salary/wage as one of the most influential factors for choosing ideal careers, which appeared to be the case for approximately half of the CS sample who chose CS courses.

Perceptions of the transferability of work seemed to vary by gender: the majority of CS males (17: 65%) agreed that this was important, whereas CS females either agreed (5: 42%) or were unsure (5: 42%). In contrast, participants interviewed seemed more optimistic about the usefulness of their courses, in preparing them for the real world/workforce (CS: M=2, F=2; NCS: F=1), providing them with the technical skills (CS: F=1) for work or research-related skills (CS: M=2, F=1; NCS: M=1) in higher degree by research. However, participants interviewed also revealed a concern that skills learnt in educational institutions would not match the skills required in their professions or workforce. Wei-Yin (CS female) further explained: “some people from the industry have told me that what I learn in college has little relevance to what I will learn in the industry...but I think what I have learnt now will help me pick up the skills I need to work in the industry”. Although Wei-Yin was concerned about this potential mismatch in skills, she had evidently attached a utility value to her CS course as useful for future career learning. Similarly, Sheng-Yao (CS male) also believed: “I think it’s useful…I mean, in this course you learn how to problem-solve, develop the problem-solving processes, create and then demonstrate your solutions”.

The concern regarding the transferability of skills was also shared by NCS participants interviewed (2: M=1, F=1). For example, Yu-Ju (NCS female) seemed more dubious about how the current course could prepare her for future work: “I think what I’m currently learning now may not be directly relevant to what I would end up doing as a career”. Ju-Yu was studying in Business Administration, and while she reported having learnt many aspects to do with administration, she had many doubts about how she would be able to apply skills learnt in her course to assist her in succeeding in a related profession. This suggests when individuals possess a lack of understanding of the careers associated with their courses, they are more likely to make uninformed course choices which may not enable them to fully utilise their abilities, thus affecting their performances and achievement in chosen courses and future careers. It is apparent that the utility value participants attached to the skills learnt in their CS courses can subsequently affect their expectations of success and achievement in the field.

In summary, although perceptions of pay did not differ by gender in the CS sample, the perceptions of the transferability of skills learnt on course to the workplace varied by gender. While the CS males interviewed revealed they found the CS coursework useful for preparing them for future careers, CS females interviewed as well as the NCS female interviewed revealed their concern about not being able to apply the skills learnt in their courses in their future careers. Further studies regarding how transferable students feel skills learnt in coursework are to the CS workforce need to be conducted to determine whether this perception influences subsequent CS course pursuit and retention.

6.3.2.2 Beliefs in colleagues' behaviours and attitudes in future workplace

Individuals' perceptions of socialisers' attitudes and behaviours can possibly affect subsequent course (or major) participation. Half of the CS sample (M=16: 61%, F=6: 50%) were not sure if their workplace would discriminate against them (37b-4). CS females disagreed (6: 50%) or were not sure (6: 50%) whether their male colleagues would not welcome them, while unsurprisingly the majority of CS males (16: 62%) disagreed. While half of the CS female survey cohort had a positive outlook about females working in a more male-dominated field of CS, the other half remained uncertain. Chi-square tests however revealed no statistically significant differences by gender in perceptions of workplace discrimination or male colleagues as not welcoming in the CS sample. Lewis et al. (2007)

also found that females who did not anticipate discrimination are more inclined to pursue IT related fields of study (such as CS).

6.3.2.3 Beliefs regarding work demands

Over half of the CS sample (M=16: 61%, F=6: 50%) surveyed agreed that it would be difficult for them to balance careers with families. Similarly, Nielsen et al. (2004) revealed one of the challenges for female IT professionals was coping with family and work. Also, a higher proportion of females than males in the CS sample agreed that their careers would require them to work long hours (M=20: 77%, F=10: 83%).These findings also implied that females had a stronger perception of the task demands (e.g. working hours) than males, yet chi-square tests did not reveal significant differences by gender.

It was interesting to observe that a higher proportion of females than males in the CS sample agreed that they would have to sit in front of computers all day (M=20: 77%, F=10: 83%). Both CS males and females perceived themselves as needing to use the computer frequently as part of their prospective careers. The higher proportion of CS females than males holding perceptions of their careers requiring them to work on computers all day in turn may have shaped their beliefs in this reliance on computer work as essential for achieving success in the CS fields.

Long working hours was also revealed as one of the stereotypes associated with CS careers during the interviews. “Working ‘til late at night/long hours” were the most common stereotypes voiced by CS participants (8: M=4, F=4), and other stereotypes included “programming all day” and “anti-social”. It was worth noting that participants still highlighted that gendered differences are still very much attached to particular fields or professions. For example, Jia-Rong (CS male) explained that more stereotypes are still attached to females who work or study in the CS field, and that female computer scientists can only do entry-level jobs but not act in developer roles, as they “will need to take care of their families”. Jia-Rong’s views highlighted not only the cultural stereotypes of the gender roles associated with females but also the stereotypes of the characteristics and task demands of CS-related professions. Jia-Rong’s gender role perceptions of females as the primary child minders further highlighted the conventional gender roles still firmly attached to females, while males could freely pursue CS professions without the burden of child-minding duties.

Interestingly, Yu-Ju (NCS female) also shared similar perceptions to Jia-Rong’s: “IT companies expect their employees to work extremely long hours. I’ve also heard that many IT graduates would work in big companies for a few intense years, earn quite a huge amount of money, and then find jobs in companies which have less pressure”. The activity task demands as highlighted by Yu-Ju also suggest that individuals’ goals and explicit motivations are likely to change after an accumulation of experience at work, which can subsequently affect their short-term or long terms goals (e.g., continuing to work in the CS field), although the expectation of success in the field did not seem to be affected. The relative costs of participating in CS study and the profession were highlighted, yet participants’ fulfilment of short-term goals (e.g., continuing to do higher degrees by research after the completion of their undergraduate degrees), or long-term goals (e.g., gaining some industry experiences and earning money to support their interests or careers in other fields) supported their on-going continuation in CS studies and determination to participate in CS professions.

6.3.2.4 Expectation of success in future careers

Over half of the CS sample (M=16: 62%, F=6: 50%) surveyed disagreed that it would be difficult to find a job. Chi-square tests however revealed no statistically significant differences by gender in perceptions of career prospects in the CS sample. The expectation of successfully securing a job after graduation was high for half of the Taiwanese participants who were interviewed (4: M=2, F=2), while the other half of the group (M=2, F=3) indicated their goals of doing postgraduate studies. It appeared that the majority of participants had a strong sense of "ideal self" which encouraged them to consider and establish long-term, career-related goals after graduation, either academically or in the workforce. Seven of the ten Taiwanese participants interviewed stated long-term goals in addition to their short-term goals; these longer term aims included seeking a career change/variety in work (CS: M=2, F=1), working as an academic or a researcher (CS: M=1), and gaining work experience then studying aboard (CS: F=1; NCS: F=1).

Participants' responses also illustrated a high expectation of success, as they must perform well in order to establish their long-term goals. They seemed to have attached a particularly strong attainment value to participation in their studies in order to fulfil their long-term goals. In other words, participants' attachment of an attainment value and relative cost to their respective courses (or majors) meant that while it was important for them to do well in their respective studies, in order to fulfil their long-term goals, a certain extent of the relative cost was attached to the options participants selected. For instance, while all participants interviewed (CS and NCS) wanted to study Masters or PhD in the future, some CS participants revealed they intended to pursue work in the CS industry as they preferred to gain some work-related experiences before resuming study (in a higher degree by research). There was thus a hierarchy of STVs playing mediating roles in the sequences of experiences and choices: attainment value in this instance is in a higher order than relative cost for those who had preferred working first than continuing study, as continuous studies would interfere with the work participation.

In summary, CS females' uncertainty about discrimination at work as well as not being welcomed by male colleagues highlight the potential effect of socialisers in influencing CS course pursuits, as females' uncertain perceptions of socialisers' (e.g. male work colleagues) attitudes and behaviours could lead females to attach a high relative cost to CS participation, by perceiving it as a field that is inappropriate for females. On the other hand, participants' awareness of the demands of CS related professions, including working long hours, sitting in front of computers all day, and the potential difficulty in balancing family and work revealed by the CS females surveyed also indicates that an understanding of the cultural stereotypes and occupational characteristics enabled females to make informed choices, by having first understood the demands of CS careers. While stereotypes associated with CS professions were well described by CS participants interviewed, a clarified understanding of the some of the stereotypes associated with the CS courses and careers – even though these may not be true but mainly due to misunderstanding – were what could have encouraged females in choosing their CS courses.

The CS sample surveyed and CS participants interviewed revealed that they were generally positive regarding the career prospects associated with CS courses, yet the personal short-term and/or long-term gaols played mediating roles in students' CS participation. Undertaking a higher degree by research was an alternative option after graduation, as raised by many CS participants (as well as the NCS participants) interviewed. It is also evident that, depending on the STVs attached (e.g. attainment value) to the short-term/long-term goals individuals possess, course pursuits by individuals in the CS field could vary.

6.4 Conclusion

Taiwanese participants seemed to have placed a strong attainment value on studying advanced senior secondary maths subjects equivalent to Maths Methods and Specialist Maths (in Victoria) while at school, as revealed by the majority of the CS and the NCS samples surveyed. One of the possible reasons could be due to participants wanting to ensure they could have a wider range of courses to choose from at the undergraduate level. Both the CS and the NCS samples surveyed revealed their overall perceptions of the relative unimportance of studying senior secondary IT. Two STVs, namely the lack of attainment value (e.g., personal importance) and/or the high relative cost the participants attached to senior secondary IT, (i.e., the score would not contribute toward participants' college entrance exam (CEE) scores) made IT subjects less highly regarded for study at the senior secondary level students.

Secondary school learning environments were assumed to have provided participants with a variety of IT-related learning experiences which may have motivated or discouraged them from pursuing CS courses after completing high school. Although a high proportion of CS females surveyed revealed a lack of access to computers in their classrooms, computer access did not seem to affect their participation in IT-related fields of study such as CS. What was of greater concern was the persistently higher proportion of CS males than CS females surveyed who reported having received encouragement from their secondary school teachers on developing computing skills. Moreover, participants' exposure to mainly male role models (including male IT teachers and/or professionals) may have further reinforced the gender roles males and females attached to CS, strengthening the perception that CS courses and related professions were male-exclusive fields.

Some motivational factors were nevertheless also explored to identify what prompted CS participants to pursue CS courses. It was found that pre-tertiary work-related experiences had minimum effect on CS participants' choices of CS courses, and personal interest, career aspirations and perceptions of skills required to achieve success were found to be stronger mediating factors for course participation in CS.

Socialisers such as fathers and mothers, as well as their encouragement to develop computer skills, seemed to exert a similar influence on males and females in the CS sample, while a smaller proportion of NCS females than NCS males reported receiving such encouragement. This illustrates that some NCS females could have possibly then ceased to associate themselves with further IT-related learning in higher education, as they were not encouraged to develop IT-related skills, and could also have been influenced into perceiving developing computing skills as unimportant. Subsequently females would be less inclined to choose courses such as CS which they perceived as requiring some IT-related skills. Participants' perception of other socialisers (e.g., female academics and other students who study in IT-related fields) seemed to be minimal influences on participants' choices of CS or NCS courses.

Perceptions of their own IT-related learning abilities revealed that while half of CS females did not believe they were good at learning IT-related skills, it could have been their perceptions of being good at learning maths while at school or the awareness of programming skills as essential to IT learning which prompted them to pursue CS courses at the undergraduate level. In contrast, those NCS females who did not perceive themselves as good at IT-related learning or at maths, or who felt they needed programming to do well in IT-related courses, may have been less inclined to choose IT-related courses such as CS.

Course-related knowledge was also found to be one of the factors which accounted for individuals' course pursuits. University websites were found to be the most common form of course information used by males and females of both samples surveyed. Yet the lack of utilisation of other sources could also mean that the failure of university websites to provide up-to-date information on the courses offered could disadvantage to students, who might not choose, for example, CS courses, as they would not know what they needed to learn, the skills they needed to possess in CS courses, or the associated research and/or work opportunities.

Although personal interest was found to be the most important reason for both male and female participants' course choices in both samples, CEE scores however did change some participants' eventual course choices: some chose other courses because their CEE scores could admit them into such courses; on the other hand, they might have been interested in CS courses, yet not studied them due to the lower CEE scores they had achieved. Nevertheless, both the CS and NCS participants interviewed revealed that prestige associated with an institution was paramount in their course choices, rather than their personal interest in CS or NCS courses. If they could attend the top university in Taiwan, it would not only satisfy their socialisers' (e.g., parents, teachers) expectations, it would also enable them to establish their positions in society among the elite who are regarded as both intelligent and high achievers, while at the same time also acknowledge their academic abilities and make them feel assured of being able to succeed in their chosen courses.

Both CS and NCS participants seemed to have an awareness of the stereotypes associated with the CS courses. An awareness of the skills required to study CS courses was more likely to have accounted for CS participants' CS course choices than those of their NCS counterparts. However, it was found that the belief among the surveyed CS sample that programming and good maths skills are important for studying CS might indicate not only their understanding of the course characteristics but also their confidence in possessing the skills or the capabilities to utilise either (or both) of these skills to perform well in CS courses, prior to CS participation.

The coursework experiences revealed by the males and females surveyed also illustrated that their CS learning environments were generally positive, while CS males surveyed emphasised that it is important to have a personal interest in CS courses or to want to work in CS, since this would help foster success for individuals who participate in CS courses. Participants' perceptions of lecturers' or tutors' (socialisers') attitudes toward them when they asked for assistance were that they were generally positive, yet the participants interviewed revealed that they found some lecturers (or TAs) less approachable, and therefore were more self-reliant in acquiring knowledge. This can have some adverse effects on individuals' learning in CS courses, and for females it may also affect their retention in the field, particularly when they are studying in fields as a minority group, which could cause them to doubt their abilities in performing well and achieving success in the field.

Career-related knowledge did not seem to have a profound effect on participants' pursuit of undergraduate CS courses. However, participants' perceptions of the transferability to future workplaces of skills learnt in courses appeared to be important for CS males and females surveyed and interviewed. It is important for schools and tertiary institutions to work together to further clarify the course characteristics and skills which can be applied in careers associated with individuals' chosen courses, particularly for females who may consider studying CS courses.

The following chapter presents a synthesis of findings and discussion on the similarities and differences in factors and how they affect females' participation and non-participation in CS courses in the Australian and Taiwanese educational contexts.

Chapter 7. Synthesis of findings and discussion across educational contexts

This chapter presents a synthesis and discussion of the themes which have emerged from an analysis of social, psychological and motivational factors contributing toward individuals' pursuit or non-pursuit of CS courses (or majors) at the undergraduate level in Australia and Taiwan.

The main research question of this thesis was "What are the factors, and how do they influence individuals', particularly females' participation and non-participation in CS courses in Australia and Taiwan?" After a careful exploration of Eccles et al.'s (2011) expectancy value model (EVM) in Chapter 2, as well as the literature in Chapter 3, a survey was developed and then used to gain an overview of the characteristics of the CS and NCS samples in Australia and Taiwan in Phase 1 of this two-phase study. Follow-up interviews were conducted in Phase 2 to gain more detailed accounts of individuals' educational experiences and the subjective task values (STVs) they attached to IT (or CS) which prompted their CS or NCS course choices. Similarities and differences in factors which resulted in Australian and Taiwanese females' course choices are presented in the following sections.

7.1 Similarities and differences in factors for CS and NCS participation

7.1.1 Senior secondary schooling experiences

Individuals' senior secondary school experiences were examined for their influences on course participation. The maths experiences of the Australian and Taiwanese groups varied. Although the majority of the Australian and the Taiwanese samples (CS and NCS) surveyed studied senior secondary maths, maths is not a prerequisite subject for entry into all Australian undergraduate courses, while it is for Taiwanese requirements. For example, maths was not a prerequisite subject required to study a Bachelor of Arts at Monash University (Monash University, 2012a). Taiwanese students in contrast needed to study either Maths A or Maths B to attend the college entrance exams (CEE) (College Entrance Examination Center, 2009a; College Entrance Examination Center, 2009b). Also, the high proportion of those in the Taiwanese CS sample who had studied Maths A (equivalent to Maths Methods and Specialist Maths in Victoria, Australia) indicated the importance of maths for studying the sciences/engineering disciplines such as CS. The Australian CS sample surveyed reported being good at maths and logical thinking as reasons for wanting to study CS courses, yet no Australian participant interviewed discussed having been good at maths as having affected their CS course pursuit. It was found that although a smaller proportion of Australian CS females studied advanced maths in contrast to Taiwanese CS females, three Australian CS females indicated having studied university-level maths compared to only one Taiwanese CS female. The influence of individuals' university maths experiences on their subsequent CS course pursuit requires further validation using larger samples.

Irrespective of cultural contexts or gender, CS participants in both the Australian (AU) and Taiwanese (TW) samples surveyed seemed to perceive participation in senior secondary IT studies as unimportant (i.e., attainment value was lacking). The Australian participants interviewed revealed that it was important to have a strong interest in IT-related learning or activities, while Taiwanese CS participants in contrast revealed that the cost of participation (e.g. relative cost) in senior secondary IT studies was too high. In other words, Taiwanese participants perceived that participation in senior secondary IT could possibly lead to not achieving good CEE scores, which could subsequently affect their goals of enrolling in their preferred universities.

Individuals' previous educational experiences in particular fields or disciplines are related to their subsequent course pursuits. Participants of this study were found to have considered previous successful achievements in IT (or CS), as well as a range of other factors, to have helped them choose from a range of course options available at the tertiary level. The following sections provide the factors identified in this study that were found to have influenced participants' decision-making processes.

7.1.2 Factors involved in course decision-making processes

7.1.2.1 Interest—enjoyment value

Factors identified by this study which were found to have influenced participants' course pursuits were interest—enjoyment value, socialisers, course knowledge and perceptions for skills required. It was found that personal interest in, or an "interest—enjoyment value" attached to particular IT-related activities, was revealed to be the most influential factor in individuals' course participation by the majority of the survey participants in the Australian and Taiwanese groups. Participants' interest in a CS or NCS related field of study or profession (e.g. interest—enjoyment value attached), and/or understanding of the skills (i.e., programming, good maths skills) required to study CS courses, were motivating factors for CS course pursuits. Lyons et al.'s (2012) study also revealed personal interest as important for choosing STEM related courses. Other studies also revealed that individuals made course choices based on what they know about their courses and their views on whether they would enjoy them (Frieze, 2005; Lewis et al., 2007; Margolis & Fisher, 2002; Papastergiou, 2008).

However, individuals' personal interest in the CS field is not the only factor for their participation in the field. Participants in this study have revealed that interest as well as other factors including socialisers, course knowledge, interest—enjoyment and attainment value attached to particular institutions together contributed towards CS course pursuit.

7.1.2.2 Influences of socialisers

The influences of socialisers including parents and teachers seemed minimal in participants' choices of courses, yet some differences were observed. A higher proportion of males than females (CS and NCS) in both the Australian and Taiwanese groups received fathers' encouragement to develop computing skills. However, it appears mothers instead of fathers may have motivated some Australian females surveyed in gaining computing skills – possibly more so than experienced by Taiwanese females. Lyons et al.'s (2012) study also revealed that Australian females were significantly more inclined than males to rate their mothers as important in their decisions to study STEM related courses. Nevertheless, the discouraging influence of mothers was not reported by the Australian females interviewed, though it was reported by only one Taiwanese female, whose mother had said that CS professions could be too demanding for females (Yu-Ju, NCS female). It appears that parents had little or almost no influence in participants' CS course choices among the CS females interviewed in the Australian and Taiwanese groups.

The role of other socialisers such as teachers and the encouragement they offered to students in developing computing skills was found to have differed by gender in the Australian CS sample surveyed but not in the Taiwanese CS sample. Australian CS males were more likely than CS females to be encouraged by their secondary teachers to develop computer skills. However, both the Australian survey sample and the number of people interviewed (only one of the three Australian CS participants) mentioned secondary school teachers as influences in her course decision-making processes, are too small to make a generalisation. The recent study by Lyons et al. (2012) did find that Australian females were significantly more inclined than males to regard personal encouragement from teachers as very important when making decisions in choosing STEM related courses. On the other hand, some Taiwanese CS females interviewed revealed that their socialisers' (e.g., parents' and/or teachers') expectations could have affected their subsequent participation in tertiary CS courses. It seems perceptions of coursework demands, future income, and expectations of success in the CS field were also other possible factors for Taiwanese females' CS course pursuits. The EVM also holds that individual's perceptions of socialisers' attitudes and expectations lead to goal and motivational pursuits in certain fields. In other words if individuals placed a strong value on the advice and/or expectations of their teachers and/or parents that they should study CS as they would do well in the field, then individuals may be encouraged to pursue CS courses.

Nevertheless, females' perceptions of other socialisers such as the representation of other females in IT related courses could have encouraged or discouraged some from pursuing CS courses. A higher proportion of Australian CS females than males contrasted with a higher proportion of Taiwanese CS males than females surveyed believing that there was a gender imbalance among students studying IT-related courses. While the Australian CS females surveyed in this study perceived male dominance in the profession as the cause for the gender imbalance in IT studies, Taiwanese CS females surveyed instead believed that females' lack of interest was the reason.

Gurer and Camp (2002) found that females' underrepresentation in the IT field was due to their stereotypical perceptions which made them disinterested in IT, which was similar to what the Taiwanese CS females perceived, but was not the perception of the Australian CS females. However, other studies have found that females who do not perceive IT (or CS) related fields of study as male-dominated are more inclined to study IT (or CS) related courses in higher education CS (Beekhuyzen & Clayton, 2005; Frome et al., 2006; Messersmith et al., 2008; Nielsen et al., 2004). Therefore, females' perceptions of IT related fields of study such as CS, and other stereotypical notions of CS courses and/or careers may result in their non-participation in CS.

7.1.2.3 Course knowledge

Individuals' sources of course information, as well as their understanding about the course features, contributed towards their selection of CS (or NCS) courses. University websites were found to be the most common source of course information for the Australian and Taiwanese samples surveyed, and possibly for those who considered pursuing CS courses. For example, one Taiwanese participant interviewed (Jia-Rong, CS male) explained that it was the informative nature of the CS faculty website that provided him with the confidence to make his choice of a CS course. Jia-Rong further expressed that, without having viewed the informative faculty website which detailed what is to be learnt each year, and the career prospects associated with CS courses, he would not have been encouraged to choose CS courses. From this it can be seen that university (or faculty) websites can be potentially useful for providing students with an informative outline of the courses they offer, to prepare them for making informed course choices, particularly in CS.

In terms of individuals' understanding of their courses, programming was a commonly known feature of CS courses to the Australian and Taiwanese CS samples surveyed, and this had also been identified by other studies (Lewis et al., 2007; Margolis & Fisher, 2002; Papastergiou, 2008). Females surveyed in this study who were found to have perceived themselves as possessing the abilities to apply (or to learn) programming well chose CS courses, whereas other females who perceived programming as technical or felt that it dominated the CS coursework could have been discouraged from the pursuit of CS. Similarly, researchers have also found that females who perceive CS related courses and/or work as technical are less likely to study in the field (Clayton, 2005; Young, 2003). It is therefore important to help females understand that CS is not only about programming, and that other skills are also required to be successful in studies and professions in the field.

7.1.2.4 Perceptions of self-ability and skills required for IT

Females' perceptions of their abilities in studying IT as well as the skills they deemed important varied between the Australian and Taiwanese CS samples. Half of the Taiwanese CS females surveyed disagreed that they were good at learning IT-related skills at school while the majority of the Australian CS females surveyed agreed. Lewis et al. (2007) also found that females were generally less confident than males in their ability to do IT, which may have been the case for the Taiwanese CS females.

Similarly, confidence in learning new computing skills seemed to have varied between the Australian and Taiwanese CS females surveyed. Although it was suggested that lack of confidence could have been the reason why some females did not end up studying CS (Miliszewska et al., 2006), it was apparent that Taiwanese CS females' seeming lack of self-efficacy beliefs in learning computing skills did not seem to have interfered with their CS course pursuit. In contrast to Machina and Gokhale (2010) who suggest that self-efficacy beliefs can predict an individuals' pursuit of choices in science and technology fields, Taiwanese females in this study have shown that confidence in learning new skills is not the only predictor or indicator of CS course choices, as other factors appear to have been more important considerations.

In addition to self-efficacy beliefs in IT, individuals' perceptions of the most important skills required to achieve success in CS courses could have influenced their CS participation. The skills perceived as essential for studying CS varied between the Australian and Taiwanese CS females surveyed. Maths was highly valued by Australian CS females (7: 63%) while Taiwanese females prioritised programming (7: 64%). Females' perceptions of the skills needed to achieve well in CS courses could have been due to having been educated in different educational contexts which affected the different values attached to CS courses. Australian CS females' views contrasted with those found by Frieze et al. (2006), who found that females' confidence in programming prompted their CS participation in the US context. This may have been the case for Taiwanese females.

7.1.2.5 Reasons for course selection

The most important reason for choosing CS courses varied by gender in the Australian CS sample but not in the Taiwanese CS sample surveyed. Personal interest was the most important reason for studying CS courses for the Taiwanese CS sample and Australian CS males, whereas for half of CS females it was career prospects. However, the two Australian CS females interviewed revealed that an interest—enjoyment in IT (or CS) related studies (or activities) prior to course enrolment motivated their CS course pursuits, as opposed to career prospects revealed by the CS females survey responses. Personal liking for using computers (Kerryn, CS female), or enjoying programming (Sinead, CS female), or enjoying doing CS (Jarrad, CS male) are all examples of the importance of the interest—enjoyment value individuals attached to CS, which may have motivated their study-related goals (CS course pursuits) and career-related goals (e.g. becoming a computer scientist). Similarly, Lyons et al. (2012) revealed that young Australians choose STEM courses primarily due to personal interest. Australian females in this study were also found to have made CS course choices based on their interpretations of previous experiences in maths and/or IT, as well as the utility value attached to maths for CS courses.

In contrast, the Taiwanese CS sample surveyed chose personal interest yet interview findings revealed that the attainment value individuals attached to attending the top institutions in Taiwan at times outweighed personal interests or preferences, as did the relative cost of CS courses (i.e., CEE scores required). All four Taiwanese CS females interviewed indicated using CEE scores as the first tool to assist them in deciding which undergraduate courses to select. The CEE scores either enabled them to study CS at one of the more prestigious courses at their chosen university, or their CEE scores meant they had to seek alternative courses. This implied that the prestige associated with the CS courses prompted many Taiwanese participants surveyed to study CS, yet the prestige associated with the university, as well as cultural expectations (the belief one should study the best course one can enrol in) were the two stronger facilitating factors in CS participation in the Taiwanese group. Other factors including the attainment value and utility value they attached to the future prospects (work and/or study related) of CS courses, positive cultural stereotypes of CS courses (e.g., studied by smart students, prestigious careers associated with the course) and associated course/work demands (e.g., programming, working long hours) were revealed by the Taiwanese females interviewed as important considerations for CS course choices.

It is also interesting to observe that while some studies have identified that stereotypical notions of CS related professions discourage females from pursuing IT-related courses such as CS (Craig, 2005; Stockdale & Stoney, 2007; Timms et al., 2006), no Australian and Taiwanese CS females interviewed mentioned stereotypes associated with CS as having made them reconsider whether or not to enrol in CS courses. Thus, this study has found that personal interest for Australian participants as opposed to attainment value and relative cost for Taiwanese participants seemed to have been the principal factors in their CS participation.

7.1.3 After enrolment

7.1.3.1 Individuals' own classroom experiences

Individuals' perceptions of the CS classroom did not differ by gender among either the Australian or the Taiwanese participants surveyed and interviewed. The majority of both the Australian and Taiwanese CS samples surveyed found their classroom welcoming, and all that were interviewed revealed that their CS classrooms were female-friendly. Gender-neutral environments were reported by the majority of Australian and Taiwanese CS males and females surveyed and interviewed, which indicates that positive classroom experiences are essential for both genders in the CS field, and for improving the inequitable participation by gender in the CS field. The Australian findings from this study are in line with the larger study by Lyons et al. (2012), which revealed no indication that females in STEM courses felt discriminated against by male students or lecturers.

In addition to the importance of gender inclusive CS learning environments as important for both males and females in tertiary CS learning settings, CS participants' rapport with their lecturers or tutors was also found to affect the degree of their involvement in CS learning. While the majority of the Australian CS and the Taiwanese CS sample surveyed believed they were confident about asking the lecturers (or tutors) for assistance, the interviews revealed otherwise. Participants' confidence in seeking help from lecturers or tutors (socialisers) was dependent on their perceptions of socialisers' (e.g., lecturers', tutors') attitudes. For example, Sinead (Australian CS female) was comfortable with the tutors but did not feel she could easily approach her lecturers.

Similarly, Taiwanese females explained that they would only approach the lecturers for assistance if they appeared approachable, and added that they felt more at ease approaching tutors. Socialisers' attitudes can affect the likelihood of females' retention in CS courses. Nevertheless, studies have found that females' perceptions of lecturers as supportive motivate them to continue to study CS (Miliszewska, 2006; Wasburn, 2004). Therefore, a good rapport between lecturers and students is essential in CS courses, to enable females to feel welcome in CS learning environments, and to be equipped with the sense that their learning can be well attended to when they need assistance.

7.1.3.2 The influence of career knowledge/aspirations on CS course pursuits

Career related knowledge may have assisted Australian and Taiwanese females in making choices about whether to participate in CS courses or not. A high proportion of both the Australian and Taiwanese CS females knew the careers associated with CS courses, and "programmer" was the most commonly identified CS profession by the Australian CS (6: 55%) and Taiwanese CS (F=7: 54%) females surveyed. Three NCS participants interviewed (Australian=AU, Taiwanese=TW) have however revealed worthwhile concerns regarding their non-pursuit of CS courses due to their perceptions of CS careers. For example, Zoe (AU: NCS female) stated that some females may choose careers in which they deem it easier for them to combine family and work, whereas Tess (AU: NCS female) believed that the fact that there are "societal expectations of females to work in more female-oriented fields" explained why some females may be less inclined to pursue CS courses.

An-Chang (TW: NCS male) on the other hand raised the notion that childcare issues prevent females from working in highly-demanding jobs that require long working hours, such as CS. An-Chang's perception that females who value a work-family balance may be less inclined to choose CS careers is similar to the view of Lewis et al. (2007), who state that some females choose careers in which they encounter fewer barriers to their sex. Therefore, females who perceived CS careers as highly demanding and possibly affecting the personal importance (e.g. attainment value) they attached to work-life balance may have felt less inclined to pursue CS courses. Individuals' perceptions of gender roles in relation to careers for males and females, as well as the work-related demands of CS related professions – particularly as related to females – were perceived by both the CS and NCS participants interviewed as factors for the gendered participation in CS-related professions.

Another concern about CS related careers which may have prevented some individuals from choosing CS courses was the transferability of skills to the workplace. While the responses did not differ statistically significantly by gender in the Australian and the Taiwanese CS samples surveyed, two Taiwanese CS participants interviewed pointed to the potential gap between “institutional learning” and “industry learning”. Both Sheng-Yao (CS male) and Wei-Yin (CS female) commented at interview on the likelihood of what they learn in CS courses being irrelevant or insufficient for application in their future work. The skills gained from coursework should be better explained by lecturers (or tutors) as should the ways students can apply the skills to solving problems in real-life situations and also at the workplace.

7.2 Conclusion

This study has found that CS females’ pre-tertiary experiences, including studying secondary school maths IT, interest—enjoyment value, self-efficacy beliefs in IT learning, perceptions of skills required to study CS, course and career-related knowledge, influenced their subsequent pursuit of CS. It was found that Taiwanese females, particularly those who were interested in CS, may have been forced not to pursue CS due to their unwillingness/inability to take the advanced maths (e.g. Maths A) they needed to study while at school. A lack of regard (or interest) in participating in senior secondary IT studies by both the Australian and Taiwanese groups surveyed did not necessarily result in NCS participation at the undergraduate level. It was found that those who attached a stronger interest—enjoyment value to IT-related activities or tasks (not necessarily IT-related learning) believed they possessed the skills and the abilities to do well in IT-related courses such as CS, which then prompted their CS course choices. This also shows that strong self-efficacy beliefs in IT-related learning for Australian females in this study, or the perception they had the maths abilities deemed useful for studying CS by Taiwanese females, motivated their participation in CS courses.

Just as individuals’ own interest in IT-related activities or in tasks influenced their CS pursuits, Australian females’ interest (i.e., an interest—enjoyment value) attached to IT (or CS) constituted the most important reason for choosing CS courses. In contrast, Taiwanese CS females revealed reasons that were more complex. The attainment value Taiwanese females attached to attending the top university in Taiwan, as well as the relative cost of participation (e.g., CEE scores), affected the course options available to them, which were not necessarily in the CS field. Other factors concerning CS course participation for Taiwanese females also included their own self-beliefs in possessing the skills (i.e., maths/programming) required to study CS courses, expectation of success and also the career prospects. The institutional factor was central to Taiwanese females’ course choices, while interest—enjoyment in IT (or CS) was undoubtedly important for Australian females in this study.

Individuals’ understanding about CS courses and the associated careers were shown to have motivated Australian and Taiwanese females in choosing CS courses. What was more, the potential issue of not being able to apply skills in future workplaces was raised by two Taiwanese CS participants interviewed. This also illustrates that CS coursework needs to include more examples of how particular skills can be utilised in certain scenarios and how to problem-solve real-world tasks, which could reassure students about the practicality of their CS courses and about their usefulness for their future professions.

This chapter has presented a synthesised discussion of the survey and interview responses across educational contexts. It is apparent that some of the findings from this small study are nongeneralisable due to the small sample sizes. However, the study has provided a cross-national insight into the factors which may have influenced females' participation and non-participation in both educational contexts. Moreover, some of the findings have not previously been reported in the literature reviewed and have implications for the future. In the final chapter of this thesis the main research question is revisited, along with the key factors identified as influencing Australian and Taiwanese females' participation and non-participation in CS courses.

Chapter 8. Conclusion and implications for course participation in Computer Science

The findings from this mixed methods study are not generalisable due to the limitations in the number of students and institutions, yet are valuable for informing further research addressing the gendered participation in Computer Science (CS) courses in higher education. This study gained an international insight into the similarities and differences in factors for CS and NCS course choices by females in two different educational contexts (Australian and Taiwanese). Earlier studies were mainly conducted in Anglo-Saxon educational contexts, whereas this study offers cross-national comparisons. Also earlier studies focused on female perspectives and insights with little or no inclusion of male perspectives. By including perspectives of males and females, the inequitable domination of males in the CS field can also be better understood, providing a more gender inclusive response to the research question.

To better understand why there is an inequitable representation of females in CS courses in both educational contexts, this study proposed the question of "What are the factors, and how do they influence individuals', particularly females' participation and non-participation in CS courses in Australia and Taiwan?" The surveys revealed that an interest—enjoyment in IT (or CS) related learning encouraged Australian participants' CS course choices. Australian CS participants interviewed revealed that they also chose CS courses due to a high self-efficacy in programming or IT-related tasks. In contrast, Taiwanese CS participants interviewed revealed their strong preference for (e.g. attainment value attached to) institutions outweighed their interest (if any) attached to CS courses. The interview findings also confirmed that stereotypical perceptions of CS courses and/or professions discouraged Australian and

Taiwanese females from pursuing CS courses. The theoretical model and literature were consulted and used to conduct this research and to better address the research question.

The Eccles et al. (2011) expectancy value model (EVM) was chosen after careful consideration by the researcher of this study. A number of empirical studies had also adopted the EVM as the basis for their research, or modified the original EVM to suit their research purposes (see Anderson, 2000; Barnes et al., 2005; Eccles, 1994; Lupart et al., 2004; Vickers & Ha, 2007; Zarrett & Malanchuk, 2005). These studies – as did the present one – considered the EVM useful for examining the influence in particular course choices of gender roles, educational experiences and the values individuals attach to particular subject matters or tasks. The subjective task value (STV) component of the EVM (interest—enjoyment, attainment, utility and relative cost) was also used to identify what STVs individuals attach to various subject matters, tasks or activities and to what extent this results in their participation or non-participation in undergraduate CS courses. In addition to the STVs, factors such as previous achievement related experiences, gender roles, expectations of success, and socialisers were explored for the extent of their influence in participation or non-participation in CS. Similarities and differences in factors for course participation by gender in both educational contexts were also examined.

Using EVM as the theoretical framework in this study, and drawing further insights from the literature, five key factors were identified from previous research which accounted for females' participation and non-participation in IT (or CS) fields of studies at both the secondary and tertiary levels in general. These five factors were:

1. Self efficacies beliefs in IT and the expectation of success reinforced subsequent participation in relevant fields of study (Bandura, 1997; Frieze et al., 2006; Machina & Gokhale, 2010; von Hellens et al., 2003)

2. Previous educational experiences, particularly being unsuccessful in IT-related learning, discouraged subsequent participation in relevant fields (Craig, 2005; Leech, 2007; Papastergiou, 2008; Redmond, 2006)

3. Stereotypes associated with IT (or CS) related studies and careers deterred course participation in the field(s) (Anderson, Lankshear, Timms, & Courtney, 2008; Lemaku, 1979; Stockdale & Stoney, 2007; Thomas & Allen, 2006; Timms et al., 2006)

4. Individuals' perceptions of socialisers' behaviours, attitudes and expectations, such as parents, teachers, role models motivated their course decision (Bandura, 1997; Eccles, 2011; Jacobs & Eccles, 2000; Margolis & Fisher, 2002)

5. Individuals' course or career knowledge and aspirations in IT have in ways limited their course choices (Clayton, 2004, 2006; Messersmith et al., 2008; Papastergiou, 2008)

Using the EVM and the five factors identified, as well as based on the goal of this research, a mixed methods approach was chosen to identify the main factors influencing the course participation by gender in two different educational contexts (Australian=AUS, Taiwanese=TW). Mixed methods research enabled the researcher of this study to gather the general characteristics of the undergraduates studying CS and NCS courses by educational context using surveys during the first phase (Phase 1: AUS=106, TW=52), then to examine in more detail the reasons for individuals' course participation by gender within groups (CS and NCS) and by context (AUS and TW) during interviews in the second phase (Phase 2: AUS=7, TW=10). Presenting data by educational context, with further break-downs by group membership (CS and NCS) and gender allowed for greater clarity in understanding the factors which influenced participation and non-participation by gender in each educational context respectively. A comparison of the similarities and differences of factors affecting the choices and non-choices of CS courses by gender also provided a better understanding of reasons for the inequitable representation of females in the CS fields in two distinctively different educational contexts, and to propose ways to address this issue.

The following section presents the main findings from this study, which are the key factors identified to have influenced individuals', particularly females' participation and non-participation in tertiary CS courses by educational context.

8.1 Main findings

This study confirmed earlier studies that attest to the underrepresentation of females in CS courses in Australia (Lang, 2010; Miliszewska et al., 2006) and in Taiwan (Fan & Li, 2005; Kuo, Yang, & Tseng, 2010). In both the Australian and Taiwanese contexts, CS participants' previous successful experiences in IT-related learning or activities (e.g., achieving good marks in IT subjects) were found to have reinforced their self-efficacies in IT-related learning. Strong self-efficacies in IT learning promoted females' expectation of success in CS, which motivated their participation in the field. STVs also influenced and/or facilitated course participation by Australian and Taiwanese participants. For example, an interest—enjoyment value (STV) was the main contributing factor in Australian participants' course participation for both males and females surveyed and interviewed.

In contrast, a more varied combination of factors and STVs was found to have motivated or discouraged Taiwanese participants' course pursuits in CS. The attainment value (e.g., personal importance) Taiwanese participants attached to attending a good university, as well as the relative cost (e.g., CEE scores) associated with the courses they could be studying at their preferred universities, were the two strongest factors in their course choices. Other factors such as the utility value (e.g., usefulness) Taiwanese students attached to their courses for gaining future employment, or their self-efficacy beliefs and expectations of success, were less important although these were also considered during their decision-making processes. Clearly an interest—enjoyment value alone did not constitute the most important or influential factor in CS course participation for Australian students in this study, just as attainment value and relative cost were not the only two influential factors in Taiwanese students' course choices.

After a review of the five main factors identified by the literature as influencing females' CS participation (or non-participation), three of the five main factors, namely self efficacy beliefs in IT, previous IT learning experiences and stereotypes associated with IT (or CS), were found to have influenced females' CS participation in this study. However, the remaining two of the five main factors from the literature, namely perceptions of socialisers' attitudes and behaviours, and course and/or career knowledge, were not influential in Australian and Taiwanese females' course choices. The four main factors identified by this study did not always influence Australian and Taiwanese students', particularly females' participation or non-participation in CS courses in the same way or to the same extent. The four main factors were:

1. Negative school IT experiences discouraged Australian females' CS pursuits;
2. Stereotypical perceptions of CS facilitated females' NCS participation in both contexts;
3. Interest—enjoyment value for Australian females' CS enrolment, and attainment value and relative cost for Taiwanese CS females; and
4. Taiwanese females' lack of confidence in learning new computing skills did not deter CS pursuits.

Each of the four main factors is presented and discussed in the following sections.

8.1.1 Negative school IT experiences discouraged Australian females' CS pursuits

The secondary IT-related experiences that the Australian females had were found to have affected their subsequent CS course pursuits. Particularly, the nature of the IT-related tasks (e.g. doing spreadsheets) that NCS females (interviewed) had to do in their IT classes, was expressed as "boring". Contrasting IT-related experiences which involved the uses of a range of applications to create websites, video clips, multimedia, were revealed by Australian CS females interviewed as "interesting" and "useful" for study and personal uses.

Both the Australian CS and NCS females demonstrated that the nature of the IT-related tasks that they undertook in IT classes formed part of their school IT-related experiences, and affected the strength of the interest—enjoyment value they attached to IT or CS, which either motivated or discouraged CS course pursuits. Positive experiences of the IT activities or tasks provided Australian CS females (and males) enjoyment and/or interest in wanting to pursue further tertiary studies in IT or CS fields, whereas more negative school IT experiences by NCS females deterred motivation in CS course pursuits. On the other hand, despite Taiwanese females (and males) being asked the same question about their school IT experiences, none of them indicated whether the nature of the IT tasks they had to perform at school had motivated or discouraged their CS course pursuits.

8.1.2 Stereotypical perceptions of CS facilitated females' NCS participation in both contexts

The Australian NCS females interviewed revealed stereotypical perceptions of CS courses (e.g., technical, nerdy) and CS professions (e.g., solitary, working long hours), which made CS courses unappealing. Similarly, Taiwanese NCS females' stereotypes of CS courses as being "nerdy", and CS female students as "tomboyish" also deterred them from choosing CS courses. It was however interesting to note that, the Australian CS females interviewed identified similar stereotypical perceptions to those of their NCS counterparts. Yet Australian CS females' positive school IT experiences, as well as either the interest—enjoyment value or utility value attached to IT (or CS), outweighed their CS stereotypes and encouraged CS course pursuits. The Taiwanese CS females similarly acknowledged holding stereotypes similar to those of their NCS counterparts, but none of those interviewed mentioned the stereotypes as a concern when deciding whether or not to choose CS courses. Australian males revealed they knew of the stereotypes associated with CS, but CS participation was dependent on whether they anticipated enjoyment and/or success in CS courses. Taiwanese males (interviewed) also revealed they were aware of the stereotypes of CS, but they were more concerned with the utility value (e.g., usefulness) of the CS courses for gaining future employment. It appears that stereotypical perceptions of CS discouraged females in both contexts from pursuing CS courses whereas for males in both contexts, CS stereotypes were not deterring factors in CS course participation.

8.1.3 The importance of interest—enjoyment for Australian CS females, and attainment and relative cost for Taiwanese CS females

The most influential factor in females' course participation differed by educational context. While the majority of the Australian females (and males) surveyed and interviewed revealed that interest in their courses motivated their course choices, the Taiwanese females (and males) chose their courses by firstly referring to their CEE scores, then determining if their scores would enable them to enrol at their preferred universities. A closer inspection found that Australian CS females (interviewed=2) described liking computers very much (Kerryn) and had enjoyed studying senior IT (Sinead), compared to no Taiwanese CS females (interviewed=4) indicating influences such as having studied senior secondary IT or having enjoyed IT learning. Yet without any interest—enjoyment attached to previous IT learning at school, Taiwanese CS females interviewed still chose IT-related courses such as CS. It is evident that for the Australian CS females in this study, an interest—enjoyment in IT-related learning was important for choosing IT related courses such as CS, whereas for Taiwanese CS females, attainment value and relative cost were the two important factors in their course choices.

Moreover, Taiwanese females have shown that the attainment value they attached to their preferred institutions can outweigh CS participation, even if it meant choosing other courses just so they could study at their preferred universities. It is also possible to suggest for Taiwanese females who wanted to study CS courses yet their CEE scores mean they could not attend their preferred universities, the relative cost in this instance was to turn down their preferred institutions so they could study CS courses at another university. On the other hand, the attainment value attached to certain institutions was not revealed by Australian females (and males) surveyed and interviewed as a factor in course selection; and the relative cost (e.g. tertiary exam scores) attached to their preferred courses was not mentioned. It is clear that while attainment value and relative cost were two facilitating factors in Taiwanese females' course participation, the two factors were not influential in Australian females' course decision-making.

8.1.4 Taiwanese females' lack of confidence in learning new computing skills did not deter CS pursuits

The confidence in learning new computing skills did not differ proportionally by gender in the Australian CS sample, but females in the Taiwanese CS sample differed from the Australian CS females. While the majority of the Australian CS females (and males in both contexts) surveyed revealed confidence in learning new computing skills, a lack of confidence was revealed by half of the Taiwanese CS females surveyed. Instead, Taiwanese females' strong self-efficacies in IT and/or maths related learning while at school encouraged their CS choices. It is evident that Taiwanese females' beliefs in their abilities in general IT learning, as well as the skills they believed they possess to study CS (e.g. programming, good maths skills) outweighed their lack of confidence in learning new computing skills. In contrast, the Australian females who are confident in learning new computing skills and more importantly, enjoy IT-related learning, were motivated to choose IT-related courses such as CS.

8.2 Limitations of study

The initial adoption of a mixed methods approach for this study was due to the possibility that there might be differences between the groups studied that could not be explained by the survey alone. Generalisations of the CS and NCS samples (by gender) in both educational contexts were expected to be obtained via the survey, and interviews were employed to provide richer data, supporting or contrasting with the survey data, or to unveil new insights. However, the time taken to recruit the participants to complete the online survey was much longer than expected (due to the need for voluntary participation), and this also meant only a limited number of participants could be recruited. The relatively small survey sample sizes also meant that the uses of other statistical tests were not appropriate, as the small sample sizes would not generate statistical differences adequate for robust discussion. Furthermore, the implications for focusing on CS courses rather than all IT-related courses also meant that this study could only present perspectives from those who had already chosen CS.

Other limitations of scope were due to the use of theoretical framework (EVM) in non-Anglo-Saxon educational contexts. The EVM was found to be useful for analysing the Australian data yet not always for the Taiwanese data. For example, it was noted that the EVM does not contain the flexibility to include an attachment to the prestige and status of "institution" by individuals when they make particular educational (course) choices, as revealed by Taiwanese students. Taiwanese students' CS participation was dependent first on fulfilling their intention of attending their preferred universities, and the best courses they could enrol in (based on their CEE scores), followed by other factors such as their self-efficacies in maths and IT-learning.

8.3 Recommendations

There are four recommendations in response to the main findings raised from this study, particularly for females. The first recommendation is to address the nature of the IT tasks students have to do at school, to form more positive IT experiences for Australian females. The second recommendation is to enhance individuals' understanding of the IT (or CS) related studies in both contexts. The third recommendation is to build Taiwanese females' confidence in the skills and/or knowledge required to study CS. The final recommendation is to provide positive discrimination for Taiwanese females entering CS courses in Taiwan. Each of the four recommendations is presented in the following sections.

8.3.1 Improve Australian females' negative school IT experiences by considering the nature of tasks in IT classrooms

School IT-related learning experiences affected IT-related course pursuits by Australian students in this study. The negative IT experiences at schools was partly due to the lack of social interaction in the tasks (e.g. uses of spreadsheets) that females had to do in their IT classes, which made IT learning seem "boring". Papastergiou (2008) suggests that female students could engage in collaborative projects aimed at the design and development of applications, to understand how these activities relate to people and to experience the collaborative efforts they entail. Thus females may develop an interest in CS activities, and consequently participate in CS courses at university. Male and female students are more likely to have an interest—enjoyment in IT or CS related learning, when they have had different exposure to different aspects of IT, and understand how they can use the skills gained from their IT-learning in future studies and work, in IT-related fields like CS.

8.3.2 Address CS stereotypes by enhancing pre-tertiary CS course and career knowledge in both contexts

NCS females from both the Australian and Taiwanese contexts in this study have revealed that their stereotypical perceptions of CS made CS courses unappealing. Australian NCS females' stereotypical images of CS being a "nerdy", and "anti-social" field meant they did not want to be associated with it. Similarly Taiwanese NCS females revealed mixed perceptions of those who study CS as "nerdy" and "tomboyish". In order to avoid being labelled as such, and in addition to their less positive IT experiences, both the Australian and Taiwanese NCS females chose courses other than CS instead.

To address the social stereotypes regarding CS images, both the Australian and Taiwanese secondary and tertiary IT curriculum need to be provided with clearer information about course and career options in the field. Also, an adequate understanding of IT (or CS) related studies at the secondary as well as tertiary courses is needed for individuals prior to course enrolment. Females in both contexts should be exposed to various aspects of IT or CS at the secondary level, to gain an insight into the breadth of the applications of CS, instead of making course choices based on their stereotypical perceptions of CS (Papastergiou, 2008). Also, an understanding of CS as comprising a variety of human and socially oriented aspects is needed by females.

The Australian data found that stereotypical perceptions of CS careers discourage females from pursuing CS courses. A strategy for addressing CS career stereotypes is to provide more accurate information about IT related careers to females. Studies have found that females' negative and inaccurate perceptions of IT careers often resulted in non-participation in IT-related courses (Craig, 2005; Leech, 2007; Thomas & Allen, 2006). Informing females of the range of IT-related careers available through careers fairs, and inviting guest speakers from the industry are useful for addressing the common questions, doubts and stereotypes females may have regarding IT or CS related careers in both contexts.

The aforementioned strategies can potentially assist in addressing females' pre-conceived perceptions of IT-related courses and careers. Without a good understanding of IT related courses (such as CS) and associated career prospects, females in both contexts are inclined to make uninformed choices other than CS which hamper their self or career interests at a later stage.

8.3.3 Apply a positive discrimination initiative for Taiwanese females entering CS courses

Taiwanese females in this study have revealed the difficulty of fulfilling both the attainment value and the relative cost when considering which courses to study, and satisfying both factors made CS choices difficult. To encourage a greater participation for females in CS at the tertiary level in Taiwan, positive discrimination in selection of students is recommended as a possible strategy. Positive discrimination refers to particular policies, initiatives or changes in curriculum that are used to improve the gender imbalance in fields of study or work that are highly populated by males (or by females) (Ayebi-Arthur, Dora, & Aheto, 2012; Lee & Faulkner, 2010; Murphy, Dainty, & Ren, 2011). Lee and Faulkner (2010) described positive discrimination as giving females “preferential treatment” over males, in the science and technology related fields to address the issue of gender imbalance. Positive discrimination was mentioned by the previous three studies cited which were at the time still examining the long-term potential of positive discrimination on improving females’ representation in male-dominated fields.

Despite the lack of literature, it is still possible to suggest that Taiwanese tertiary institutions have positive discrimination in place for tertiary CS course admission. To do this, Taiwanese universities are encouraged to lower CEE score requirements for females applying for CS course admission. This would not only satisfy Taiwanese females’ preferences of attending particular universities (e.g., attainment value), it will also at the same time increase their likelihood of being able to enrol in CS courses at their preferred universities, due to the lower relative cost attached to CS courses (e.g., lower CEE scores required). When both influential factors (i.e., attainment value, lower relative cost) in course participation are addressed through positive discrimination, the higher the likelihood for females to participate in tertiary CS courses, which could assist in reducing the gender imbalance in the field.

8.3.4 Build and support Taiwanese females' confidence in general IT learning, through both pre-tertiary and on-going support initiatives

Taiwanese CS females in this study revealed that their CS participation was partly due to their confidence in their abilities to master the necessary skills required to study CS, instead of not choosing CS courses due to limited experiences with IT or programming. Taiwanese females should be provided with opportunities for building a higher level of confidence in IT in general and particularly in CS. Confidence-building can commence with pre-tertiary programs and on-going support initiatives (Carlson, 2006; Frieze, 2005). For example, it would be helpful to invite a group of female CS undergraduates and graduates to share their experiences about studying CS, and do activities with them to promote secondary female students' interest in CS and to motivate them to study in the field. On-going initiatives for females already studying in CS courses such as mentoring services provided to female students with support for coursework and the rigours of the CS courses could also help retain female participation in the field.

The pre-tertiary and on-going initiatives as discussed for increasing females' confidence in general IT and CS will require efforts from the CS faculties, lecturers and tutors and parties of interest involved in both contexts.

8.4 Future research

Further research is needed into the factors accounting for females' participation or non participation in CS courses in various educational contexts. While Australian females in this study reported an interest—enjoyment in IT or CS as the key factor, an attainment value and relative cost were central to Taiwanese females' course choices. This study has identified three areas for future research, namely: 1) the influence of previous IT experiences on subsequent CS course participation; 2) understanding the factors accounting for students' choices of other IT courses than CS; and 3) the feasibility of including "institution" as a factor in course enrolment choices in the EVM.

Secondary IT experiences were found to have discouraged the Australian NCS females interviewed from wanting to study CS courses, and this revealed a strong link between negative school IT experiences and subsequent NCS participation. The uninteresting and seemingly irrelevant IT-related learning experienced by Australian females resulted in their NCS course pursuits. Further research into the females' IT-related experiences in Australian secondary schools can provide a better insight into the link (if any) between school IT-related learning and subsequent IT-related participation at tertiary level, and provide schools with direction on how to better provide positive IT-related learning for females and to encourage them to participate in CS. Other factors in such choices could also be investigated, which could assist in explaining the inequality or lack of equality in participation by gender in certain IT courses compared with CS in both contexts.

Another area of future research is the use of the EVM in non Anglo-Saxon educational contexts. Attainment value attached to particular tertiary institutions was revealed by

Taiwanese participants in this study as the main factor behind their course pursuit, yet "institution" was not featured in the EVM for use in explaining why Taiwanese students made the course choices they did. In addition to attainment value, Taiwanese students' CEE scores could also change their subsequent CS choices. This means the combined influences of attainment value and relative cost together affected the course choices for Taiwanese students. The fact that the interrelationships of the two factors were not represented in the EVM in influencing course choices, perhaps makes EVM a less appropriate theoretical model for explaining the course participation by gender in a non Anglo-Saxon educational context such as Taiwan.

8.5 Concluding remarks

This research concludes that stereotypes associated with IT-related studies and careers during secondary school were what discouraged many females from wanting to study undergraduate CS courses. Most importantly of all, the Australian CS participants surveyed showed that the interest–enjoyment value was most influential factor for course participation, while the Taiwanese participants focused on the attainment value attached to certain tertiary institutions (regardless of CS pursuits or not). However, other influences such as the perceived usefulness (e.g., utility value) attached to CS courses in gaining particular skills required for other studies and also for future professions, as well as the career prospects associated with CS, were also factors considered by both the Australiana and Taiwanese CS participants before enrolling in their CS courses.

When using the variables shown in the EVM to explore the factors which accounted for individuals' course participation, Australian students' experiences were easily interpreted and understood, yet this was not always so for the Taiwanese findings. The emphasis on "institution", or individuals' attachments to particular universities, was not factored into the EVM, which thus weakened its capacity to explain Taiwanese females' CS or NCS course pursuits in this study.

This thesis concludes that the reason CS continues to be male dominated is partly due to stereotypical perceptions of CS. However, recommendations for addressing the inequitable representation of females in CS in both contexts are likely to be different due to differences in educational values. Nevertheless, the collaboration of schools and tertiary institutions is required to improve the gender imbalance in the CS related fields of study and work, regardless of educational contexts. Greater participation by females in the CS field will in turn bring fresh insights and new perspectives, and help counterbalance the negative stereotypes associated with it. Increasing the female representation in CS also breaks the cycle of gender inequity in the field, and enables females in both contexts to perceive the CS field as containing abundant opportunities for study and careers.

References

Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008). "Because it's boring,irrelevant and I don't like computers": Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education, 50*(4), 1304-1318.

Anderson, P. N. (2000). *Cost perception and the expectancy-value model of achievement motivation*. Paper presented at the Annual Meeting of the American Educational Research Association, April 24-28, 2000, New Orleans, LA.

Ayebi-Arthur, A., Dora, B. A., & Aheto, S. K. (2012). Including the digital divas: female representation in ICT programs at the University of Cape Coast. *International Journal of Research Studies in Computing, 1*(2), 3-12.

Babbie, E. (2005). *The basics of social research*. Belmont, CA: Thomson/Wadsworth.

Bandura, A. (1997). *Self-efficacy: the exercise of control*. New York: Freeman.

Barker, L. J., & Aspray, W. (2006). The state of research on girls and IT. In J. M. Cohoon & W. Aspray (Eds.), *Women and information technology*. Cambridge, Massachusetts: The MIT Press.

Barnes, G., McInerney, D. M., & Marsh, H. W. (2005). Exploring sex differences in science enrolment intentions: an application of the general model of academic choice. *Australian Educational Researcher, 32*(2), 1-24.

Beekhuyzen, J., & Clayton, K. (2005). Chaging ICT career perceptions: not so geeky? *Redress, 14*(3), 20-25.

Best, S. J., & Krueger, B. S. (2004). *Internet data collection*. London: SAGE.

Brown, C., Garavalia, L. S., Fritts, M. L. H., & Olson, E. A. (2006). Computer science majors: Sex role orientation, academic achievement, and social cognitive factors. *Career Development Quarterly, 54*(4), 331-345.

Carlson, S. (2006). Wanted: female computer science students. *The Chronicle of Higher Education, 52*(19), 35.

Clayton, K. (2004). Information quality: the relationship to recruitment in pre-tertiary IT education. *Issues in Informing Science and Information Technology, 1*, 65-78.

Clayton, K. (2005). *Engaging our future ICT professionals: what is the missing piece of the puzzle?* Paper presented at the Women, Work and IT Forum: Contemporary perspectives on the reproduction of gender inequalities in employment.

Clayton, K. (2006). Diversity and attitudes towards ICT in Brisbane schools. Griffith University.

Clayton, K. L., von Hellens, L. A., & Nielsen, S. H. (2009). Gender stereotypes prevail in ICT: a research review. *Proceedings of the Special Interest Group on Management Information System's 47th Annual Conference on Computer Personnel Research* Limerick, Ireland, 153-158.

Clough, P., & Nutbrown, C. (2002). *A student's guide to methodology*. London: Sage.

Cohen, J. (1992a). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Cohen, J. (1992b). Statistical power analysis. *Current Directions in Psychological Science, 1*(3), 98-101.

Cohoon, J. M. (2002). Recruiting and retaining women in undergraduate computing majors. *SIGCSE Bulletin, 34*(2), 48-52.

College Entrance Examination Board (1994). *Guidelines of college entrance examination for the year of 1994*. Taipei, Taiwan: College Entrance Examination Board.

College Entrance Examination Board (2003). *Guidelines of college entrance examination for the year of 2003*. Taipei, Taiwan: College Entrance Examination Board.

College Entrance Examination Center (2009a). Ability exam. Retrieved February 11, 2011, from http://www.ceec.edu.tw/abilityexam/AbilityExamProfile.htm

College Entrance Examination Center (2009b). Appointed exam. Retrieved February 11, 2011, from http://www.ceec.edu.tw/AppointExam/AppointExamProfile.htm
College Entrance Examination Center (2010). 2010 Course outline: examination of core subjects (Mathematics A/B test questions). Retrieved February 11, 2011, from http://www.ceec.edu.tw/
Corder, G. W., & Foreman, D. I. (2009). *Nonparametric statistics for non-statisticians: a step-by-step approach*. New Jersey: Willey.
Craig, A. (2005). Girls not choosing computing: causes and effects. *Redress, 14*(3), 2-7.
Craig, A. (2006). Girls and computing: still a way to go. *Independent Education, 36*(2), 32-33.
Craig, A., Lang, C., & Fisher, J. (2008). Twenty years of girls into computing days: has it been worth the effort? *Journal of Information Technology Education, 7*, 339-353.
Crandall, V. C. (1969). Sex differences in expectancy of intellectual and academic reinforcement. In C. P. Smith (Ed.), *Achievement-related motives in children* (pp. 11-45). New York: Russell Sage Foundation.
Creswell, J. W. (2009). *Research design: qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, California: Sage.
Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, California: Sage.
De Vaus, D. A. (2002). *Surveys in social research* (5th ed.). St. Leonards, N.S.W., Australia: Allen & Unwin
Department of Education Employment and Workplace Relations (2004). *Analysis of equity groups in higher education 1991-2002*. Retrieved September, 3, 2009. from http://deewr.gov.au/.
Department of Education Employment and Workplace Relations (2012). Enrolment count by gender and year, 2006-2010 (uCube). Retrieved April 25, 2012, from http://www.highereducationstatistics.deewr.gov.au/
Department of Secondary Education (Taiwan) (2012a). Information science syllabus. Retrieved July 3, 2012, from http://140.111.34.54/HIGH-SCHOOL/
Department of Secondary Education (Taiwan) (2012b). Introduction to information technology syllabus. Retrieved July 3, 2012, from http://140.111.34.54/HIGH-SCHOOL/
Department of Secondary Education (Taiwan) (2012c). Subject index. Retrieved July 3, 2012, from http://140.111.34.54/HIGH-SCHOOL/
Eccles [Parsons], J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motivation* (pp. 75-146). San Francisco: W. H. Freeman.
Eccles, J. S. (1985). Model of students' mathematics enrollment decisions. *Educational Studies in Mathematics, 16*(3), 311-314.
Eccles, J. S. (1994). Understanding women's educational and occupational choices: applying the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly, 18*(4), 585-609.
Eccles, J. S. (2005a). Studying gender and ethnic differences in participation in math, physical science, and information technology. *New Directions for Child and Adolescent Development* (110), 7-14.
Eccles, J. S. (2005b). Subjective task value and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105-121). New York: Guilford Press.
Eccles, J. S. (2011). Gendered educational and occupational choices: applying the Eccles et al. model of achievement-related choices. *International Journal of Behavioral Development, 35*(3), 195-201.

Eccles, J. S., Adler, T. F., & Meece, J. L. (1984). Sex differences in achievement: a test of alternate theories. *Journal of Personality and Psychology, 46*, 26-43.

Eccles, J. S., Wigfield, A., Harold, R., & Blumenfeld, P. B. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 64*(3), 830-847.

Fan, T.-S., & Li, Y.-C. (2002a). Is math ability beneficial to performance in college computer science programs? *Journal of National Taipei Teachers College, 15*, 69-98.

Fan, T.-S., & Li, Y.-C. (2002b). Prior computing learning experience and subsequent performance in college computer science courses: a correlational study. *Journal of National Tainan Teachers College, 36*, 147-165.

Fan, T.-S., & Li, Y.-C. (2005). Gender issues and computers: college computer science education in Taiwan. *Computers and Education, 44*(3), 285-300.

Fan, T.-S., Li, Y.-C., & Niess, M. L. (1998). Predicting academic achievement for college computer science majors. *Journal of Research on Computing in Education, 31*(2), 155-172.

Fisher, J. (2011). Information Technology: where are the women? Retrieved April 24, 2012, from http://www.monash.edu.au/news/show/information-technology-where-are-the-women

Frieze, C. (2005). Diversifying the images of computer science: undergraduate women take on the challenge! *Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education*, St. Louis, Missouri, *37*(1), 397-400.

Frieze, C., Hazzan, O., Blum, L., & Dias, M. B. (2006). Culture and environment as determinants of women's participation in computing: revealing the "women-CS fit". *SIGCSE Bulletin, 38*(1), 22-26.

Frome, P. M., Alfred, C. J., Eccles, J. S., & Barber, B. L. (2006). Why don't they want a male-dominated job? An investigation of young women who changed their occupational aspirations. *Educational Research and Evaluation, 12*(4), 359-372.

Grouws, D. A. (1992). *Handbook of research on mathematics teaching and learning*. New York: Macmillan.

Guillet, E., Sarrazin, P., Fontayne, P., & Brustad, R. J. (2006). Understanding female sport attrition in a stereotypical male sport within the framework of Eccles' expectancy-value model. *Psychology of Women Quarterly, 30*(4), 358-368.

Gurer, D., & Camp, T. (2002). An ACM-W literature review on women in computing. *Inroads SIGCSE Bulletin, 34*(2), 121-127.

Hyde, J. S., & Kling, K. C. (2001). Women, motivation, and achievement. *Psychology of Women Quarterly, 25*(4), 364-378.

Jacobs, J. E., & Eccles, J. S. (2000). Parents, task values, and real-life achievement-related choices. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: the search for optimal motivation and performance* (pp. 405-439). San Diego, CA: Academic Press.

Jepson, A., & Perl, T. (2002). Priming the pipeline. *SIGCSE Bulletin, 34*(2), 9-10.

Johnson, B., & Christensen, L. (2004). *Educational research: quantitative, qualitative, and mixed approaches* (2nd ed.). Boston: Pearson.

Johnson, B., & Christensen, L. (2008). *Educational research: quantitative, qualitative and mixed approaches* (3rd ed.). Thousand Oaks, California: Sage.

Kim, K. A., Fann, A. J., & Misa-Escalante, K. O. (2011). Engaging women in computer science and engineering: promising practices for promoting gender equity in undergraduate research experiences. *ACM Transactions on Computing Education, 11*(2), 19.

Kuo, L. H., Yang, H. J., & Tseng, T. H. (2010). *Computer and information course curricula of the university general education in Taiwan*. Paper presented at the American Conference on Applied Mathematics, January 27-29, 2010, Cambridge, USA.

Kvale, S. (2007). *Doing interviews*. London: Sage.

Lang, C. (2010). Happenstance and compromise: a gendered analysis of students' computing degree course selection. *Computer Science Education, 20*(4), 317-345.

Lang, C., & McKay, J. (2006). Australian IT enrollment trends and model of contributing factors. In E. M. Trauth (Ed.), *Encyclopedia of gender and information technology* (pp. 50-56). Hershey, PA: Idea Group Publishing.

Lang, C., McKay, J., & Lewis, S. (2006). Declining popularity increases lack of diversity in the ICT discipline: extending the discourse of the discipline. *Proceedings of the 17th Australasian Conference on Information Systems: Thought Leadership in IS,* Adelaide, South Australia.

Larose, S., Ratelle, C. F., Guay, F., Senecal, C., & Harvey, M. (2006). Trajectories of science self-efficacy beliefs during the college transition and academic and vocational adjustment in science and technology programs. *Educational Research and Evaluation, 12*(4), 373-393.

Lee, L., & Faulkner, W. (2010). Turning good policies into good practice: why is it so difficult? *International Journal of Gender, Science and Technology, 2*(1), 89-99.

Leech, R. (2007). Geek chic: getting girls into IT. *Teacher* (178), 4-10.

Lemaku, J. P. (1979). Personality and background characteristics of women in male-dominated occupations: a review. *Psychology of Women Quarterly, 4*(2), 221-240.

Lewis, S., Lang, C., & McKay, J. (2007). An inconvenient truth: the invisibility of women in ICT. *Australasian Journal of Information Systems, 15*(1), 59-76.

Lewis, S., McKay, J., & Lang, C. (2006). The next wave of gender projects in IT curriculum teaching at universities. *Proceedings of the 8th Australian Conference on Computing Education*, Hobart, Australia, *52*, 135-142.

Lewis, T. L., Smith, W. J., Belanger, F., & Harrington, K. V. (2008). Are technical and soft skills required? The use of structural equation modeling to examine factors leading to retention in the cs major. *Proceedings of the 4th international Workshop on Computing Education Research*, Sydney, Australia, 91-100.

Lupart, J. L., Cannon, E., & Telfer, J. A. (2004). Gender differences in adolescent academic achievement, interests, values and life-role expectations. *High Ability Studies, 15*(1), 25-42.

Lyons, T., Quinn, F., Rizk, N., Anderson, N., Hubber, P., Kenny, J., et al. (2012). *Starting out in STEM: a study of young men and women in first year science, technology, engineering and mathematics courses*. Armidale: University of New England.

Ma, Y. (2009). Family socioeconomic status, parental involvement, and college major choices - gender, race/ethnic, and nativity patterns. *Sociological Perspectives, 52*(2), 211-234.

Machina, K., & Gokhale, A. (2010). Maintaining positive attitudes toward science and technology in first-year female undergraduates: peril and promise. *International Journal of Science Education, 32*(4), 523-540.

Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse: women in computing*. Cambridge, MA: MIT Press.

McInerney, C. R., DiDonato, N., C, Giagnacova, R., & O'Donnell, A., M (2006). Students' choice of information technology majors and careers: a qualitative study. *24,* 35.

McMillan, J. H., & Schumacher, S. (2010). *Research in education: evidence-based inquiry* (7th ed.). Boston: Pearson.

Messersmith, E. E., Garrett, J. L., Davis-Kean, P. E., Malanchuk, O., & Eccles, J. S. (2008). Career development from adolescence through immerging adulthood: insights from information technology occupations. *Journal of Adolescent Research, 23*(2), 206-227.

Miliszewska, I. (2006). Gender bias in computer courses in Australia. In E. M. Trauth (Ed.), *Encyclopedia of gender and information technology* (pp. 501-506). Hershey, PA: Idea Group Publishing.

Miliszewska, I., Barker, G., Henderson, F., & Sztendur, E. (2006). The issue of gender equity in computer science - what students say. *Journal of Information Technology Education*, *5*, 107-120.
Millar, J., & Jagger, N. (2001). Women in ITEC courses and careers. London: Department of Education and Skills, Department for Employment.
Ministry of Education (Taiwan) (2012a). Enrollment in Tertiary - by programme (23 categories) and gender. Retrieved July 1, 2012, from http://english.moe.gov.tw/ct.asp?xItem=9874&CtNode=404&mp=2
Ministry of Education (Taiwan) (2012b). The three major classifications of higher education courses. Retrieved July 5, 2012, from http://www.edu.tw/pages/detail.aspx?Node=1745&Page=5350&Index=10&WID=31d75a44-efff-4c44-a075-15a9eb7aecdf
Ministry of Education (Taiwan) (2012c). University course standards - search by classification. Retrieved July 5, 2012, from http://www.edu.tw/pages/detail.aspx?Node=1745&Page=5350&Index=10&WID=31d75a44-efff-4c44-a075-15a9eb7aecdf
Monash University (2009a). Bachelor of Computer Science. Retrieved July 10, 2009, from http://www.monash.edu/study/coursefinder/course/2380/
Monash University (2009b). Enrolment history: 2004-2008. Retrieved June 26, 2009, from http://www.opq.monash.edu.au/us/pivot-table/index.html
Monash University (2009c). Information technology courses. Retrieved June 26, 2009, from http://www.infotech.monash.edu.au/
Monash University (2011). Admissions information for domestic students: Bachelor of Computer Science. Retrieved February 11, 2011, from http://www.monash.edu/study/coursefinder/course/2380/domestic-requirements.html
Monash University (2012a). Admissions information for domestic students: Bachelor of Arts. Retrieved May 16, 2012, from http://www.monash.edu/study/coursefinder/course/0002/domestic-requirements.html
Monash University (2012b). Enrolment history: 2007-2012. Retrieved July 5, 2012, from http://www.opq.monash.edu.au/us/pivot-table/index.html
Moorman, P., & Johnson, E. (2003). Still a stranger here: attitudes among secondary school students towards computer science. *ACM SIGCSE Bulletin*, *35*(3), 193-197.
Multimedia Victoria (2007). Attitudes to ICT careers. Retrieved June 23, 2010, from http://www.mmv.vic.gov.au/attitudestoictcareers
Murphy, L. A. (2006). Breaking into the boys club. *Scholastic Administr@tor*, *5*(4), 9.
Murphy, M., Dainty, A., & Ren, Z. (2011). Understanding women's experiences of construction education: a need for longitudinal research? *Proceedings of the 27th Annual Association of Researchers in Construction Management Conference*, Bristol, UK, 57-166.
National Taiwan University (2010a). Admissions pathways. Retrieved February 11, 2011, from http://council.csie.ntu.edu.tw/highschool/entrance.php
National Taiwan University (2010b). CSIE required courses for undergraduate. Retrieved July 10, 2009, from http://www.csie.ntu.edu.tw/stu/super_pages.php?ID=education4&Sn=21
National Taiwan University (2010c). Overview. Retrieved July 16, 2009, from http://www.csie.ntu.edu.tw/intro/super_pages.php?ID=introen
National Taiwan University (2010d). Undergraduate admission. Retrieved May 16, 2012, from http://www.csie.ntu.edu.tw/admiss/super_pages.php?ID=admiss2
National Taiwan University (2012). Course - undergraduate. Retrieved July 7, 2012, from http://exp.management.ntu.edu.tw/IM

Newmarch, E., Taylor-Steele, S., & Cumpston, S. (2000). *Women in IT - what are the barriers?* Paper presented at the Network of Women in Further Education Conference, “Net Gains: Women, Information Technology and Emerging Issues”.

Nielsen, S., von Hellens, L., & Beekhuyzen, J. (2004). Challenge or chaos: a discourse analysis of women’s perceptions of the culture of change in the IT industry. *Journal of Issues in Informing Science and Information Technology 1*, 715-727.

Pallant, J. F. (2009). *SPSS survival manual: a step by step guide to data analysis using SPSS* (3rd ed.). Crows Nest: Allen & Unwin.

Papastergiou, M. (2008). Are computer science and information technology still masculine fields? High school students' perceptions and career choices. *Computers & Education, 51*(2), 594-608.

Prensky, M. (2005). Listen to the natives. *Educational Leadership, 63*(4), 8-13.

Redmond, P. (2006). Increasing female participation in ICTs. *Quick* (99), 15-18.

Scott, V. A. (1996). Why are girls so under represented? Ten years on. *Australian Educational Computing, 11*(1), 17-21.

Stockdale, R., & Stoney, S. (2007). Generating a gender balance: making introductory information systems courses a positive experience. *Australasian Journal of Information Systems, 15*(1), 25-40.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: integrating quantitative and qualitative approaches in the social and behavioral sciences*. Thousand Oaks, California: Sage.

Thomas, T., & Allen, A. (2006). Gender differences in students' perceptions of information technology as a career. *Journal of Information Technology Education, 5*, 165-178.

Timms, C., Courtney, L., & Anderson, N. (2006). Secondary girls' perceptions of advanced ICT subjects: are they boring and irrelevant? *Australian Educational Computing, 21*(2), 3-8.

Trusty, J., Robinson, C. R., Plata, M., & Ng, K.-M. (2000). Effects of gender, socioeconomic status, and earl y academic performance on postsecondary educational choice. *Journal of Counselling and Development, 78*(4), 463-472.

Valian, V. (1999). *Why so slow? The advancement of women*. Cambridge Massachusetts: The MIT Press.

van Zoonen, L. (1992). Feminist theory and information technology. *Media, Culture and Society, 14*(1), 9-29.

Vickers, M., & Ha, M. T. (2007). The imagined curriculum: who studies computing and information technology subjects at the senior secondary level? In J. Lynch (Ed.), *Gender and IT: ongoing challenges for computing and Information Technology education in Aystralian secondary schools*. ACT, Australia: Australian Curriculum Studies Association.

Victorian Curriculum and Assessment Authority (2010). VCE studies: mathematics. Retrieved November 9, 2011, from http://www.vcaa.vic.edu.au/Pages/vce/studies/index.aspx#H3N10297

Victorian Curriculum and Assessment Authority (2012a). Senior secondary certificate statistical information. Retrieved July 2, 2012, from http://www.vcaa.vic.edu.au/Pages/vce/statistics/index.aspx

Victorian Curriculum and Assessment Authority (2012b). VCE studies: information technology. Retrieved July 2, 2012, from http://www.vcaa.vic.edu.au/Pages/vce/studies/index.aspx#H3N101E5

Victorian Curriculum and Assessment Authority (2012c). VCE VET Programs. Retrieved September 12, 2012, from http://www.vcaa.vic.edu.au/Pages/vet/programs/index.aspx

von Hellens, L., & Nielsen, S. (2001). Australian women in IT. *Communications of the ACM, 44*(7), 46-52.

von Hellens, L., Nielsen, S., & Beekhuyzen, J. (2003). Women working in the IT industry: challenges for the new millennium. *Journal of Business & Economics Research 1*(11), 21-32.
Wajcman, J. (2005). He, she and IT. *Australasian Science, 26*(2), 41.
Wasburn, M. H. (2004). Is your classroom woman friendly? Ten strategies for reaching this goal. *College Teaching, 52*(4), 156.
Wasburn, M. H. (2007). Cultivating greater acceptance of women in technology: a pilot study. *International Journal of Information and Communication Technology Education, 3*(1), 22.
Wasburn, M. H., & Miller, S. G. (2004). Retaining undergraduate women in science, engneering and technology: a survey of a student organization. *Journal of College Student Retention*, *6*(2), 155.
Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*(4), 548-573.
Weng, F., Cheong, F., & Cheong, C. (2009). IT education in Taiwan: relationship between self-efficacy and academic integration among students. *Proceedings of the 2009 Pacific Asia Conference on Information Systems*, India.
Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: a theoretical analysis. *Developmental Review, 12*, 265-310.
Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of motivation. *Contemporary Educational Psychology, 25*, 68-81.
Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievemnet values from childhood to adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91-120). San Diego: Academic Press.
Yin, R. K. (2003). *Case study research: design and methods* (3rd ed.). Thousand Oaks, California: Sage.
Young, J. (2003). The extent to which information technology careers fulfil the career ideals of girls. *Australian Journal of Information Systems, 10*(2), 115-125.
Zarrett, N. R., & Malanchuk, O. (2005). Who's computing? Gender and race differences in young adults' decisions to pursue an information technology career. *New Directions for Child and Adolescent Development* (110), 65-84.

Appendices

Australian participants

Appendix 1. Letter of introduction

Shu-Hua Chao
Faculty of Education,
Monash University
Mobile: [redacted]
Email: [redacted]

16 May 2010

Faculty of Information and Technology
Monash University

Dear Sir/Madam,
I am writing to you to ask for assistance in recruiting participants for my doctoral project. My name is Shu-Hua Chao. I am studying for a Doctor of Philosophy at the Faculty of Education at Monash University. I am currently working on a thesis titled: “Female Undergraduates’ Participation in Computer Science: Australian and Taiwanese Contexts”, under the supervision of Dr. Michael Henderson at Faculty of Education, Monash University.

The main aim of my research is to study the possible key factors which affect female undergraduates’ participation and non-participation in Computer Science (CS) courses or CS majors. I believe that by recruiting students from your faculty will allow me to gain a more thorough understanding into reasons which ultimately influence undergraduates’ educational decision-making in or not in the field of Information Technology.

I would like to ask for your assistance in recruiting participants for my online questionnaires. I will require approximately eighty participants of both male and female undergraduates who study Bachelor of Computer Science or any CS majors. I would benefit, with your permission, in posting announcements on BlackBoard about my research project, as well as informing students in your class. I have hereby attached Monash Ethics approval letter, recruitment poster, the explanatory statement and consent form.

I look forward to hearing from you soon.

Yours faithfully,

[redacted]

Shu-Hua Chao

Appendix 2. Survey and explanatory statement

Female undergraduates' participation in Computer Science survey

Thank you for taking part in this questionnaire. The questionnaire will take approximately 20 to 30 minutes to complete. Please follow the instructions carefully to provide your answers. The information provided on this questionnaire is confidential, and accessible only by the research team, and any information will remain anonymous. At no point will you be identifiable. If you are interested in participating in an interview at a later stage, please register your email address in Question 38 of this survey.

Should you have any complaint concerning the manner in which this research (CF090/3316 – 2009001772) is conducted, please do not hesitate to contact the Monash University Human Research Ethics Committee (MUHREC) at the following address:

Executive Officer
Human Research Ethics
Building 3E, Research Office
Monash University VIC 3800
Tel: +[redacted]
Fax: +[redacted]
Email: [redacted]

Before proceeding, you are requested to read the full explanatory statement which details the purpose of this research and contact details.

Explanatory statement

Female Undergraduates' Participation in Computer Science: Australian and Taiwanese Contexts

---

Dear Participants:

My name is Shu-Hua Chao and I am conducting a research project with Dr. Michael Henderson, a senior lecturer in the Faculty of Education, towards a PhD degree at Monash University. At the completion of my degree I will produce a thesis regarding female undergraduates' participation in Computer Science (CS) courses in Australia and Taiwan.

I am looking for participants who are currently undertaking any undergraduate CS degrees, or any undergraduate studies with a CS major. I am also looking for a number of individuals who have considered studying CS prior to their entry to university but were later not enrolled in a CS degree or related study.

The aim of this study is to examine the possible influences which affect CS participation at the tertiary level. It is proposed that the findings from this research enable educators to better understand what factors encourage or discourage some females to study CS.

You are invited to participate in a 20-minute questionnaire. If you are interested in participating in an interview at a later stage you can register your interest with the researcher by completing Question 38 on the questionnaire. The questionnaire items and interview questions are designed not to cause participants discomfort; no sensitive information is being sought. A draft copy of the interview questions will be provided prior to interview. Nevertheless, in the unlikely event that you should become upset during the interview, you will be offered the opportunity to talk to the counselling services available on campus as provided below.

Counselling at Monash University
Building 10, Clayton campus

(03) 9905-3156

No payment will be offered to participants for their involvement in this research.

Being in this study is voluntary and you are under no obligation to consent to participation. No participant is required by law to report in this project. Participants' personal information will be kept in a filing cabinet and a password-controlled computer. Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. Data will only be withdrawn upon submission of the survey/completion of the interview for fully anonymised data. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report. It is impossible to make an absolute guarantee of confidentiality but participants' real names will not be used in the thesis or any other publication.

If you are interested in participating in the online anonymous questionnaire, please visit the link below:
www.surveymonkey.com/s/austcs

If you would like to be informed of the questionnaire results, please contact Shu-Hua Chao: [redacted]

The findings are accessible, in the form of a brief summary during December 2010.

If you would like to contact the researchers about any aspect of this study, please contact the Chief Investigator:	If you have a complaint concerning the manner in which this research (CF09/3316-2009001772) is being conducted, please contact:
Dr Michael Henderson Faculty of Education Monash University Clayton Campus Melbourne 3800 Tel: [redacted] Email: [redacted]	Human Ethics Officer Standing Committee on Ethics in Research Involving Humans (SCERH) Building 3e Room 111 Research Office Monash University VIC 3800 Tel: [redacted] Fax: [redacted] Email: [redacted]

Thank you.

Shu-Hua Chao

**** For the following questions, please select the radio buttons applicable.***

PART 1: PERSONAL BACKGROUND

1. Sex: Male ☐ Female ☐

2. Age: Under 18 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23 ☐ 24 ☐ 25 ☐ Over 25 ☐

3. Are you the eldest child in your family?
   Yes ☐ No ☐

4. Current highest level of education:
   School leaver ☐
   TAFE certificate or diploma ☐
   University undergraduate degree ☐
   University undergraduate degree with honours ☐
   University postgraduate degree ☐
   Masters degree ☐
   Doctoral qualifications ☐
   Other (please describe) __________________ ☐

5. a) Type of school attended during Victorian Certificate of Education (VCE):
   Government ☐

Catholic ☐
Independent ☐

b) Was the school you attended single-sex or co-educational?
Single-sex ☐
Co-ed ☐

c) If you attended senior secondary schooling interstate or overseas, please specify state or country.
____

6. a) Did you study any senior secondary Mathematics subjects?
Yes ☐
No ☐

If yes, which mathematics subject(s) did you study in VCE (more than one response allowed)?
Specialist Mathematics ☐
Mathematical Methods OR Mathematical Methods (CAS) ☐
Further Mathematics ☐
Other ☐

If you attended final year of senior secondary school overseas, please specify mathematics subjects studied in the "Other" field.

b) Did you study any senior secondary IB Maths?

Yes ☐
No ☐

If yes, please specify subject(s) you studied:
____
____
____

c) Did you study University-level mathematics in Year 12?

Yes ☐
No ☐

If yes, please specify the subject/s and the university that offered the subject
____
____

7. Did you study any IT or ICT or computer studies at senior secondary level?
Yes ☐
No ☐

If yes, indicate IT subject(s) studied, and the sex of the teacher(s):

		Male	Female
A. IT Applications (formerly Information Processing &Management)	☐	☐	☐
B. Software Development (formerly Information Systems)	☐	☐	☐
C. Other (If you studied IB, please specify)	☐	☐	☐

If no, indicate reasons why you did not: ____________________

8. a) Did you attend any Open Days regarding IT-related courses or careers during VCE?
Yes ☐
No ☐

If yes, for what institutions and which year level were you in?
Institution 1: __________________________ Year level: __________

Institution 2: ___________________________ Year level: __________
Institution 3: ___________________________ Year level: __________

b) Did you attend any Information sessions regarding IT-related courses or careers during VCE?
Yes ☐
No ☐

If yes, who ran the session/s and which year level were you in?
Presenter 1: ___________________________ Year level: __________
Presenter 2: ___________________________ Year level: __________
Presenter 3: ___________________________ Year level: __________

9. Did you know any computer professionals when you were in high school (e.g. Programmers)?
Yes ☐
No ☐

If yes, indicate the profession(s) and the sex of the professional(s):

	Male	Female
Professional 1: __________________	☐	☐
Professional 2: __________________	☐	☐
Professional 3: __________________	☐	☐

10. I had access to computers in my secondary school classrooms
Yes ☐
No ☐

11. My secondary school teachers encouraged me to develop computing skills
Yes ☐
No ☐

12. Please indicate the extent to which you agree or disagree with the following statements. Please circle ONE response for each item.

SD = Strongly Disagree
D = Disagree
NS = Not Sure
A = Agree
SA = Strongly Agree

I was good at learning IT-related skills at school	SD	D	NS	A	SA
I was good at learning maths at school	SD	D	NS	A	SA
I believe that good mathematical skills are essential to IT	SD	D	NS	A	SA
I believe that good programming skills are essential to IT	SD	D	NS	A	SA
I believe that logical thinking is important for studying IT	SD	D	NS	A	SA
I am confident about my ability to learn new computer skills	SD	D	NS	A	SA

PART 2: PARENTS/GUARDIANS

13. Highest level of education completed by your father/male guardian:
Primary school ☐
Secondary school ☐
TAFE certificate or diploma ☐
University undergraduate Degree ☐
University undergraduate degree with honours ☐
University postgraduate degree ☐
Masters degree ☐
Doctorial qualifications ☐
N/A ☐
Other (please specify) ____________________ ☐

14. Highest level of education completed by your mother/female guardian:
    - Primary school ☐
    - Secondary school ☐
    - TAFE certificate or diploma ☐
    - University undergraduate Degree ☐
    - University undergraduate degree with honours ☐
    - University postgraduate degree ☐
    - Masters degree ☐
    - Doctorial qualifications ☐
    - N/A ☐
    - Other (please specify) ____________________ ☐

15. Occupation of father/male guardian: ____________________ (Indicate N/A if not applicable)

16. Occupation of mother/female guardian: __________________ (Indicate N/A if not applicable)

17. My mother/female guardian uses a computer regularly
    - Yes ☐
    - No ☐

18. My father/male guardian uses a computer regularly
    - Yes ☐
    - No ☐

19. My mother/female guardian encouraged me to develop computer skills
    - Yes ☐
    - No ☐

20. My father/male guardian encouraged me to develop computer skills
    - Yes ☐
    - No ☐

PART 3: TERTIARY EDUCATION

21. What is the full name of the degree that you are currently studying? (e.g. Bachelor of Computer Science)
    ____

22. Which year or level are you currently enrolled in?
    - 1st ☐
    - 2nd ☐
    - 3rd ☐
    - 4th ☐
    - 5th ☐
    - Other (please specify) ☐

23. Was your current course your first preference at the time you were admitted to university?
    - Yes ☐
    - No ☐

    If no, what was your first preference?
    ____

24. Where did you find the information about the course you are now enrolled in?
    ____

25. a) Prior to this course, for what other purposes did you mainly use computers? (you may tick one or more)
    A. Internet ☐ B. Email ☐ C. Games ☐

D. School work ☐ E. Word processing ☐ F. Programming ☐
G. Social Networking ☐ H. Blogs ☐ I. Instant Messaging ☐
J. Other ☐
Please describe: ______________________

b) Which one of A to J above did you use most often? _________

c) Which did you enjoy the most? ____________________Why?________________________

PART 4: EDUCATIONAL DECISION-MAKING

26. a) Why did you choose your current course (you may tick one or more)?
A. Challenging ☐ B. Future Income ☐ C. Career prospects ☐
D. Peer influence ☐ E. Encouragement from family/parents ☐ F. Other reasons ☐ Please list _______

b) Which one of A to F was the most important reason? __________________________

27. What specify at least one feature you knew about your current course before your enrolled?
____
____
____

28. a) Who influenced you in choosing your current course (you may tick one or more)?

A. Father/male guardian ☐ B. Mother/female guardian ☐ C. Friends ☐
D. Family members ☐ E. Teachers ☐ F. Career counsellors ☐
G. Personal interest ☐ H. Other people (please list) ☐ ______________

b) Which one of A to H was the MOST influential? _____________________

29. What do you think are the three MOST IMPORTANT skills required to achieve success in your current course?
____
____
____

PART 5: CAREER ASPIRATIONS

30. Before you enrolled, did you have any prior work experience in the IT industry?
Yes ☐
No ☐
If yes, please indicate type of work you did (e.g. IT helpdesk)
____

31. What type of career(s) do you intend to pursue once you have graduated from your current degree?
____

32. What are THREE IMPORTANT skills required to pursue your desired career(s)?
____
____
____

PART 6: COMPUTER USAGE

33. How often do you perform the following activities on the computer for STUDY?

	Daily	A few times a week	About once a week	About once a month	Rarely
E-mail: contact lecturers, other students	☐	☐	☐	☐	☐
Using library resources	☐	☐	☐	☐	☐
Using online learning systems (e.g. Blackboard)	☐	☐	☐	☐	☐
Accessing the internet	☐	☐	☐	☐	☐
During lectures/labs/tutorials	☐	☐	☐	☐	☐
Completing work tasks/assignments	☐	☐	☐	☐	☐

34. How often do you perform the following activities on the computer for LEISURE?

	Daily	A few times a week	About once a week	About once a month	Rarely
Email	☐	☐	☐	☐	☐
To play some form of computer games	☐	☐	☐	☐	☐
For creative fun (e.g. Photoshop)	☐	☐	☐	☐	☐
Blogs	☐	☐	☐	☐	☐
Chat	☐	☐	☐	☐	☐
Social Networking (e.g. FaceBook)	☐	☐	☐	☐	☐

PART 7: PERSONAL OPINIONS

35. I am interested to know your opinions on the current course you are studying. Please indicate the extent to which you agree or disagree with the following statements by circling ONE response for each item.

SD	=	Strongly Disagree
D	=	Disagree
NS	=	Not Sure
A	=	Agree
SA	=	Strongly Agree

I find the coursework time-consuming	SD	D	NS	A	SA
I find the coursework difficult	SD	D	NS	A	SA
The workload is heavier than I expected	SD	D	NS	A	SA
The coursework is too mathematical	SD	D	NS	A	SA
The coursework is technical	SD	D	NS	A	SA
I am considered "nerdy" for studying this course	SD	D	NS	A	SA
I find the subjects I am studying interesting	SD	D	NS	A	SA
The classroom environment is welcoming	SD	D	NS	A	SA
I am confident about asking lecturers/tutors for help	SD	D	NS	A	SA
I need to be good at mathematics to achieve well	SD	D	NS	A	SA
I need to be good at programming to achieve well	SD	D	NS	A	SA

36. a) Do you think there are enough female lecturers/tutors teaching computing courses?

Yes ☐
No ☐

If no, what do you think are the reasons there are not enough female lecturers teaching computing courses?

____

b) Do you think there is a gender imbalance among students in IT-related studies?

Yes ☐

No ☐

If yes, what do you think are the reasons?

____

37. I am interested in your opinions on the associated careers with your current course after graduation.

a) I know the types of the careers associated with my current course.

Yes ☐

No ☐

b) Please indicate the extent to which you agree or disagree with the following statements by circling ONE response for each item.

SD	=	Strongly Disagree
D	=	Disagree
NS	=	Not Sure
A	=	Agree
SA	=	Strongly Agree

I believe the pay will be high	SD	D	NS	A	SA
It will be difficult to balance a career with raising a family	SD	D	NS	A	SA
The career will require me to work long hours	SD	D	NS	A	SA
The workplace will discriminate against me	SD	D	NS	A	SA
Male colleagues will not welcome me	SD	D	NS	A	SA
I will have to sit in front of computers all day	SD	D	NS	A	SA
It will be difficult to get a job	SD	D	NS	A	SA
I am not sure if I will be able to transfer skills learnt in my course to the workplace	SD	D	NS	A	SA

38. Are you interested in participating in an interview in the future?

Yes ☐ If yes, please contact Shu-Hua Chao: [redacted] for further details about the interview as well as to obtain a consent form.
OR ALTERNATIVELY,
Leave your email address here ___________________________________, and I will contact you, thank you!

No ☐

Thank you for completing this questionnaire. Your opinions are valuable to me. Please feel free to leave any feedback or comments below:

THANK YOU FOR COMPLETING THIS SURVEY!

Appendix 3. Interview consent form and questions

Consent form

Female Undergraduates' Participation in Computer Science: Australian and Taiwanese Contexts

---

NOTE: This consent form will remain with the Monash University researcher for their records

I agree to take part in the Monash University research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records. I understand that agreeing to take part means to:

1. Participate in a 45-60 minute interview ☐ Yes ☐ No
2. Allow the interview to be audio-taped ☐ Yes ☐ No

I understand that I will be given a transcript of data concerning me for my approval before it is included in the write up of the research.

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

I understand that any data that the researcher extracts from the interview for use in reports or published findings will not, under any circumstances, contain names or identifying characteristics. Data specific to your interviews can only be withdrawn from the research up to months after the interviews. After that time the data will be completely deidentified and consequently it could be very hard to remove your specific details.

Name (PRINT IN FULL) ________________________

Signature ____________________

Date _____________

Interview questions for CS students

Secondary experiences

1. What was your earliest recollection of working on computers?
2. What can you tell me about your IT experiences in secondary school at the senior level?
3. Did you think it was important to study IT in Year 12? Why?

Perceptions of study

4. What did you know about Computer Science prior to studying this course?
5. What do your peers think of you studying CS?
6. What kinds of gender stereotypes do you think are associated with this study?
7. Do you consider your classroom “female-friendly”? Why?
8. What has been similar or different to your previous expectations of studying CS?

Opinions of study

9. When did you first decide to enrol in CS?
10. What are your reasons for choosing to study CS?
11. What do you expect to achieve in this course this year?
12. Are you comfortable in asking for assistance from the lecturers? Why?
13. Do you attend all lectures and/or tutorials? Why?
14. What have been your experiences as a male (or a female) in the classroom?

Career aspirations

15. What do you think are the stereotypes associated with CS as a career option?
16. Do you think individuals should choose careers deemed appropriate for their gender? Why?
17. How useful do you think your current course is for preparing you for future careers? Why?
18. What are your plans after graduation?

Interview questions for NCS students

Secondary experiences

1. What was your earliest recollection of working on computers?
2. What can you tell me about your IT experiences in secondary school?
3. Did you think it was important to study IT in Year 12? Why?

Perceptions of study

4. What did you know about CS prior to choosing your current course?
5. What are your impressions of people studying CS?
6. What kinds of gender stereotypes do you think are associated with CS?
7. Do you think there are considerably fewer females doing CS? Why?
8. Do you think individuals should choose courses deemed appropriate for their gender? Why?

Opinions of study

9. Why are your reasons for not study CS?
10. Why did you choose your current course?
11. Would you have considered studying CS if IT was taught differently at school? Why?
12. What do you expect to achieve in your course this year?
13. Are you comfortable in asking for assistance from the lecturers? Why?
14. Do you attend all lectures and/or tutorials? Why?

Career aspirations

15. What do you think are the stereotypes associated with CS as a career option?
16. Do you think individuals should choose careers deemed appropriate for their gender? Why?
17. How useful do you think your current course is for preparing you for future careers? Why?
18. What are your plans after graduation?

Taiwanese participants

Appendix 4. Letter of introduction (translated)

2010 年 6 月 15 日

國立 XX 大學　資訊工程系

尊敬的師長您好：

後學目前是 Monash 大學教育學院的博士候選人，在該校教育系 Michael Henderson 博士的指導下從事“影響澳大利亞和台灣大學生參與資訊工程課程之因素”的研究。目的在於探討影響大學生（尤其是女性）參與和不參與資訊工程學習的主要因素。希望藉由此信，向您請求幫助。

後學的課題研究需要約 80 名資訊工程系（主修資訊工程）、目前就讀學士班的男女同學參與網上問卷調查。後學希望取得您的同意，以便在貴系通知欄上張貼、及在您的課堂上向學生們闡述有關後學的研究項目事宜。所有相關資料如 Monash 大學研究批准（CF09/3316-2009001772）、項目闡述和說明書已隨此信附上，請您過目。

後學靜候佳音。

敬祝

教安

趙淑華　敬上

Shu-Hua Chao

澳大利亞 Monash 大學（Monash University）

教育系（6 棟）

郵箱：[redacted]

Appendix 5. Survey and explanatory statement

Female undergraduates' participation in Computer Science survey (translated)

影響澳大利亞和台灣大學生參與資訊工程課程之因素　概述

感謝您參與該問卷調查。本問卷需要約 20 分鐘填寫。請認真閱讀問卷說明來回答問題。您在該問卷上所提供的資料皆爲保密，只有研究小組的成員能夠閱覽，且所有的資料都采用匿名制，您的身份將不會外泄。如您有興趣參加第二階段的訪談，請回答該問卷的第 38 題。
如對該調查研究（CF090/3316-2009001772）有任何不滿，請聯繫 Monash 大學人力研究道德委員會（Monash University Human Research Ethics Committee,簡稱 MUHREC）如下:

執行官
人力研究道德委员会
研究所，3E 楼
莫纳士大学(Monash University)，維多利亞州，3800
電話：+[redacted]
電子郵件地址：[redacted]

填寫問卷前，您需閱讀所有項目陳述說明，以瞭解此研究目的與所有相關資訊。

Explanatory statement (translated)

項目陳述說明

影響澳大利亞和台灣大學生參與資訊工程課程之因素

尊敬的問卷參與者您好：

後學目前正在澳洲 Monash 大学攻讀博士學位，及與該校教育系的一名資深講師， Michael Henderson 博士共同進行一個研究項目。。在完成學位之際我將會攥寫有關澳大利亞和台灣大學生參與資訊工程課程之因素的博士論文。

目前後學正在尋找的主修資訊工程的學士班學生。我亦在尋找那些在進入大學前打算學習資訊工程、但之後卻放棄了的學生。

該研究的目的爲調查在高等教育中影響到參與資訊工程課程的諸多可能性因素。該研究結果宗旨爲使教育工作者能更加地瞭解哪些因素促進或是妨礙大學生，尤其女性学習資訊工程。

此問卷需 20 分鐘完成。如您對之後的訪談感興趣，可在線上問卷的第 38 題表露您的意願。該問卷調查或訪問之設計以不讓您感到不安、或從您那裡獲取敏感資料。但若您在回答問卷或受訪過程中有任何不安，可聯繫 Monash 大學的輔導中心。

Monash 大学輔導中心
Clayton 校區，10 號樓
[redacted]

該項研究的參與者没有薪酬回報。

本問卷調查採自由參與式，您不會被強制要求參加。該項目中所有參與者無需依據法律程序進行彙報。參與者的個人資料以及獲取的相關資料將根據大學的規定在學校的保險柜內保存五年。

資料將以完全匿名的形式呈現。該研究所出版的相關報告絕不會洩漏參與者的個人資料或身份。雖不能夠做到絕對保密，但參與者的真實姓名決不會在論文或任何出版物中出現。

如欲瞭解調查問卷結果，請聯絡 Shu-Hua Chao：[redacted]

研究結果可見 2010 年 12 月簡要。

如您想聯繫該研究項目任何一個領域的研究人員，可同首席研究員聯繫：

Michael Henderson 博士
Monash University 教育系
電話：+[redacted]

非常感謝。

Shu-Hua Chao

如何回答問題：
請用線上問卷調查中的 “上一頁” 或 “下一頁” 按鍵檢查你的答案。在瀏覽時請不要使用遊覽器的 “後退” 或 “向前” 鍵，因爲這樣做會干擾題目的排列順序且資料有可能會遺失。

請注意一旦點擊 “提交” 鍵，您將不能後退也不能更改答案。

個人資訊

*1 性別
男 ☐
女 ☐

*2 年齡
18 歲以下 ☐
18 ☐
19 ☐
20 ☐
21 ☐
22 ☐
23 ☐
24 ☐
25 ☐
25 歲以上 ☐

*3 你是家中最爲年長的孩子嗎？
是 ☐
不是 ☐

*4. 目前最高學歷
高中畢業 ☐
職業教育或大學專科文憑 ☐
大學 ☐
研究生 ☐
博士生 ☐
其它（請詳細標明） ☐

*5. a) 高中期間就讀學校類別
公立學校 ☐
教會學校 ☐
私立學校 ☐

*5. b) 該學校是男子/女子學校還是男女合校？
男子/女子學校 ☐
男女合校 ☐

高中數學學習

*6. a) 你在讀高三時有學習任何數學相關課目嗎？
有 ☐
沒有 ☐

若（6a）爲有:
*請列舉在你高三學習的所有數學課目：
課目 1 ___________________
課目 2 ___________________
課目 3 ___________________
課目 4 ___________________

*6.b) 你學習過國際文憑數學嗎？
有 ☐
沒有 ☐

若（6b）爲是
如你有學習國際文憑數學，請列舉所學課目：
課目 1 ___________________
課目 2 ___________________
課目 3 ___________________

*6.c) 你有在高三那年學習大學程度的數學嗎？
有 ☐
沒有 ☐

若（6c）爲有:
請列舉所學課目，并標明於那所大學學習該課目
（例如：大學數學， Melbourne 大學）
課目 1 ___________________ 大學 ___________________
課目 2 ___________________ 大學 ___________________
課目 3 ___________________ 大學 ___________________

高中資訊教育學習

*7 你在高三時有學習過任何計算機/資訊科目嗎？
有 ☐
沒有 ☐

如答案爲"有"
*請列舉在高中最後一年所學習的所有 IT 科目，及各科目教師的性別：

	男	女
科目 1 ___________________	☐	☐
科目 2 ___________________	☐	☐
科目 3 ___________________	☐	☐
科目 4 ___________________	☐	☐

如答案爲“沒有”
請說明沒有學習 IT 課目的原因，用逗號來分隔每個原因。
____

對 IT 專業的接觸
*8a) 在高中時你有參加過任何 IT 相關課程的校園參觀日嗎？
有 ☐
沒有 ☐
如答案爲“有”
*請列舉你參加過哪個組織舉辦的校園參觀日，并說明是在讀哪一年級時參加的。
（例如：Monash 大學，12 年級）
組織 1 ___________________ 年級 ______
組織 2 ___________________ 年級 ______
組織 3 ___________________ 年級 ______

*8 b）除了校園參觀日，你在高中時還有參加過任何其它的有關 IT 課程的講座或說明會嗎？
有 ☐
沒有 ☐
若答案爲“有”
*若你出席过任何有關 IT 課程的講座或說明會，請列舉當時由誰主持的，并標明你當時就讀的年級。
（例如：職業諮詢老師，10 年級）
說明會 1 ___________________ 年級 ______
說明會 2 ___________________ 年級 ______
說明會 3 ___________________ 年級 ______
其它 ___________________ 年級 ______

對 IT 行業的接觸
*9. 你高中學習時有認識任何 IT 方面的專業人士嗎？（例如：程式編寫員）
有 ☐
沒有 ☐
若答案爲“有”
*請說明專業人士的專業屬性（例如：程式編寫員），及其性別。

	男	女
專業人士 1 ___________________	☐	☐
專業人士 2 ___________________	☐	☐
專業人士 3 ___________________	☐	☐
專業人士 4 ___________________	☐	☐

IT 方面的經歷
*10 在高中的課堂上我使用過電腦
有 ☐
沒有 ☐

*11 我高中的老師鼓勵我提高電腦方面的技能
有 ☐
沒有 ☐

*12 對以下陳述請標明你同意或不同意的程度，請在每項陳述后只做一個選擇。

SD=強烈不同意
D=不同意
NS=不確定
A=同意
SA=強烈同意

	SD	D	NS	A	SA
在學校時我善於學習 IT 相關的技能	☐	☐	☐	☐	☐
在學校時我擅長數學課目	☐	☐	☐	☐	☐
我認爲好的數學技能對 IT 非常重要	☐	☐	☐	☐	☐
我認爲好的程序技能對 IT 非常重要	☐	☐	☐	☐	☐
我認爲好的邏輯思考對學習 IT 很重要	☐	☐	☐	☐	☐
我對學習新計算機技能的能力很有信心	☐	☐	☐	☐	☐

你的雙親

*13 你的父親或男性監護人的最高學歷

小學教育 ☐
高中學歷 ☐
職業教育或大學專科文憑 ☐
大學學位 ☐
研究生學位 ☐
博士生學位 ☐
無 ☐
其它 ☐（請詳細標明）__________________

*14 你的母親或女性監護人的最高學歷

小學教育 ☐
高中學歷 ☐
職業教育或大學專科文憑 ☐
大學學位 ☐
研究生學位 ☐
博士生學位 ☐
無 ☐
其它 ☐（請詳細標明）__________________

*15 父親或男性監護人的職業（如沒有請填寫 N/A）__________________

*16 母親或女性監護人的職業（如沒有請填寫 N/A）__________________

*17 我父親或男性監護人定期使用電腦

有 ☐
沒有 ☐

*18 我母親或女性監護人定期使用電腦

有 ☐
沒有 ☐

*19 我父親或男性監護人鼓勵我提高電腦技能

有 ☐
沒有 ☐

*20 我母親或女性監護人鼓勵我提高電腦技能
有 ☐
沒有 ☐

高等教育

*21 你目前所學學位的全稱？（例如：計算機科學學士）________________________

*22 你現在就讀哪一年級
一年級 ☐
二年級 ☐
三年級 ☐
四年級 ☐
五年級 ☐
其它 ☐（請標明）____________________

*23. 你現在學習的專業是你進入大學時的第一志願嗎？
是 ☐
不是 ☐

若 23 題答案爲“不是”
*你初選專業的全稱是什麼？（例如：計算機科學學士）_______________________

*24 你在哪裡找到現在所學課程的資料？（例如：大學網站）_____________________

*25 a) 在學習這門課程前，你使用電腦的主要目的是什麼？（你可進行單項或多項選擇）
A 上網 ☐
B 寄電子郵件 ☐
C 打電子遊戲 ☐
D 做功課 ☐
E 打字 ☐
F 寫程式 ☐
G 社交聯絡 ☐
H 寫部落格 ☐
I 發送即時通訊 ☐
J 其它 ☐（請詳述）__________________

*25 b ）以上從 A 到 J 哪項你使用的最爲頻繁？__________________

*25 c ）以上從 A 到 J 哪項活動你最喜歡？爲什麼？__________________

課程選擇

*26 a）你爲什麼選擇現在的課程？（你可以單選或多選）
A 有挑戰性 ☐
B 將來好收入 ☐
C 職業潛力 ☐
D 同齡人的影響 ☐
E 家人或朋友的鼓勵 ☐
F 其它原因 ☐（請列舉）__________________

*26 b) 以上從 A 到 F 哪項是最爲重要的原因？__________________

*27 請詳述至少一項你還未學習該門課程前、所瞭解的特徵。
特徵 1 ___________________
特徵 2 ___________________
特徵 3 ___________________

*28 a) 誰影響你選擇現在的課程？（你可單選或多選）
A 父親或男性監護人 ☐
B 母親或女性監護人 ☐
C 朋友 ☐
D 家庭成員 ☐
E 老師 ☐
F 職業顧問 ☐
G 個人興趣 ☐
H 其他人 ☐（請標明）___________________

*28 b) 以上從 A 到 H 哪個因素對你影響最大？___________________

*29 你認爲哪種技能是你在現今課程中取得成功最爲重要的技能？
技能 1 ___________________
技能 2 ___________________
技能 3 ___________________
其它（請標明）___________________

就業理想
*30 在你入學前，你在 IT 領域有過什麽工作經驗嗎？
有 ☐
沒有 ☐

若答案爲"有"
*請闡明你從事過哪種 IT 工作。（例如： IT 客戶服務）
____

*31 畢業後你打算從事哪個行業？（你可回答一個或多個）
行業 1 ___________________
行業 2 ___________________
行業 3 ___________________

*32 哪些是從事你理想職業的重要技能？
技能 1 ___________________
技能 2 ___________________
技能 3 ___________________
其它 ___________________

電腦使用
*33 你多常以學習爲目的在電腦上從事以下活動？

	每天	每週數次	每周一次	每月一次	很少
電子郵箱： 聯繫老師或同學	☐	☐	☐	☐	☐
使用圖書館資源	☐	☐	☐	☐	☐
使用網上學習系統	☐	☐	☐	☐	☐
使用網路	☐	☐	☐	☐	☐
用於課堂，電腦教室或小組討論時	☐	☐	☐	☐	☐

完成分派工作、功課	☐	☐	☐	☐	☐

*34 你多常以娛樂爲目的在電腦上從事以下活動？

	每天	每週數次	每周一次	每月一次	很少
電子郵箱	☐	☐	☐	☐	☐
玩網路遊戲	☐	☐	☐	☐	☐
創新娛樂 （例如 Photoshop）	☐	☐	☐	☐	☐
使用部落格	☐	☐	☐	☐	☐
聊天	☐	☐	☐	☐	☐
社交聯絡（例如 Facebook）	☐	☐	☐	☐	☐

個人觀點

我想瞭解你對自己目前所學的專業持有怎樣的觀點。

*35 對以下陳述請標明你同意或不同意的程度，請在每項陳述后只做一個選擇。
SD=強烈不同意
D=不同意
NS=不確定
A=同意
SA=強烈同意

	SD	D	NS	A	SA
我覺得課程很花費時間	☐	☐	☐	☐	☐
課業量比我想像得要多	☐	☐	☐	☐	☐
我覺得課程很難	☐	☐	☐	☐	☐
課程過於數學化	☐	☐	☐	☐	☐
課程過於技能化	☐	☐	☐	☐	☐
學習該課程是"書呆子"	☐	☐	☐	☐	☐
我發現我所學習的科目是有趣的	☐	☐	☐	☐	☐
課堂氛圍是接納性的	☐	☐	☐	☐	☐
我對於向導師或助教尋求幫助很有信心	☐	☐	☐	☐	☐
我需要擅長數學才能取得好成绩	☐	☐	☐	☐	☐
我需要擅長編/寫程式才能取得好成绩	☐	☐	☐	☐	☐

*36 a)你認爲在教授計算機科學專業是否有足夠的女性導師或是助教？
是 ☐
否 ☐

如（36）的回答爲"否"

*你認爲是什麼原因使得計算機領域沒有很多的女性導師？

____

*36 b）你認爲學習 IT 有關課程的學生中是否出現性別比例失衡？
是 ☐
否 ☐

若在（36b）中回答是

*你認爲什麼原因使得學習 IT 相關的課程性別比例失衡？______________________

我想瞭解你在目前所學課程畢業后，從事相關工作事宜上的想法。

*37 a）我知道跟我目前所學課程相關的工作種類

知道 ☐

不知道 ☐

*37b）對以下陳述請標明你同意或不同意的程度，請在每項陳述后只做一個選擇。

SD=強烈不同意

D=不同意

NS=不確定

A=同意

SA=強烈同意

	SD	D	NS	A	SA
我認爲薪水會很高	☐	☐	☐	☐	☐
平衡事業和家庭將會很難	☐	☐	☐	☐	☐
這行業將會要求我長時間工作	☐	☐	☐	☐	☐
工作環境會有歧視	☐	☐	☐	☐	☐
男性同事不會歡迎我	☐	☐	☐	☐	☐
我需要整天坐在電腦前面	☐	☐	☐	☐	☐
將很難找到一份工作	☐	☐	☐	☐	☐
我能夠把目前所學的技能運用到工作中	☐	☐	☐	☐	☐

*38 你對未來的訪問感興趣嗎？

是 ☐

否 ☐

*如對（38）題的回答爲"是" 請聯繫：*Shu-Hua Chao [redacted]

以瞭解更多資料并獲取同意書，或者請在下聯留下你的電子郵件地址，我將會和你聯繫，非常感謝！

您的電子郵件地址 ________________________

*你願意進行電話訪問嗎？

願意 ☐

不願意 ☐

致謝

感謝你完成該問卷調查。你的意見對我非常有用。請在這裡隨意留下你的回饋或建議。

回饋或建議:

Appendix 6. Interview consent form and questions

Consent form (translated)

說明書

影響澳大利亞和台灣大學生參與資訊工程課程之因素

注意：Monash 大學的研究人員將保存這份說明書作爲記錄

我同意參加 Monash 大學上述所說的研究項目。我瞭解該項目向我解釋的事宜并閱讀過網上問卷調查的說明條款，我明白參與訪問是指：

1．參與 45 到 60 分鐘的訪問	同意 ☐	不同意 ☐
2．允許訪問進行錄音	同意 ☐	不同意 ☐

我明白在訪問內容形成研究成果的書面資料前我會收到訪問的文字記錄并需經過我的同意。

我明白這種參與是自願性質的，我可以選擇不參與部份項目或不參與整個項目，而且能夠在項目的任何階段終止參與而不受到任何不平等對待。

我明白研究人員從訪問中獲取的任何資料用於報告或出版時，在任何情況下都不會包含受訪者的姓名或確實身份。訪問的特定資料只能在訪問數月后從研究數據中刪除。在此之後該資料將完全無法得到確認，因此將無法刪除與您有關的詳細數據。

姓名: ____________________________

簽名: ____________________________

日期: ____________________________

Interview questions for CS students (translated)

中學教育體驗

1. 您最早使用電腦的回憶是什麼？
2. 您中學時期的 IT 相關經驗包含哪些？
3. 您覺得在高三時學習 IT 相關課程重要嗎？爲什麼？

學習感想

4. 您在學習 CS 之前，您對於這門課程的瞭解爲何？
5. 您的同儕對你學習 CS 有何感想？
6. 您認爲 CS 課程有哪些性別刻板印象？
7. 您認爲您的學習環境對女性是友善的嗎？爲什麼？
8. 您在學習 CS 後、有什麼和與當初預期是相似或不同的呢？

學習意見

9. 您第一次想選擇 CS 時是在什麼時候？
10. 您選擇 CS 的理由有哪些？
11. 您希望今年能完成哪些學習目標？
12. 您是否能從容地向師長們尋求幫助？爲什麼？
13. 您參加所有的講座和/或實習課嗎？爲什麼？
14. 作爲一名男性（或女性）同學，您有過什麼樣的課堂經驗？

職業生涯志向

15. 您覺得 CS 相關工作有哪些既定刻板印象？
16. 您認爲每個人都應該選擇適合自己的性別的職業嗎？爲什麼？
17. 您認爲目前所學的能助你籌備未來的職業生涯嗎？爲什麼？
18. 您畢業後有什麼計劃？

Interview questions for NCS students (translated)

中學教育體驗

1. 您最早使用電腦的回憶是什麼？
2. 您中學時期的 IT 相關經驗包含哪些？
3. 您覺得在高三時學習 IT 相關課程重要嗎？爲什麼？

學習感想

4. 在選擇您的課程前，您對 CS 的瞭解爲何？
5. 您對學習 CS 的人有什麼想法？
6. 您認爲 CS 課程有哪些性別刻板印象？
7. 您認爲學習 CS 的女性相當少嗎？爲什麼？
8. 您認爲每個人都該選擇適合自己的性別的課程嗎？爲什麼？

學習意見

9. 您當初不選擇 CS 的理由有哪些？
10. 您當初爲什麼選擇目前就讀的課程？
11. 如果您當時高中的 IT 課程是用不同的方式授課，您是否會考慮選擇 CS？
12. 您希望今年能完成哪些學習目標？
13. 您是否能從容地向師長們尋求幫助？爲什麼？
14. 您參加所有的講座和/或實習課嗎？爲什麼？

職業生涯志向

15. 您覺得 CS 相關工作有哪些既定刻板印象？
16. 您認爲每個人都應該選擇適合自己的性別的職業嗎？爲什麼？
17. 您認爲目前所學的能助你籌備未來的職業生涯嗎？爲什麼？
18. 您畢業後有什麼計劃？