Declining Participation of Female Students in Computer Studies Programs at an Ontario College: What Stands in their Way?

by

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A thesis submitted in conformity with the requirements
for the degree of Master of Information Studies
Graduate Department of Faculty of Information Studies
University of Toronto

Your file Votre référence
ISBN: 978-0-494-40197-2
Our file Notre référence
ISBN: 978-0-494-40197-2

Declining Participation of Female Students in Computer Studies Programs at an Ontario College: What Stands in their Way?

Thesis submitted for Master of Information Studies degree, 2007
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Abstract

Previous research examining the declining participation of females in post-secondary computing programs focuses primarily on computer science programs in U.S. universities and rarely distinguishes between the needs of different groups of females. This study explores obstacles experienced by females in computer studies programs at an Ontario college where female enrollment in computer studies programs declined from 35% in 1999 to 14% in 2006. Experiences of obstacles are explored by age and race. Fifteen female students participated in an interview and completed a three-part questionnaire. Findings revealed the importance of mentors and role models, participants' lack of interest and weak backgrounds in computer programming, participants' desire for balance in their work, negative images of computing work discouraged participants, especially younger participants, and a perceived lack of computing jobs discouraged participants, especially visible minority participants. Finally, four personas were created from a composite of the words, perceptions, and life stories of participants to convey how they experience obstacles to their academic progress.

Acknowledgements

I would like to recognize the contributions of my supervisors, Ethel Auster and Joan Cherry, in providing the light and the path for my journey. Ethel's capacity for generosity and delight in learning lives on in the faith she had in each of us. Joan's ability to persistently provide structure to my divergent thoughts gave me the scaffolding on which to build this thesis. Wendy Duff provided second reading and picked me up when I wavered. Without the support of these three professors I could not have completed this work. I would also like to thank Wendy Cukier, the external examiner for this thesis, for her insight into the problem of decreasing female participation in computer studies programs.

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CHAPTER 1

INTRODUCTION

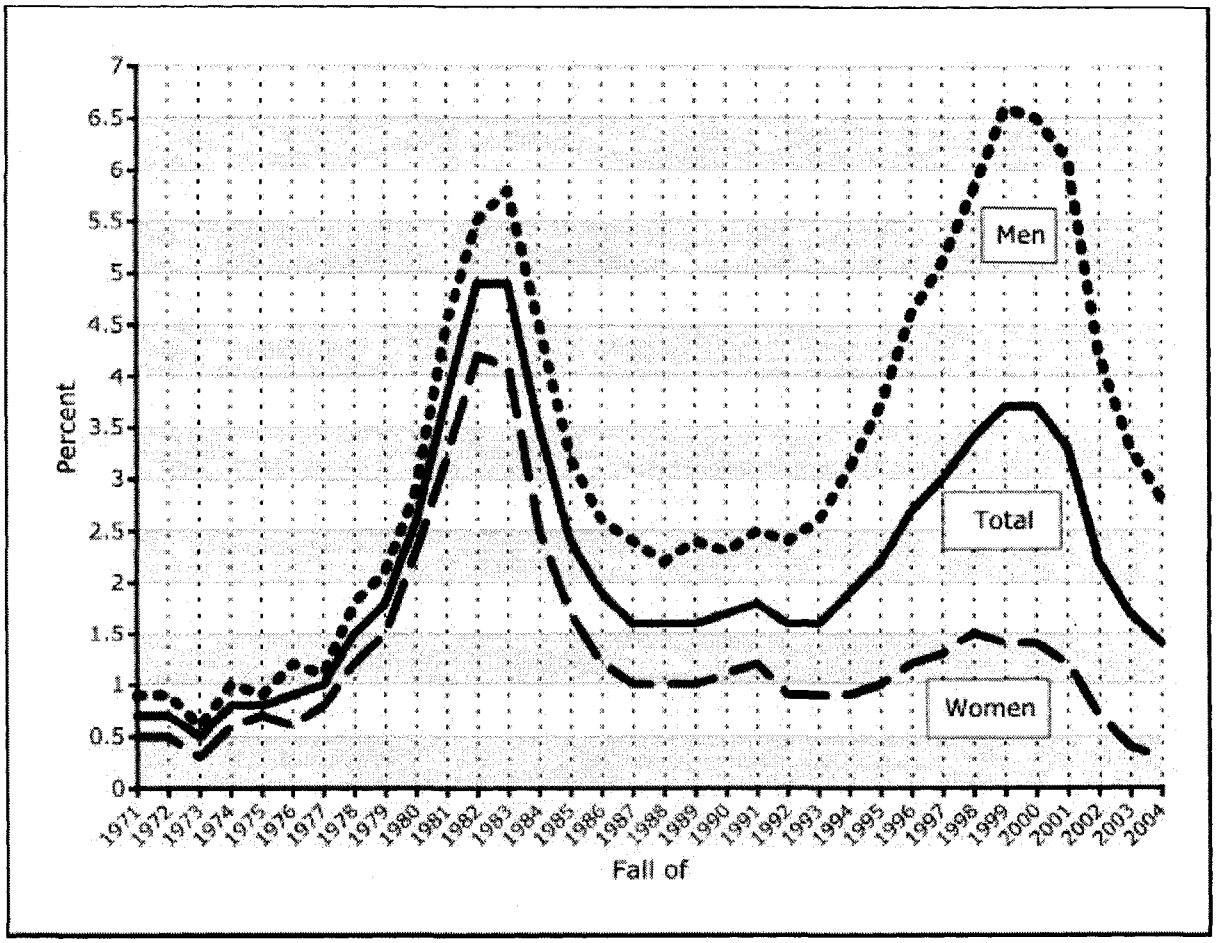
1.1 Chapter Overview

This chapter introduces the problem of the declining participation of women in post secondary computer studies programs addressed in this thesis. It describes the background to the problem, and states the problem, purpose, and significance of the study. Research questions are identified along with definitions of terms pertaining to the questions, and the scope and methodology of the research is outlined. Finally, an overview is given of the remaining chapters in the thesis.

1.2 Background to the Problem

In the past three decades there have been two surges in interest among incoming post secondary students in the U.S. and Canada in majoring in computer science. Figure 1, prepared by the Higher Education Research Institute at the University of California at Los Angeles (Vegso, 2005), documents trends in interest in computer science by gender over this time period. Female interest, although chronically lower than male, parallels male increase in interest in the early 1980s and subsequent decrease in the late 1980s. However, the second surge of interest by males in the late 1990s was not equaled by females, resulting in the current level of female interest that is a lower percentage of overall interest in computer science than it was in the early 1970s.

Figure 1
U.S. University students expressing an interest in a computer science major 1971 to 2004. Obtained from the Higher Education Research Institute at the University of California (Vegso, 2005).



While women are currently entering professions such as law, medicine, business, and other science and engineering programs in record numbers in the U.S. and Canada, the ratio of females to males enrolled in computer science and computer engineering programs has been steadily decreasing. Camp (1997) analyzed data from the annual Taulbee Survey of the Computing Research Association to document the "incredible shrinking pipeline". Camp reported that from 1984 to 1994, the percentage of those obtaining a bachelor degree in

computer science in the U.S. who were female dropped each year from 37% in 1984 to 28% in 1994. Additionally the pipeline of women in computer studies shrank the more advanced the studies: when females made up 50% of the high school computer studies course enrolment in 1994 in the U.S. and Canada, only 28% of the bachelor degrees, 26% of the Masters and 15% of the PhDs in computer science were awarded to women (Camp, 1997). Within the same decade, female participation rose in nearly all other science and engineering programs (National Science Foundation, 2003). Camp's study prompted further research exploring the ways in which females are discouraged from choosing and persisting in post secondary computer studies programs.

In Canada as well the percentage of women enrolled in computer science majors fell 50% from the mid-1970s to 1998 (Klawe, 2002). More recent data in the U.S. and Canada shows a continuing decline as the number of incoming female post secondary students who indicate an interest in majoring in computer science decreased by 80% from 1998 to 2004, as compared to a 60% decrease in male interest in the same time period (Vegso, 2005). Female participation in Canada's largest undergraduate program with a computer science major at the University of Waterloo fell from 33% in the mid 1980s to 15% by 2003 (Graham & Latulipe, 2003). Computer engineering carried the lowest female enrolment of engineering specializations in 2004 at 11% of the students enrolled compared to almost 20% in other engineering disciplines (Canadian Council of Professional Engineers, 2006).

Further, female visible minority participation in computer science must be considered in light of trends in visible minority as well as female participation. As Leggon (2003) points out, "research on the degree trends in information technology focuses either on gender OR racial

gaps. Since degree trends are different for women of colour than for white women, it may be the case that what works for one group will not work for the other" (p. 42). In 2001 only 7% of baccalaureate computer science degrees were earned by visible minority students, when they made up approximately 15% of the U.S. population of appropriate age (Margolis, Holme, Estrella, Goode, Nao, & Stumme, 2003). This reflects the under-representation of visible minorities in post secondary education in general in the U.S. as statistics compiled from 1980 to 1999 show that 12.1% of the doctorate age population in the U.S. were African-American but they earned only 5.5% of the PhDs awarded. This gap was larger for minority women, especially in the disciplines of science and engineering (Solorzano, 1995). With some notable exceptions, under-representation of women in post secondary computing programs appears to be a worldwide trend with most countries and programs falling in the range of 10% to 40% female participation (Galpin, 2002).

Several recent large studies have identified barriers for female students who do not enter or stay in university computer science programs in the U.S. and Canada, and obstacles to their academic progress for females who enroll and persist in these programs. When females choose to enroll in post secondary computer studies, studies show they drop out at a higher rate than males (e.g., Camp, 1997; Cohoon, 2006; Margolis & Fisher, 2002). Studies at the University of British Columbia centered around access barriers for female high school students applying to computer science programs (Chan, Stafford, Klawe & Chen, 2000). A four year longitudinal study at Carnegie Mellon University focused on both the attraction to and retention of female students in university computer science programs (Margolis & Fisher, 2002). In surveys at 18 large U.S. university computer science departments researchers investigated the retention of both female students and faculty in a wide range of

computer science programs (Cohoon, 2001). These studies found that female students tend to: 1) be attracted to computing for a social purpose, unlike male students who showed more interest in building bigger faster machines; 2) view computer science as cutthroat and competitive, narrow and inflexible, and as requiring that they work too many hours to maintain a balanced life; 3) view computing as only for 'geeks' without social skills and with whom they do not identify; 4) be interested in creative hands-on applications of computing in a wide variety of real-life situations; and 5) spend less time on computing activities in high school and have less interest and confidence than male students in their own ability in computing, especially computer programming. Not surprisingly, female students in these studies especially seem to benefit from mentoring, encouragement, and female role models (e.g., Cohoon, 2001; Cohoon 2006).

1.3 Statement of Problem

The declining participation of females in computer science programs in the U.S. is well documented (e.g., Camp, 1997; Margolis & Fisher, 2002). However, there is little research into the participation of females in Canadian universities or in community college programs. Ontario has a different history and mandate for university and college teaching and research from the U.S. Additionally, professional organizations such as the Canadian Information Processing Society [CIPS] provide computing accreditation for programs and professionals in different ways than do their American counterparts. Higher education's relationship with the computing profession also varies across national borders. Further, university computer science programs tend to focus on mathematics in admission and program requirements, a factor often cited as a barrier for females (Cohoon, 2001). College computing programs generally do not have a heavy emphasis on mathematics, which may lower the obstacles for

female college students. And finally, unless college programs in Ontario are oversubscribed, students do not compete for positions, a factor identified in the U.S. university studies as an obstacle for females (Cohoon, 2002). Findings of the U.S. university computer science studies may not apply to Canadian college programs given these differences between computer studies programs in the U.S. and Canada, and between university and college programs. This study attempts to address these gaps by examining the perceptions and experience of female students in a Canadian college computer studies program.

Further, research studies in the U.S. have not yet fully addressed the influence and interplay of different social locations, in particular positions by race, age and gender, on an individual's experience and perception of obstacles in computer studies education. This study will examine differences by race and age, and how they interact with gender to impact the experience of female students in computer studies programs in an Ontario college. Recently studies have begun to pay attention to how perception and experience is produced and reproduced through curriculum, pedagogy, and school processes and culture to exclude some people, perspectives and epistemologies. This study explores how female students feel they fit in their computer studies programs, and their perception of the way computing and software development is characterized in their studies.

1.4 Purpose and Significance of the Research

This study is primarily concerned with exploring the perceptions and experiences of female computer studies students at an Ontario college in order to identify obstacles to their academic progress. It also explores whether obstacles and gender differences in approaches to computing identified by American university female computer science students are also

experienced by female students in computer studies at an Ontario college. Beyond identifying obstacles, the role of participants' families, programs, and the social and cultural processes which they experience daily in structuring their expectations and choices around computer studies is explored. This is in keeping with recent studies that have moved from identifying obstacles and gender differences in computing to exploring the social and cultural narratives and discursive practices around computing and computer studies that produce and reinforce individual differences and obstacles for women (e.g., Cukier, Shortt, and Devine, 2002; Frieze, Blum, Hazzan & Dias, 2006). Further, this study of computer studies students at an Ontario college explores the ways that gender, age, and race impact female students' experience of computer studies programs. Scientist and feminist theorist Harding (1993) describes a "matrix" of social hierarchies that mutually construct and reinforce each other in the lives of female scientists.

Universities and colleges need to be aware of the ways in which female students perceive and experience computer studies programs. Understanding the plurality of perspectives and differences in their students can inform computer studies programs and create the possibility to achieve inclusive school curriculum, policies and practices. This in turn sets the stage for students with a broad range of strengths, accomplishments and social commitment to enter and experience success in computer studies programs, which may contribute to a broader and more community and user-centered application of technology in society.

There are two arguments commonly made for increasing female participation in computer studies programs. The first, from the perspective of society, is equitable access for all and the second, from the perspective of the profession, is higher productivity which may accompany

increased female participation. Addressing the first argument, in their work with Pennsylvania computer science high school and Carnegie Mellon University students, Margolis and Fisher (2002) use a line from a children's book to warn "if 'boys invent things, and girls use things that boys invent', a cyberspace culture will inevitably reflect the desires and sensibilities of males to the exclusion and often denigration of females" (p.12). Canada has a history of supporting equity, as indicated by workplace changes such as those attributed to Pay Equity Legislation enacted in the 1990s. Equity requires that all people have equal opportunity to succeed in their academic program and chosen profession. This includes an equal amount of encouragement, role models, and work and study environments that support different abilities, interests, and needs. The notion of equity is described by Klawe (2002), then Dean of the Faculty of Science at the University of British Columbia, when she says "I didn't believe in gender-related differences in ability ... just in gender-related differences in opportunity" (p. 16). If technology is to reflect the aspirations, priorities, and dreams of all members of society, there must be equitable access to entry and success in computer studies programs.

Addressing the second argument for increased productivity in the IT sector, Canada has historically supported the notion of a cultural mosaic or multicultural society, recognizing the richness and strength of its diversity. To maximize the creativity and productivity of the use of technology and to achieve a broad range of applications of technology in society, the computing profession would benefit from a diverse range of people with a broad mix of perspectives involved in the invention of technology and its applications. Society's historic gendered relationship with technology is demonstrated today in male students' expressed interest in extending the limits of technology while females tend to be attracted to

"computing with a purpose" (Margolis & Fisher, 2002, p. 49). The male students' approach may have contributed to the 'productivity paradox', a theory introduced by Morgan Stanley's chief economist, Roach (1987). This theory postulates that investment in IT and technology work has not resulted in a corresponding increase in productivity or return on investment. Male interest in developing 'technology for technology's sake', often without a clear social or business purpose, may cost more than it returns in the marketplace, while female students' interest in social purpose may have the potential to contribute to a commercially and socially more effective balance in investment (Cukier, 2006; Cukier, Shortt & Devine, 2002). Invention for a purpose, rather than to stretch technological limits, may also help reduce the well documented gap in the IT industry between the developers of technology and the communities who use the products of development (e.g., Denning, 2001).

1.5 Research Questions

Four research questions directed the exploration of the experiences of female students in their computer studies programs.

1. What obstacles to their participation and academic progress are identified by female students enrolled in computer studies programs at an Ontario college?

2. How do female computer studies students at an Ontario college experience identified obstacles in their programs?

3. To what extent do demographic factors play a role in the identification and experience of obstacles for female students in computer studies programs at an Ontario college?

4. In what ways do computer studies programs at an Ontario college contribute to or mitigate obstacles to the academic progress of female students?

1.6 Definition of Terms

The following definitions are used throughout the study:

Barriers to participation: Factors that participants feel contribute to female students choosing to not enroll or persist in computer studies programs.

Computer Science Programs: This term describes degree programs located in universities which focus on computing as a science based on discrete mathematics.

Computer Studies Programs: This term describes academic programs in colleges and universities that focus on software development. These include the computer programming diploma program and software development degree program in which participants are enrolled.

Computing: This term is used to denote work designing, implementing, managing, and maintaining information and communications technology in a range of contexts.

IT Profession: This is an evolving profession and includes many disciplines and occupations that design, develop and support the use of IT in all sectors of industry. It includes computer programming and science, but also management of information systems, database administration, and data communication.

Obstacles to academic progress: Factors that discourage female students and make it more difficult for them to succeed in their computer studies programs.

Ontario Colleges: There are 24 institutions in Ontario that are designated as Colleges of Applied Arts and Technology [CAAT], or commonly known as community colleges. They

offer certificate, diploma, advanced diploma, and degree programs (one to four years in length respectively), along with graduate certificates.

Visible Minority: The Canada Census[1] definition of visible minority was used: Aboriginal, Chinese, South Asian, Black, Arab, West Asian, Filipino, Southeast Asian, Latin American, Japanese, or Korean.

1.7 Limitations of Study

Studies that focus on declining female participation in computer science and software development programs may contribute to the perception that computing and IT work is exclusively computer science and programming, something that has proven to be an obstacle for women (Cukier, 2003). However, the discourse around, and approaches to, technological progress that favour technology and technical skills over use of technology and 'soft' skills, impact both computer programming and a broader range of IT programs and work. As scientists tend to define the boundaries of their science (Bloom, 1988; Gieryn, 1983), the intention of this study is to find ways to include a broad range of perspectives *within* computer programming and computer science programs, to encourage the examination of boundaries of IT disciplines and professions from an inclusive and critical perspective.

Further, this study focuses on identifying obstacles to female participation. However, equal access to opportunities may not be reached solely through the removal of obstacles. As feminist theorist Patricia Williams says, "it is a dangerous if comprehensible temptation to imagine inclusiveness by imagining away any obstacles. It is the way that the moral high ground of good intentions knows its limit" (Williams, 1997, p. 3). For example, studies in the

[1] see: http://www12.statcan.ca/english/census01/Products/Reference/tech_rep/vismin.cfm#

U.S. have shown that policies aimed at removing obstacles for women and visible minority students in schooling have narrowed previous differences in educational achievement but have had no discernible impact on the subsequent workplace income gaps between women and men, or visible minorities and white workers (Fine & Weis, 2003; Mickelson & Smith, 1994). Identifying obstacles for female computer studies students at an Ontario college, although limited in its impact for social change, is intended to inform and support change that will encourage female participation in these programs. Broader educational and societal structures that inhibit inclusiveness are beyond the scope of this study.

1.8 Scope of Research

The population consists of all female students at an Ontario college enrolled in a computer programming diploma program or a software development applied degree program. Qualitative data was gathered through individual interviews of female students to explore their experience of obstacles in their studies and how these obstacles are constructed and reproduced, and their perception of similarities and differences between how males and females approach computer studies. Interview data was supported by a questionnaire administered during the interview to gather specific information regarding whether obstacles identified in previous studies impact participants in this study. This study was limited to examining the perceptions of female students, along with enrolment data from the college that provided further information pertaining to the perceptions expressed.

The findings of this study will be used to inform the computer studies programs of participants and will contribute the perspectives of female students from an Ontario college to the literature. With only one college involved in the study, findings cannot be generalized

to programs at other colleges, but they may provide insight into the nature of the problem on which further studies in Ontario colleges can build.

1.9 Outline of Thesis

Chapter 2 contains a review of the literature relevant to this research. Chapter 3 describes the methodology used to explore the research questions. Chapter 4 presents the findings of the research. Chapter 5 provides discussion of the findings, and makes recommendations for changes in the college computer studies programs of participants, along with suggestions for further research.

1.10 Chapter Summary

This chapter examined the problem of the declining participation of women in computer studies to which this thesis is addressed. It described the background to the problem, and stated the research problem, and the purpose and significance of this study. Research questions were identified along with a definition of terms pertaining to the questions, the scope of the research was established, and the remaining chapters in the thesis were outlined.

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Overview

This chapter reviews relevant studies from literature in four areas of research. First, studies published in the past 20 years that document the number of female students enrolled and persisting in U.S. and Canadian high school and post-secondary computer studies programs are reviewed. This establishes the relevance of this research by identifying existing conditions and trends in post-secondary computer studies enrolment and retention. In these studies female students identify perceived or experienced barriers and obstacles to success in entering and persisting in their computer studies programs. This work provides the basis for the exploration in this study of specific obstacles experienced by female students in previous studies. Second, relevant highlights of literature on gender in education and computing pertaining to the ways young people are introduced to and approach computing, and the ways they generate knowledge are reviewed. Third, research is presented that identifies social and cultural influences on female participation in computer studies programs, approaches to technology and software development that discourage females, and discourse around IT that may impact female interest in computing. And finally, literature in education provides insight into 'girl-friendly' pedagogy and 'minority-friendly' classrooms.

2.2 Declining Participation of Women in Computing

Declining female participation in post secondary computer studies programs in the U.S. and Canada was reported in chapter 1. However, this trend starts before college or university. A 2003 study of Canadian high school students taking computer courses indicates only one in

three students was female, and in advanced courses female participation fell to less than one in four (Wu & Perelgut, 2004). This becomes important when up to a third of female computer science students say that a high school programming course was the main reason they chose post secondary computer studies programs (Margolis & Fisher, 2002). A similar trend appears in high schools in the U.S. with females comprising 17% of the students who take the national Advanced Placement Computer Science [APCS] test required for admission to post secondary computer studies. Further, visible minorities are also underrepresented as only 6% of the students who wrote the APCS test were African-American or Hispanic (Leggon, 2003).

The IT workforce also reflects the declining female participation in post secondary studies. The Software Human Resource Council in Canada reported that 30% of the IT workforce was women in 1991, 25.4% in 2000 and 22.8% in 2005 (Balfour, 2005). Further, the number of women already working in the IT industry is declining. It is estimated that in the first year after the dot-com bust in 2001, approximately three female IT workers in North America lost their jobs for every two male jobs that were lost (Bowlby & Langlois , 2002). A recent study of 2800 IT professionals in the U.S. found that women were 2 ½ times as likely to leave the industry (Wardell, Sawyer, Reagor & Mitory, 2006). The same study found that for employees with equivalent IT education, men's salaries were 23% higher than women's, reflecting broader workplace inequalities. These trends mean fewer female role models and mentors exist for aspiring computer studies students and indicate the decline in female participation in computing is broader than just computer studies programs.

The next section reports on studies that examine computing and gender including; how young people are introduced to computers and the Internet, how males and females tend to approach computing and computer programming, and differences by gender in approaches to learning.

2.3 Computing and Gender

Most studies of the declining participation of females in computing focus on identifying differences between how women and men approach computer technology and studies. The social construction of gender and how young people gain a sense of their own competence as males and females in society is played out in both the creation of these differences, and how differences influence approaches to computing and computer studies.

2.3.1 Introduction to Computing

Students' access to and interaction with computers early in life has an impact on their later interest in studying computer science (Margolis & Fisher, 2002). Since young people in North America experience computers in their daily lives through their use of the Internet, it is worthwhile to explore how gender is experienced in this medium. Males dominated the early days of the Internet but by 2002 the gap had narrowed as 73% of American men and 69% of American women reported use of the Internet (Chen & Wellman, 2003). However, men use the Internet primarily for entertainment and leisure while women tend to use it for interpersonal communication and educational purposes (Weiser, 2000). Some theorists such as Turkle (1995) thought the Internet might lessen gendered views of computers as boys and girls try out multiple identities of different genders using computers in online simulated environments (e.g., multiplayer games). However, Nakamura (2002) reminds us that we

bring our real life experiences, values, and cultural myths with us when we log on. For example, males tend to choose stereotypical and fetishized 'avatars' such as geisha girls to represent their chosen identity online. This allows them to operate as 'identity tourists' on the web (González, 2000) while maintaining distance rather than building an understanding of the 'Other' as expected by Turkle. Young people using the Internet appear to replicate rather than transcend existing social constructions of gender and race.

Studies show that visible minority students have had less access to computers at home and school than have white students, a further influence on visible minority females' early experiences with computing. In 1998 in the U.S. twice as many white people owned computers at home (40%) as did black and Hispanic minorities (20%), three times as many were online, and six times as many reported using the Internet at work (Simama, 2001). Additionally, almost 50% more white students used computers at school (56%) than did visible minority students (39%). This difference in computer access is significant since owning a computer and using it in pre-college computing classes increase the likelihood of success in post-secondary computer studies programs (Kagan, 1988; Taylor & Mountfield, 1994).

Young people, particularly boys, encounter computers early in their lives while playing computer games. Use of computer games is linked to increased computer literacy (Greenfield, 1984). However, the violence and sexual stereotypes of popular computer games such as Mortal Kombat and Grand Theft Auto alienate females (Cooper, Hall & Huff, 1990; Greenfield, 1996). A study of 47 computer games found that only 14% of the characters were female, and further, they wore less clothing than the male characters (Beasley &

Standley, 2002). Another study of 33 popular computer games found that there were no females in 41% of the games, and in those that had female characters, they were portrayed as sex objects 28% of the time (Dietz, 2004). Further, 27% of the games depicted violence against others and almost 80% of those depicted violence against females in particular. Boys and girls who are exposed to these games learn female gender roles that limit women's self efficacy and work with technology. Information technology terminology reproduces similar masculine and violent symbolism, such as the 'killer app' that is the desire of every programmer and denotes a software application that has 'wiped out' all market competition. As computer games have been identified by males in some studies as the strongest motivator in their decision to enter post secondary computer studies programs (Carter, 2006), young computer gamers entering the industry are likely to be comfortable with and may re-inscribe computing with these masculine and militaristic signifiers.

Given the ways that young people are introduced to computing, it is perhaps not surprising that women entering computer studies programs tend to have taken fewer high school computer courses and have less self-directed computing experience than their male classmates (e.g., Carter, 2006; Margolis & Fisher, 2002; Murphy et al, 2006; Sackrowitz & Parelius, 1996). Female students in science and technology report less defined career goals and become interested in IT later than males (Cohoon, 2002; Hanson, 1996). Women working in the IT industry in Ontario often report unconventional career paths, as if they came upon a career in IT 'by accident' (Scott-Dixon, 2004). These informal routes into computing work that facilitate female participation may in fact be shrinking as increasing credentialism and IT industry certification more narrowly define the skills required in the industry.

2.3.2 Approaches to Computing

Early research into different approaches to computing by gender describes intense male interest in using and controlling computers while a more observational role is taken by females, one of "computational reticence" (Turkle, 1986). The latter approach to computing is marked by qualified enthusiasm for computing and preference for a relationship at a distance with technology since it is seen as somewhat threatening. These gendered approaches to computing may be reflected today in male students' higher comfort level in experimentation with technology, a learning strategy that is often positively correlated with achievement in computer programming (Katz, Aronis, Allbritton, Wilson & Soffa, 2003). Male fascination with computers and computer programming is described in the findings of a large study at Carnegie Mellon University as, 'boys dream in code' (Margolis & Fisher, 2002). Males have consistently shown a higher interest and confidence in programming than females, especially early on in their post secondary programs (Cohoon, 2006; Irani, 2004; Madigan, Goodfellow & Stone, 2007; Margolis & Fisher, 2002; Murphy et al, 2006). Computer studies programs that use first year programming courses as 'weeding out' courses, entrench the view that coding is the fundamental computer skill to master. Lewis, (2007) associates the overall decline in interest in computer studies with this reduction of computer studies to computer programming. Cukier (2003) describes the detrimental impact of this reduction on females. Studies at U.S. Universities found that computer programming 'weeding out' courses had a pronounced negative impact on females (Cohoon, 2002).

In their study at Carnegie Mellon University, Margolis and Fisher (2002) found that females tended to be attracted to 'computing for a purpose', to practical real-world applications of technology that help people, rather than computing for the sake of computing. Females, and

especially visible minority females, have been found to be interested in applications that allow them to give back to their community (Hanson, 1996). In California, Carter (2006) found that the desire to use computer science in another field was the primary motivator for women to study computing (while interest in computer games motivated the most men). An intervention at the University of Waterloo in Ontario exposed high school girls to a wide range of applications and uses of computer technology in business and society and increased their interest in studying computer science after high school (Graham & Latulipe, 2003). As one student wrote at the end of the study, "It is way, way, way more interesting. There is a lot more to it than just programming" (2003, p. 325). To incorporate these different interests when learning to program, some professors, such as Bernstein in New Jersey (Frenkel, 1990), have used software applications rather than procedural programming in an initial course to teach fundamental concepts of computing such as logic and data structures. In this approach students are introduced to concepts through real-life applications of computing, which software applications such as MS Access can produce much more quickly than can be achieved using programming languages. The traditional 'hello world'[2] initial program commonly taught in introductory computer courses illustrates technical capabilities like output functions and the syntax of a programming language without an obvious purpose for this functionality in sight.

One way of describing this difference in approach to computing is that women tend to view technology as a tool while men tend to view it as a toy (e.g., Almstrum & Last, 2006; Frenkel, 1990). In this theory, men are enthralled with challenging the limits of technology

[2] The 'hello world' program is one that consists of the shell of a program containing one line of code that displays 'hello world' on the screen when it is run. It is commonly used to introduce learners to the structure of a program along with the editing, compiling, and debugging environments.

(with the resulting Moore's Law, from Intel's Gordon Moore, that the processing speed of a CPU doubles every 18 months). When asked to imagine the future of IT, men tend to create fantasies that extend the limits of technology or allow them to have control over real world limitations (such as a magic carpet) while women imagine technology that could help them and their communities communicate, share, and coordinate their everyday lives (Bennett, Brunner & Honey, 1999).

2.3.3 Knowledge Generation

In 1986 Belenky, Clinchy, Goldberger, and Tarule reported on interviews with 135 female students that resulted in the classic text 'Women's Ways of Knowing'. These interviews explored gendered epistemological positions, the ways in which men and women tend to create knowledge. Findings showed that men more often employed separate knowledge creation methods – objective, analytical, detached evaluation of an argument – while women tended to use connected knowing – attempting to understand another's point of view before evaluating their argument. As cited by Gilligan (1993), in 1944 Virginia Woolf suggested that women tend to create an arena of knowledge through careful observation of repeated patterns of social interactions. Gilligan describes this as "taking the pulse, the temperature of the human climate" (1993, p. 145). This includes the ability and interest of many women in bringing their own inner thoughts and feelings into relationship with the thoughts and feelings of others, a connected rather than autonomous way of creating knowledge, and one that in today's computing world would most certainly involve interaction with 'users'. This description of knowing is demonstrated in the findings of current studies that show that working in pairs, rather than alone, to learn programming is of benefit to all students but has the most benefit for female students (e.g., Hanks, 2006).

Education and feminist theory have long articulated the value of using students' own concrete, situated and subjective experience in the creation of meaning (Collins, 1990; Dewey, 1944; hooks, 1989, 1990; Williams, 1991). Dewey speaks of learning as adjustments to and active participation with one's environment. Collins and Williams describe the ways that higher education denies subjective experience, emotions, ethics, and dialogue as appropriate methods of knowledge construction. Collins and hooks describe the use of one's own experience, intuition, caring, dialogue, and personality as a criterion for meaning, wisdom, and a way to judge credibility of knowledge in black U.S. communities. Even students considered to be low in skills, income, and motivation are often eager to employ their own experience in generating knowledge in a participatory pedagogy (Lather, 1991). It is particularly important for students from oppressed minorities and those whose first language is not English to employ and articulate one's own experience in knowledge creation (Bannerji, 1992; Cummins & Danesi, 1990). Women of colour especially have expressed the need to move from consumers to producers of knowledge that reflects their own subjectivities (Collins, 1990). Feminists Haraway (1991) and Ellsworth (1989) describe the contextual nature of knowledge and the way in which partial perspectives from people in different social locations contribute to a deeper understanding of social 'truths'. Harding describes "feminist standpoint theory" (1987, p. 184) in which these partial perspectives on reality are gained from actual concrete activities and experience rather than a detached observation of others.

2.4 Social and Cultural Narratives around Computing

Studies are beginning to emerge which indicate that when social and cultural conditions and the learning environment allow for diversity, gender differences tend to dissolve. At Carnegie

Mellon University changes were made in the late 1990s to encourage female participation resulting in a steady increase in females entering undergraduate computer science programs from 7% in 1995 to 38% in 1999 to 42%[3] in 2000 (Frieze, Blum, Hazzan & Dias, 2006). Changes included a variety of first year programming courses at different levels and with different approaches to programming, a first year survey course to show the breadth of the discipline to students, and hands-on interdisciplinary projects to support the broad and applied interest of females. The result has been a more balanced environment in which all students show a more diverse range of interests. Previously documented differences by gender in computer science students at Carnegie Mellon University in their approach to computing ('for a purpose' versus technology for technology's sake), interest in programming, confidence in computing abilities, and sense of fitting in (Margolis & Fisher, 2002), were mostly non existent in later studies conducted in the mid 2000s at the University (Frieze, Blum, Hazzan & Dias, 2006). Both male and female students currently show a range of relationships with technology, including using it as both a toy and a tool for a broad range of purposes. This indicates that it may be that gender interacts with social and cultural narratives around computing and the computer studies environment to influence students' perspectives on computing. Further, a case study of students taking computer science courses in high schools in Israel showed that 50% of the Arab students but only 25% of the Jewish students were female (Frieze, Blum, Hazzan & Dias, 2006). One cultural factor appeared to make up much of the difference: the female Arab students received far more encouragement and support to study computer science from just about everyone in their family and school than did the female Jewish students.

[3] The increase in females entering undergraduate computer science programs at Carnegie Mellon University has not been sustained in recent years. A recent report (Carnegie Mellon Institutional Research and Analysis, 2005-2007) shows that in 2005 only 22% of the freshman class were female and in 2006 21% were female.

Early studies examining differences in preferences and strengths between males and females, conceptualized gender as a set of characteristics or traits, whether biologically determined or socially constructed. More recent theorists describe gender as 'performative' (Butler, 1990), played out in one's response to their environment, needs, and desires. Trauth (2006) describes an 'individual differences theory' in which differences between females are examined to understand how different characteristics, abilities, and needs interact with the computing environment to undermine students' participation.

A study of countries in which female participation in computing is high might shed light on other cultural influences on choices of studies and careers. In Armenia, female participation outstripped male participation in computer science programs throughout the 1980s and 1990s (although increases in male enrolment have caused the percentage of females to dip to 44% of the total enrolment in the last few years). In a study of computer science students in Armenia (Gharibyan & Gunsaulus, 2006), both males and females say they chose computer science because of the wide range of employment opportunities, a perspective not generally shared by their North American counterparts. Parents and role models appear to have little influence in Armenian culture when choosing a course of studies, replaced instead by an individual's pragmatic choice of careers based on a realistic evaluation of job opportunities and their own abilities. Perhaps this cultural method of choosing careers mitigates the impact of gender norms and social expectations in the workplace, given that Armenian society is thought to be no less patriarchal than North America society.

2.4.1 The Computer Studies Environment

Studies show that 'stereotype threat' has an impact on student performance. When negative stereotypes of female mathematicians were shown to female math students their subsequent scores on math tests plummeted (Steele, 1997). Students may be aware of and actively resist a stereotype, but its mere existence appears to lower their performance. Other studies show that the expectation of success in computer studies affects students' decision to enter post secondary computer studies programs (e.g., Zarrett, Malanchuk, Davis-Kean and Eccles, 2006). However, as stated earlier, findings of studies on gender differences in computing indicate that women lack confidence in their computing abilities. This may lead them away from computer studies. In fact, women tend to underestimate their abilities and men tend to overestimate their abilities (e.g., Irani, 2004). In a study at Stanford in which there was little difference by gender in performance, female computer science students rated themselves as less comfortable and confident with computers than their peers while male students rated themselves as more comfortable and confident (Irani, 2004). Irani credits linguist Tannen (1995) with showing that "women tend to downplay their certainty while men downplay their doubts" (2004, p. 197). It appears that male computer students give a less than accurate impression to themselves and others that they understand course material and easily complete assignments on their own (Murphy et al., 2006). Studies show that females may receive slightly lower grades in their first computer programming courses but those who stay very quickly catch up to the academic levels of their male classmates (e.g., Vilner & Zur, 2006). And some studies show girls outperforming boys in pre-college and undergraduate programming classes in the U.S. (Kafai, 1988; Taylor & Mountfield, 1994; Volet & Styles, 1992). However, judging themselves against this impression of superior male ability, and often in the presence of confidence-sapping negative female stereotypes, females feel they

are less capable (Irani, 2004). This may contribute to the higher dropout rate of female students (e.g., Margolis & Fisher, 2002).

These studies in computing are consistent with earlier studies that identified an 'imposter syndrome', in which people doubt their abilities and expertise and feel they are a 'fraud' even in the face of many external indicators of their superior ability and success. This syndrome is particularly prevalent and intense among successful females (e.g., Clance & Imes, 1978, Deaux, 1976).

Male student behaviour in computer studies that exudes an unruffled confidence and ability to work on their own secures their sense of competence as a male given society's association of computers and independence with masculinity (Irani, 2004). Even the image of 'hardcore' computer students who are glued to their screens day and night generates an acceptable male identity. As Irani says, "In our gender system, men have an incentive to spin their struggle into a rite of passage and endurance. Women in our culture do not experience the same expectation. Thus, it is not surprising that no woman in her study expressed a desire to be "hardcore"" (2004, p. 197). The need for a strong masculine 'computer guy' image may arise because many 'nerdy' male computer students don't fit traditional male gender stereotypes. In Kendall's (2000) study of an online community she describes the ways that participants in virtual, mostly-male, 'nerd' environments "create and enact a culture that continually reiterates this pattern of distancing from other men and most women" (2000, p. 272). She describes how this culture strengthens the connection between technological competence and masculinity, contributing to the undermining of women's confidence that they belong in the community. At Carnegie Mellon University Margolis (2002) found that the "geek-like"

image of computer programmers often did not 'fit' women's sense of their own identities, interests and abilities. Studies in Great Britain and Australia found that girls are discouraged from participating in computer science because they feel that IT jobs are isolated and have a low level of social interaction and that computer programmers have few social skills (e.g., Durndell & Thomson, 1997). Further, competition for scarce resources discourages female participation with computers in public schools (Clarke, 1990; Clarke & Teague, 1994). Similarly, the tighter the competition for seats in university computer science programs in the U.S., the less women are inclined to apply to these programs (Cohoon, 2001). Females tend to be dissuaded from entering computer science programs because they view them as competitive and aggressive, filled with people with large egos (e.g., Margolis & Fisher, 2002).

Given their relative lack of confidence in their computing ability, it is not surprising that retention of female students increases significantly more than male students with encouragement from faculty and peers (e.g., Cohoon, 2001; Frenkel, 1990; Margolis & Fisher, 2002; Seymour, 1999). In particular, encouragement from parents to enter computer studies appears to have a large impact on females considering which post secondary program to study (Madigan, Goodfellow & Stone, 2007; Meszaros, Laughlin, Creamer, Burger & Lee, 2006; Teague, 2002). Strong parental support and encouragement was also found to be a common ingredient for women working in IT (Scott-Dixon, 2004). Cohoon (2001) found that valuing and praising female students' strengths contributed to increased recruitment and retention of women in computer science programs in universities in the United States. African American women prove to be an important exception in their ability to resist discouragement. Studies have found them to be determined, persistent and self-reliant

(Fordham, 1993; Seymour, 1999), possibly characteristics needed to survive for the very few female African American women in computing. Role models that counteract the stereotypes and association of computing with males, and mentors that offer encouragement and support, have proven to be powerful influences in the recruitment and retention of female students in science, engineering and computing programs (Brunner & Bennett, 1997; Cohoon, 2001; Hornig, 1984; Sturm & Moroh, 1994; Margolis & Fisher, 2002). Students require networks of support systems in order to succeed but older women, especially older visible minority women, have been shown to benefit even more from mentoring, advising and other support (Malcolm, 1993; Thomas, 2001). Older and visible minority students often face isolation and a sense of incongruence with their educational environment (Tinto, 1993). Role conflict and overload is more of a problem for older female students than male students, and is magnified for women of colour (Thomas, 2001).

There is some evidence to suggest that women may be discouraged by their perception of computing as a career that requires long hours and isn't compatible with childrearing (e.g., Etkowitz et al, 1994; Margolis & Fisher, 2002). Although this may change with broadening views of gender roles and careers in computing, the female role of nurturer and caregiver in society is deeply embedded in our psyche. Irani (2004) cites the work of sociologist Kanter (1977) on the phenomenon experienced by highly visible minorities. Kanter says that that their differences (such as being emotionally nurturing in the case of females in the minority) distract the majority from noticing their technical performance (which is not so different). To the male majority, the rare female classmate represents the female gender and thus their female characteristics and roles are most memorable, rather than their technical skills, since femininity is their most visible difference. This situation would be doubly true for women of

colour with mostly white, male classmates. Female computer science students at Stanford University attempted to decrease their minority visibility and attract attention to their computing skills by 'dressing down' (Irani, 2004).

2.4.2 Models of IT Development

There are competing models of IT development favouring different views of the way technology interacts with society. These models are examined for their potential impact on the participation of females in computer studies.

Franklin (1990) borrows German philosopher Immanuel Kant's definition of mechanism and organism to describe two divergent models of technological progress. Franklin says that technology is currently often designed as independent parts that are assembled into a functioning unit, or 'mechanism', under a coherent, uncontextual, and unchanging plan. In the 'organism' model of technology, parts grow or emerge in unpredictable ways through their interaction with each other and with their environment. Franklin feels that we often employ the mechanism model, favoured in its predictability by capitalism, when the organism model of technology development is more appropriate. The lack of consideration for context and the whole organism in the mechanism model is illustrated today in the approach to network security favoured by IT professionals in which complex technical procedures around passwords are created in order to outwit hacking programs. However, these procedures are often incompatible with work values and practices, eroding compliance and therefore security (Hawkins & Oblinger, 2006). Lewis (2007) describes the over attention to technical aspects of computer systems and under attention to human aspects as a result of the high costs and difficulty historically associated with the technical aspects. He

notes that the costs and difficulties are now higher for human interaction than for the development of technology itself but the discipline has not yet changed how it approached the design and development of computer technology.

Studies have found that female students are more likely than males to be interested in the social context of computing and the interrelation between computer systems and their social, economic and natural environment, the organism model (e.g., Margolis & Fisher, 2002). Male students, fascinated with extending the power of the 'technical bits' of a computer, reinforce the mechanism model. "Women are much more likely to be concerned with how new technologies fit into the social and environmental surround, whereas men are much more likely to be preoccupied with doing things faster, more powerfully, and more efficiently regardless of social and environmental consequences" (Bennett, Brunner & Honey, 1999, p.5). Increased attention to the organism model of IT development might balance the unhindered progress of the technical parts of a computer, such as processing speed and data communications, with understanding and regard for the environment with which they interact.

Software development appears to embody the tension between the autonomous mechanism and interconnected organism views of technology. Computer scientist Denning (2001) describes the ideas of Dertouzos, Director of MIT's Laboratory for Computer Science, in the statement: "our tradition as inventors and visionaries is fresh; it inclines us to create products and then extol the virtues of our creations ... a practice of "creating goodies and throwing them over the wall" where ordinary users pick them up and (hopefully) put them to good use" (2001, p. 23). Denning says this 'supply-side' practice by developers of technology

needs to shift to a 'demand-side' approach of creating what people who will use the technology say is of value to them. Computer science programs reinforce the 'creating goodies' approach when software development is taught in a 'black box' with social context abstracted away. This approach appeals to students who are interested in technology for technology's sake rather than for a social purpose. Participatory design methodology and 'extreme programming' on the other hand, employ design-in-use strategies of systems design and development (Henderson & Kyng, 1991) in an attempt to shift developers from supply-side to demand-side approaches to development. Participatory design views technology as embedded in work practices so responsibility for development is shared with users and evolves. Design is iterative as computer systems change work practices, which in turn change the design of the system (e.g., Bruckman, 2003). This view of IT development might attract students, and particularly female students, who tend to be user-oriented and interested in how technology interacts with people, practices, and environments.

Denning (2001) suggests the need to understand and practice IT within social context and as a component of interrelated systems when he recommends computer science take an interdisciplinary team approach to technology development. An interdisciplinary university course at Georgia Tech in race and technology helped bridge the gap between technical and non-technical students, between communities with IT access and those with less access, and taught the need for diverse communities to produce information for and about themselves (Simama, 2001). Inter-disciplinary and multi-disciplinary courses have proven to be attractive to women considering computer studies programs (Cohoon, 2001).
Further, the 'creating goodies and throwing them over the wall' model of development leaves the social fingerprints of the developers on the product. A study by psychologists Huff and

Cooper (1987) showed that when educators creating instructional software were asked to design software for a boy, they designed it differently than when they were asked to design it for a girl. When they were asked to design it for a student, the design turned out to be the same as the 'boy' design. These designers used male as the default when thinking about students using computers. The flexibility of software allows for many such unexamined biases (Friedman & Nissenbaum, 1994). A view of technology as unbiased, and creating goodies on one's own, allows developers to steer clear of users, and further, positions people and communication skills, where females often have strength, to be less valued and considered unnecessary for programmers. A different view of technology as 'frozen social relations' (King, 2003), acknowledges the plural but static ways that technology interacts with people in social context, a view of IT development as an organism, in which external factors such as developer bias play a role.

2.4.3 Discourse around IT

The skills required in computing vary with the view one takes of technology, systems development, and the IT profession. Cukier (2003) analyzes the prevalent discourse in IT professions to argue that equating IT with computer science and programming alone, and program entry requirements that favour areas of traditional male dominance and that are not essential to student performance, such as mathematics, work together to exclude women. Cukier points out that:

> The notion that computer science, engineering and mathematics are the preferred entry routes to the IT profession may, in the same way, have unintended consequences for women. In addition, the (mis)representation of the IT Profession in this way, reinforces the stereotypes of it as a "technocentric" profession rather than one with broader appeal

> requiring diverse disciplines and skill sets. More study is needed to explore the ways in which our definition of 'IT professional', the occupational categories, skill requirements, education and admission requirements may present barriers to the full participation of women. (2003, p. 31)

Historically the culture of programmers, especially in the early age of the Internet, was that of cowboys riding off into the 'undeveloped' West. There was a widespread notion of freedoms: 'information wants to be free' (Brand, 1987) evolved into the open source software movement's 'free as in speech not free as in beer' slogan (Stallman, 1985) to describe the way that software 'should' be free. The anti-censorship, anti-regulations sentiment of programmers (e.g., Shade, 1996) may not attract women and visible minorities who rely on labour and human rights regulations to protect their rights and interests (e.g., pay equity and affirmative action legislation). Freedom to speak in misogynist terms or in a combatative style approximating computer games, as too often occurs in unmoderated forums online (e.g., Kendall, 2000), can especially discourage visible minorities and women. Today the culture of freedom on the Internet has largely been overtaken by commercial interests but the open source community has replaced it as the freedom frontier. This community has even lower female participation than computing in general, estimated at 1.5% in North America (Nafus, Leach & Krieger, 2006).

2.5 Gender in Education

Educational theorists have pointed out an underlying agenda of schooling to teach students dominant cultural values and fit them into the industrial economy (Bowles & Gintis, 1976; Giroux & Penna, 1983; McLaren, 1989). Walkerdine (1985) theorizes that students'

performance, or non-performance, in the prescribed elements of school helps slot them into a productive place in the economy by creating internal expectations about the type of work that 'suits' their abilities and roles. Further, middle-class schools inculcate notions of individual autonomy, choice and meritocracy (Fine & Weis, 2003) to ensure that students view their decisions around studies and work as their own free and unfettered choice. The notion that one might be a pawn in processes of social organization is not thought to create a happy or compliant workforce (Walkerdine, 1985). A recent U.S. study of how college students choose their disciplines and careers shows a discourse around 'individual choice' on the surface but underneath assumptions about gender roles greatly impact students' choices (Montgomery, 2004). Students in Montgomery's study expected females to sacrifice their own needs, desires, and autonomy for those of their family and children. This steers career choices of females towards ones that are seen to be compatible with these roles and expectations.

Dominant cultural systems, often hidden from view, confuse students from other classes and cultures in deciphering how they are to act, communicate, dress, network, and succeed at school (Delpit, 1988; Fine & Weis, 2003; Overall, 1998). Delpit documents the interest and success of visible minority students in post-secondary writing classes when they were taught the explicit dominant discourse patterns, interaction styles and language required in academia. Students acquired better the codes and rules for participation when taught them directly than when they were de-emphasized by teachers who were uncomfortable with accepting the reality that not all modes of communication are treated equally in academia. This denial of unequal status of language and experience and the 'bracketing' of difference can produce hierarchies and inter-group tensions (Fine, Weis & Powell, 1997, p. 250). As

Black feminist Lorde (1984) says, "certainly there are real differences between us of race, age, and sex. But it is not these differences between us that are separating us. It is rather our refusal to recognize these differences, and to examine the distortions which result from our misnaming them and their effects upon human behavior and expectation." (Lorde, 1984, p. 115). It has been discovered that students are most able to change their view of themselves and their worlds and relate best across differences when these differences are recognized, named, confronted, and explored (Mickelson & Smith, 1994; Fine, Weis & Powell, 1997).

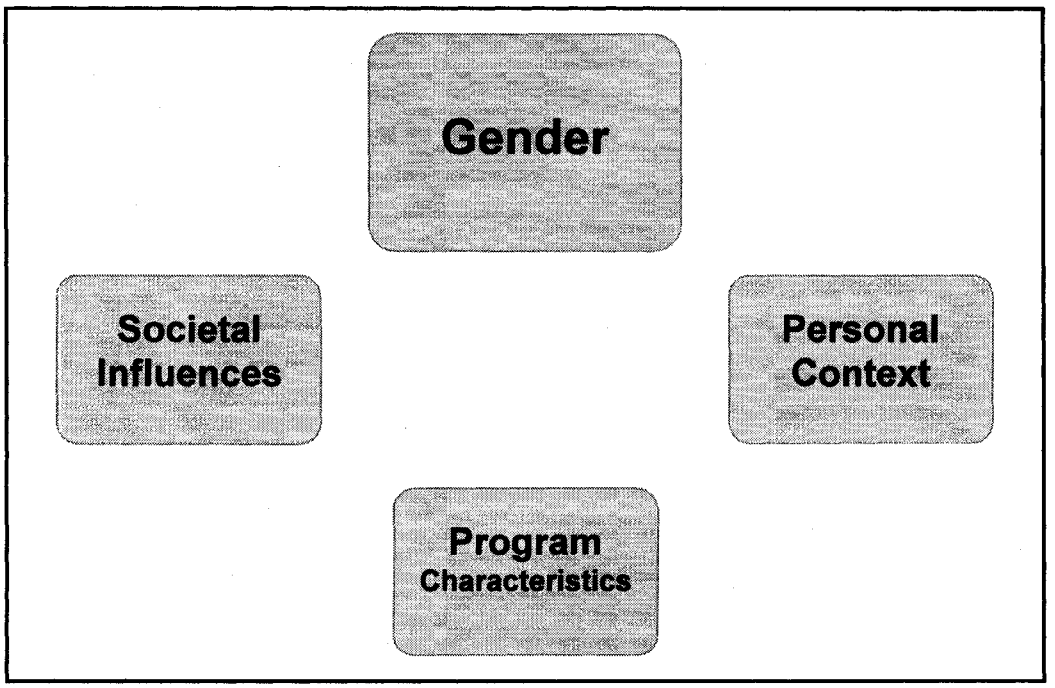
Educational institutions have sometimes been experienced as difficult places for students to further the process of identity negotiation given the documented silencing of difference within their walls (Fine & Weis, 2003). Often schools will not speak about systemic inequalities, drop-outs, drugs or violence in an attempt to not discourage students. They use pedagogical methods meant to soothe and smooth over their contradictions (Fine & Weis, 2003). This results in students' experiences, realities, and identities being denied and excluded from the public realm (Gilligan, 1993). Students become alienated from their own embodied knowledge, heritage, and lived experience. Girls especially lose their own viewpoints and take on the world view superimposed on them (Gilligan, 1993; Fine & Weis, 2003). Minority students take on a split identity (Williams, 1997) as they learn how to exist in the different cultural practices of school and home community. A complex understanding and negotiation of roles and issues is silenced. Students who are successful in this milieu are more depressed, less politically aware, more conformist, and less assertive than unsuccessful students (Fine & Weis, 2003). Anticipation of an inclement academic culture or 'chilly climate' and actual pedagogical problems encountered in school tend to hurt females, especially visible minority females, more than males in their participation in computer

studies programs (Frenkel, 1990). Pedagogical techniques such as valuing social support and organization in the classroom, and seeking knowledge through flexible problem solving and a collaborative advancement of explanations contribute to female engagement when using computers (Chen & McGrath, 2003; Hakkarainen & Palonen, 2002; Littleton & Bannet, 1999; Mayer-Smith, Pedretti & Woodrow, 2000).

2.6 Conceptual Framework

The literature reviewed here indicates that gender interacts with: i) societal influences such as an association of technology with masculinity in society; ii) characteristics of the program of study such as teaching methods, curriculum design, and mentoring; and iii) the personal context of students (e.g., race, experience with computers, family influences), to produce obstacles to female participation and academic progress in their postsecondary computing programs. Figure 2 shows the conceptual framework for the study.

Figure 2
Conceptual framework: Factors that influence participation of females in computer studies programs.



2.7 Chapter Summary

This chapter explored areas of influence on the attitudes and perceptions of female computer studies students about computing. Findings of previous studies that document declining female attraction to and persistence in computer studies in North America were examined. The literature on differences by gender in the introduction of young people to computers, approaches to computing, and in education and learning were reviewed. Studies of the social and cultural narratives and norms surrounding computing and computer studies programs were reported. This includes the impact of gender in technology development, the impact of different models of IT development by gender, and the influence of the discourse surrounding computing. Relevant literature on gender in education was presented. Finally, a conceptual framework for the study describes gender interacting with social influences, characteristics of the program of study, and students' personal contexts to produce obstacles to their participation and academic progress.

CHAPTER 3

METHODOLOGY

3.1 Chapter Overview

This chapter describes the research methods used to address the questions posed in this study. Previous studies of the declining participation of females in post secondary computer studies have used a variety of methodologies depending on the approach to the problem and the specific aspect of the problem under investigation. However, questionnaires, surveys and interviews are the dominant research methods employed in these studies. Studies of social inequity in education gravitate towards ethnographic methods, often participant observation. In this study interviews, supplemented with questionnaires, were chosen to explore the perceptions and experiences of participants. In addition, institutional data was examined for trends in female enrolment and success in the computer studies programs of participants. The research design and protocol for recruiting participants and administering the instruments is outlined in this chapter.

3.2 Research Methodology

3.2.1 Qualitative Methods

Individual interviews were selected in this study to provide a means for students to have a voice in as open and safe a forum as possible. This was the primary method used to gain an in-depth understanding of the perceptions of participants. A three part questionnaire was used to supplement findings of the interviews. The questionnaire was designed to investigate whether the reasons expressed by computer science students in U.S. universities for their

interest in computer science and their identification of obstacles to participation hold true for computer studies students in an Ontario college.

Feminist and post structural paradigms describe the tension between commonality and difference in the change in focus from universal, objective knowledge to a more particular, subjective view of experience. Common knowledge claims (say, an obstacle that is discouraging for *all* women for example) are rarely used in an unqualified fashion but can be useful to illuminate the ways in which patriarchy structures our lives. This study explores both plural and common realities, interpretations, and representations of the ways in which computer studies education at an Ontario college impacts female students. Experiences are considered by age and race but other differences may impact participants' perceptions and experiences in their programs. These differences include family responsibilities of participants raising children, the needs of participants whose families are overseas, and the different ways in which females choose to identify and cope while in a mostly male environment. In one case, a participant and her family were issued a 24 hour deportation notice a few months after her interview. Fear of deportation or other life situations unknown to the researcher may have had an impact on the views participants were willing to express, a limitation in any study of participants' perspectives.

Contemporary qualitative research methodology understands that "there is no clear window into the inner life of an individual. Any gaze is always filtered through the lenses of language, gender, social class, race, and ethnicity" (Denzin & Lincoln, 2003, p. 31). The researcher's beliefs and feelings, thought of as paradigms, interpretive structures (Razack, 1998) or generative themes (Friere, 1970) about the world, guide research questions and

methodology. Where once qualitative research tried to minimize and neutralize researcher bias, described by Thomas Nagel (1986) as 'the view from nowhere', the responsibility of the researcher now is to be reflexive about and center their social position, especially influences of race, class and gender, and to "integrate them creatively into both the process of observation and the production of a written representation of the fruits of the observation" (Agrosino & Mays de Pérez, 2003, p. 134). Harding (1993) comments that "strong objectivity requires that we investigate the relation between subject and object rather than deny the existence of, or seek unilateral control over this relationship" (1993, p. 152). The researcher's position in interviews as a white female and former teacher and administrator in participants' programs was considered in its influence on what and how participants expressed their experiences. Maintaining focus on students' opinions, following up on these opinions, and encouraging students to follow their own train of thought in interviews were techniques used to center the experiences of the student rather then the researcher in the research process. The possibility that participants might not wish to invalidate a study of obstacles by failing to identify any was taken into account by judging the intensity with which participants expressed their experience of obstacles. Comfortable answers were probed for explanations to back up what might appear to be responses expected or desired by the researcher. The impact of the researcher's proclivity to hear obstacles in participants' stories was offset by the use of questionnaire data to provide further information to complement the interpretations of narratives.

3.2.2 Interviews

Structured interviews invariably follow a stimulus-response format which has been criticized for manipulating participants by methods that attempt to increase the amount they are willing

to reveal. Interviewers traditionally tried to be seen as neutral by not revealing opinions or feelings (Denzin & Lincoln, 2003). To overcome this, contemporary methods create a more collaborative approach in which participants have some direction over the interviewing method and direction and there is a more reciprocal interaction. As Oakley says "there is no intimacy without reciprocity" (1981, p. 36). Contemporary interviewing sometimes includes revealing one's own experiences, thoughts and feelings as a method of minimizing distance, hierarchy, and the one-way interaction between researcher and participants (Fontana & Frey, 2003). This type of interaction frames the interview as a social encounter or "negotiated text" (Fontana & Frey, 2003, p. 90). The researcher in this study talked in interviews, where appropriate, about her own experiences as a female in a computer studies program in different circumstances, as well as experiences of colleagues that differed from her own. She made an effort to ensure that participants felt that all views were welcome, dissent was positive, and that they did not need to feel they must answer any question in which they weren't sure what they thought about the topic. This final tactic was designed to counteract the influence of testing and questioning in post-secondary classes which generally encourages students to answer every question whether they feel they have an answer or not.

Group interviews would have contributed to this study as they lessen the power and imposition of the ideas and language of the researcher as well as the direct interaction between participants and researcher. Group interviews might also have empowered participants as communal dialogue with like others validates and legitimates one's own experiences, allows people to see that their problems are not individual but structural and shared, and allows participants to build on each other's thoughts and ideas. "Social empowerment enables people to speak and speaking empowers" (Benmayor, 1991, p. 159).

Some large studies of declining female participation in computing have used focus groups (e.g., Cohoon, 2001). However, there was a sense expressed by faculty members in the program, and backed up by the testimony of the pre-test participants, that female students in their isolated position in their programs tend to self censor in group discussions. Given this sense, along with possible pressure to 'fit' with the only other females in the program, individual interviews were chosen as a safer space for many female students to present and explore their concerns, observations and beliefs.

Interview questions in this study were designed to provide insight into the four research questions. Appendix A maps each question in the interview script and on the questionnaire to a topic that was identified in the literature review as a potential contributor to the issue addressed by each research question. Interview questions were divided into two parts scheduled for 20 to 30 minutes each with a break in between. Appendix B contains Part I of the interview guide, *Experience of the Computer Studies Program.* This part of the interview delves into the reasons participants were attracted to computing, how computers were viewed in their homes and schools growing up, and how they tend to use a computer. Participants were asked to describe their most and least favourite class to explore their preferred teaching and learning environment. Their experience working alone and in groups in their program, and their experience of how difference is addressed in their classes was examined. Finally, Part I examines participants' view of their curriculum, including its breadth, the relevance of their studies, and the nature of their profession. Appendix C contains Part II of the interview guide, *Reflections on Computer Programming and your Future in IT.* This part of the interview explores participants' experience of their fit as females in their programs and profession, and their strengths, preferred type of job, and support systems. Participants were

asked to imagine what they would like technology to be able to do, an exploration of their desires for computing. Participants were invited to discuss why they thought there were so few women in computing, and how they think their programs would change if there were more females, questions designed to elicit their view of gender differences and obstacles to female participation and progress in their programs. Interviews were audio taped and later transcribed for data analysis.

3.2.3 Questionnaires

Questionnaires were chosen to reduce both the impact of the researcher's social position and the interaction between researcher and participant on some of the data gathered (Berdie and Anderson, 1974). Questions explored whether the results of the studies presented in the literature review apply for participants in their programs at an Ontario college. Questions gathered information and expanded on findings of previous U.S. studies. Participants were familiar with questionnaires as they fill them out each semester in evaluation of their courses, faculty and college. As the researcher was present while the questionnaire was administered, there was strong motivation to complete the questionnaire, and opportunity to clarify questions. The questionnaire was divided into three parts and administered at the beginning of the interview, after Part I of the interview, and at the end of the interview respectively. Questions on the questionnaire explored topics covered in the interview. Parts II and III of the questionnaire followed up on topics explored in previous interview questions. This order of gathering data was used to ensure that ideas brought up by participants in the interview were not influenced by suggestions of the findings of previous studies contained in the questionnaire.

Each part of the questionnaire took 5 to 10 minutes to complete. Appendix D contains Part I of the questionnaire entitled *Your Computing Background.* This part gathers information on participants' access to and time spent on a computer along with previous computer courses taken and a self-assessment of their skills. It was intended to help participants gain confidence in their knowledge and ability to answer the questions of the research session. Appendix E contains Part II of the questionnaire, administered after the first half of the interview, entitled *Your Experience in the Computer Studies Program.* This part follows up on participants' experiences in their programs reported in the interview so far by having them rate the importance to themselves of a variety of factors identified in previous research studies that female computer studies students found encouraging, discouraging, or supportive. Appendix F contains Part III of the questionnaire, administered at the end of the interview, entitled *Views on your Program, Discipline and Future Career.* This part of the questionnaire concluded the research session by requesting demographic information of participants (age and visible minority status), having participants rate their interest in different types of IT work, and asking participants whether they agreed or disagreed with statements depicting different perspectives and approaches to computing and different learning preferences. Appendix G contains the script for the research sessions which describes the order and timing of the three parts of the questionnaire and interview questions.

3.2.4 Institutional Data

Summative longitudinal data about students in participants' computer studies programs was examined to document the extent of decline in female participation, and to verify the observations raised by participants in interviews. In particular, data around the academic progress and curricular interests of male and female students in the participants' programs

was analyzed. Summative enrolment, grade, and transcript data that indicated the status of students' academic progress and choice of specialization within their program was examined by gender to establish patterns for all students in these computer studies programs.

3.3 Research Design

The research protocol was approved by the Social Science and Humanities Research Ethics Board of the University of Toronto and the Research Ethics Board of Seneca College in April 2005.

3.3.1 Participants

A two and three-year computer programming diploma program, and a four-year applied degree program in software development at a large Ontario college were selected from which to recruit participants. They were viewed as the college programs most similar to university computer science programs in admission criteria (with reduced emphasis on mathematics), curriculum, types of jobs attained by graduates, attrition rates, and declining female enrolment. While college programs are not computer science programs, a shared focus on software development was seen as necessary in order for the body of knowledge generated around barriers and obstacles for computer science students to be relevant and useful to this study.

There were 450 students in the upper years of the selected programs at the Ontario college in the 2004/5 academic year (193 in year 2 and 257 in year 3), 65 of whom were female. Students in the upper years of the programs were chosen in order to maximize the length of experience in the programs on which they could report. All female students in these cohorts

were invited to participate in a research session in which their experiences as female students in a computer studies program would be explored.

The research procedures and instruments were pre-tested on two female first year students in a computer studies program. Following the pretest, three questions on Part II of the Questionnaire were reworded to improve clarity. One question was removed from Part I of the interview regarding how emotions are displayed in class. This was due to the incredulous response from both students pre-tested that no one *ever* shows emotion in class, and the sense of the researcher that the interview lost credibility with the question. Two questions were removed from the Part II of the interview regarding ethics in computer studies and bias in computer systems as it was evident the pre-tested students had not been exposed to the terminology and concepts intended in this question.

3.3.2 Recruitment

The Chair responsible for computer studies programs sent an email to the college email addresses of the 65 female students in the upper years of the computer studies programs. Students were informed of the purpose, risks, and benefits of the study, and they were invited to participate in an interview to be scheduled on campus at their convenience. Students who wished to participate were asked to respond to the researcher by email to set up a time to conduct a research session on campus. See Appendix H for the invitation to participate in a research session. As only six students volunteered, possibly given the proximity of the invitation to the end of the semester when student workload increases, faculty members in second and third year courses were encouraged to announce the study and its benefits in their classes. See Appendix I for the in-class announcement. A second email request for

participation was sent out by the Chair to all female students in the upper years of the computer studies programs who did not respond to the previous email. See Appendix J for the follow-up invitation to participate. Most participants reported they received direct encouragement to contribute to the study from one of their professors.

At the start of the interview the researcher went over the contents of the consent form with the participating student. The consent form (see Appendix K) informed the student that their participation in this study was voluntary and would not affect their treatment or grades in their studies. It also said that a participant could choose to not answer any question they did not wish to answer and could withdraw their consent to participate without penalty or explanation at any time during the research session. Once the student indicated she understood the contents of the consent form and agreed to participate, she signed the consent form and the interview began. Students' participation in the study was not known by anyone except the researcher so there was little chance of any perception of coercion to participate. Participants sometimes expressed negative opinions about their program or faculty during an interview. However, the nature of the questions in this study left little scope for divisive or incriminating responses by participants. Their identities and comments were known only to the researcher. Participants were assured that their words used in research publications would not identify them. This ensured there was minimal real or perceived risk that participants' treatment in their studies would be influenced by their responses to questions in the study. Participants were not identified by name, student number or by unique personal characteristics in any documentation of the study or reports of its findings. Students who participated in an interview were assigned a coded identifier in all notes and data recording. Interviews were audio recorded upon participants' consent and tapes will be destroyed upon

completion of the study. Participants received a small college memorabilia worth less than $15 for their participation.

The researcher is a former faculty member, Chair, and Dean responsible for the participants' programs. However, the researcher was on sabbatical for 18 months prior to the start of this study. There was no direct involvement in academic matters with any students who were invited to participate in this study nor is it anticipated there will be in the future.

3.4 Chapter Summary

Questionnaires, interviews, and an examination of institutional enrolment and transcript data were used to study obstacles to participation for a sample of female students in computer studies programs at an Ontario college. Individual interviews with female participants explored their perspectives and experiences in detail. A questionnaire was designed to supplement the interview data and examine whether obstacles identified in previous studies were experienced by participants. Institutional data documented trends in enrolment, choice of studies, and success in computer studies programs by gender.

CHAPTER 4

DATA ANALYSIS

4.1 Chapter Overview

This chapter reports on the analysis of the data from interviews and questionnaires with 15 female computer studies students, along with summative institutional enrolment and transcript data for all students in participants' programs, to identify and explore obstacles to the academic progress of females in computer studies programs. Transcriptions of interviews were analyzed and codes assigned for each observation expressed in the interview. The frequency of coded responses expressed by participants was noted. Frequencies for questionnaire responses were also accumulated. Both sets of data are reported by participant categories of age and race, and differences in responses by participants in these demographic categories are described. Institutional enrolment and transcript data was examined by gender to ascertain whether patterns found in previous studies existed for participants in this study, and to provide further information around themes arising from the interview and questionnaire data. Finally, personas, drawn from a composite of participants' experiences, were created to illustrate how the themes that emerged in the findings are played out, often in different ways in the lives of participants of differing age and race.

4.2 Methods of Data Analysis

Data from interviews with all participants was transcribed by the researcher then coded using Atlas.ti software to identify and group similar experiences, issues, perceptions and observations described by participants. The researcher examined the codes for similarities and differences, merging some where similar sentiments were expressed and separating those codes in which differences in meaning appeared to exist. Frequencies of coded responses

were recorded and accumulated. Appendix L reports the number of times each participant gave each specific coded response, along with the number of participants who gave this response at least once and the total number of times the response was given throughout the interviews. Codes for which at least five participants expressed the concept, or four participants expressed the concept many times, are highlighted in the appendix and reported in this chapter. To support theoretical sensitivity, codes and later themes that supported findings of previous studies or expectations of the researcher were examined for alternate interpretations of the participants' responses before the code was assigned. Interview transcripts were reexamined for responses that might refute the interpreted meaning of the response. Contradictory responses were coded and analyzed. The questionnaire data provided evidence that shed more light on the interpretation of interview data by the researcher.

Data from questionnaires completed by participants was compiled and gave a more detailed examination of participants' perspectives as it probed specific experiences and views of computing. Frequencies of questionnaire responses are found in Appendix M. Responses that were used to supplement the interview data are highlighted in the appendix and reported in this chapter. These findings were compared to those of previous studies and similarities and differences are reported throughout this chapter. Some differences by age and race not discovered by the researcher in interviews became apparent in the analysis of questionnaire data. For example, differences by race in the perception of which skills are important for success in the IT profession and differences by age in the impact of negative stereotypes of computer programmers went unnoticed in interviews but were revealed in the questionnaire data cumulated by age and race.

The importance assigned to coded observations in interview responses was determined primarily by the number of different participants who made similar observations. The intensity with which the experience was described (including the number of times it was raised by a participant), and the sophistication of insight were also considered in assessing importance. The questionnaire data and coded responses in interviews were also tabulated by age and race and examined for insight into the role of age and race in participants' experience of obstacles. For example, in interviews three participants raised the notion that women and men are treated equally in the program while three other participants illustrated how they were treated inequitably as females in computer studies. Given that only 6 of 15 participants raised these issues, this did not appear to be of importance to the researcher until the responses were grouped by race. All three participants who reported equal treatment were from the white group and all three who reported unequal treatment were from the visible minor. The questionnaire data was then examined for more information on this issue. It supported the tendency for a difference in this perspective for participants in different racial groups. This example also demonstrates the potential for the existence of an intervening variable, such as socioeconomic status, that might be associated with membership in an age or race group and correlate to a particular experience or response. See Appendix L (ii) for interview data compiled by age and race and Appendix M (ii) and (iii) for corresponding questionnaire data.

Interview data was organized initially in the order that the responses arose in each section of the interview. Each section pertained to a research question. Frequency of codes is reported in this order in Appendix L (i). To support the use of creativity in determining themes that might arise across the categories of questions posed in the interview (Strauss & Corbin,

1990), recordings of interviews were rewound and reviewed for patterns of responses that suggested themes. Interview and questionnaire data was reexamined for how these themes played out in the lives and studies of participants, and in their strategies to cope with marginalization. In addition, the mode and intensity of expression in interview recordings was examined for meaning. Codes were regrouped where they seemed to relate to the same emergent theme or phenomena. For example, participants expressed an interest in balance in their lives in many different ways: not wanting to spend all of their time at school or on a computer, enjoying both group and independent work, and interest in a wide variety of courses and careers in the IT profession. Codes relating to these experiences were grouped under a theme of "participants' desire for balance". Themes emerged as follows:

1. Breadth of participants' interests and strengths.
2. Role of mentors and role models in participants' success.
3. Participants' perceived computing inferiority.
4. Time required for computing and not available to participants.
5. Participants' desire for balance.
6. Discouraging image of computing/computer professionals.
7. Participants' desire for active learning.
8. Participants struggle in first year programming courses.

See Appendix L (iii) for codes regrouped into these themes.

Institutional data on students' success in early semester programming courses and choices of upper year 'specialization' was examined to provide further insight into participants' struggles in first year programming courses (themes 1 and 8) and the breadth of participants'

interests and strengths. The nature of themes 2 through 7 does not lend itself to possible further insight from institutional data.

Enrolment data in each fall semester from 1995 to 2006 was used to examine trends in female participation. Transcript data for each academic semester from 2003 to 2006 was used to calculate the number of students by gender who chose different specialization of studies, the percentage who passed their first and second semester programming courses, and the percentage who were placed on probation or removed from their program due to low academic standing. Choice of specialization and decisions on academic progress are recorded with specific comment numbers on students' transcripts. The number of students by gender who chose to withdraw from their programs on their own accord was also recorded. Retention by gender from 2003 to 2006 was calculated as the percentage of students in the first semester of their program in each fall semester who continued into second semester of their program in the subsequent winter term.

In each theme different elements of the conceptual framework combine to produce obstacles for participants. For example, the program characteristic that requires students in early semesters to spend a large amount of time independently practicing programming clashed with the personal context of participants whose gendered family role placed demands on their time, and combined with societal messages that computing is isolated work, to discourage participants early in their studies. The findings of the study are described below as combinations of the factors that impact the progress of participants: gender, societal influences, program characteristics, and personal context.

4.3 Findings

Fifteen female students enrolled in computer studies degree and diploma programs in an Ontario College with different ages, ethnicities and histories participated in the study. Ten participants were in the younger group (18 to 23 years old) while five made up the older group (28 to 39 years old). Nine participants identified as visible minority while six did not. The average age of both visible minority and white participants was 26. The participants appeared in general to be socially comfortable, capable, hard-working and responsible. They tended to express self-reliance and a desire to be in control of their worlds. These traits may be related to the participants' self-selection for programs in which they will be in the minority by at least gender and possibly self-selection for this study as well. These traits may also contribute to their persistence in their programs.

Although findings cannot be generalized given the small number of participants and their location in one college, participants provided many interesting insights into specific problems which the College could address to support increased female participation in their programs. Some of the insights were general in nature and could form the basis of further study.

4.3.1 Decreasing Participation of Females

While previous studies document a decline in female participation in computer science programs in Universities in the U.S. in the late 1980s and early 1990s, female participation in the programs in the institution where this study was conducted rose to a peak in 1998/1999 and has declined steadily at a greater rate than male participation in each year since (see Table 1). Total enrolment in these programs has declined for most of the past decade; enrolment in 2006 was only 28% of the enrolment in 1998/1999. Furthermore, females made

up only 14% of the 2006 enrolment, down from 35% of the enrolment eight years earlier. See Appendix N (i) for complete enrolment data.

Table 1
Fall semester enrolment from 1995 to 2006 in participants' computer studies programs.

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Program Enrolment	1110	1091	1276	1464	1823	1951	1982	1227	1281	884	646	562
Female Enrolment	315	330	418	514	632	644	596	426	266	149	95	81
Female Participation	**31.2%**	**30.2%**	**32.8%**	**35.1%**	**34.7%**	**33%**	**30.1%**	**25.8%**	**20.8%**	**16.9%**	**14.7%**	**14.4%**

The sharp decline in female participation in the programs of participants starting in 2000 parallels a similar decline in interest in computer science majors displayed by U.S. University students starting in 2000 (see Figure 1, page 2). These trends occurred at the same time as the 'dot com bust' and well publicized decline in jobs in the IT sector in North America since 2000, particularly computer programming jobs (Sargeant, 2004; U.S GAO, 2006).

4.3.2 Societal Obstacles to Participation

There was a sense expressed by participants that computers in society are viewed as *'a guy thing'*, and that this was discouraging for females in considering and persisting in studies and a career in computing. As one participant said: *"The media plays a huge part in what girls think about going into the programming field. People relate technical things with being for men ... By the time females are at college level they have already been bombarded by so many things that say that this is a male profession."* This was expressed more strongly by younger participants (ages 18 to 23). Gaming was felt to contribute to this gendered view of computing: *"In high school the guys are always gaming so they like and take the computer*

courses. Some people associate computers with males. The types of games need to change for girls to take part." Some participants experienced this gendered view of technology in incidents at school in which they felt other students didn't take their ideas seriously and didn't think they were as good at computing as males until they proved themselves. In one participant's words, *"Guys think girls aren't as good at computers. My systems project teammates wouldn't listen to my suggestion then later the teacher said that I was right. They think girls don't know."* There was a sense expressed by some participants that society viewed males as more logical and more suited to technology than females. This is consistent with previous findings of lower levels of confidence in computing ability expressed by female students (e.g., Cohoon, 2006), and the gendered impact of computer games (e.g., Cooper, Hall & Huff, 1990).

Another societal obstacle participants had to deal with was traditional gender roles in society, especially female roles within families, which reduced the amount of time participants had to practice on computers. Seven participants raised this issue on 13 occasions when asked about obstacles for females in computer studies. One participant describes this below: *"Men practice more because they were raised with it and have had time since high school to work on computers. No one expected anything of them so they had the opportunity to practice more. The nature of women is they take responsibility and take care of others so they don't have time. Men have time."* But even if participants had more time, most did not wish to spend it on a computer where they worked an average of 7 ½ hours per week (three wished to spend less time on a computer, three wanted more time, and nine felt their current amount of time was just right). Unlike participants in previous studies (e.g., Cohoon, 2001) computer access does not appear to be a limitation for participants in this study (all reported having

access *'whenever they needed it'*). It may be lack of interest in spending a great deal of time on a computer as much as gender roles that limit the computing practice time of participants.

The female role of caregiver in society, with the accompanying expectation that others' needs will supercede their own, may result in the limited amount of time participants felt females can afford to spend on a computer. Consequently perhaps, when asked to imagine what they would like computers to be able to do in the future, half of the participants replied *"do my housekeeping"* or a similar response such as provide shopping lists, cook dinner, do the banking, and monitor the children. They imagined help with daily life and household chores - as one participant put it, *'useful inventions'*. Participants suggested that their computer studies program did not build on this sort of practical interest in computing, especially in the early years, an obstacle to their persistence. This may be especially true for visible minority participants as this issue arose mostly from this group.

Other than creating a robot to do their household chores, the most common interest in computing expressed by participants was to help people. This appears to be similar to the desire expressed by female students in previous studies to practice 'computing for a purpose' (Margolis & Fisher, 2002). For example, in the questionnaire all participants indicated medium to high interest in *'designing software with which people communicate and collaborate'* and 14 of the 15 participants indicated interest in *'designing software for people with disabilities'*. Most participants also placed a high importance on users' needs in software development. These perspectives were expressed most strongly by older participants. Further, participants felt that this interest in using computers to help other people and in household work was not reflected in the way careers in computing are portrayed in society.

This finding is consistent with the dominant models of IT development described by Franklin (1990) and Denning (2001) in which technology is developed without motivation for or incorporating how and by whom it will be used. It is also consistent with the suggestion of Cukier (2002) that these models negatively impact female participation.

Another obstacle identified by participants was society's view of their work *'in a dark room writing code all night'*, an unattractive prospect to them. Female students in previous studies also expressed the perception that computing professionals have isolated jobs (Durndell & Thomson, 1997; Margolis & Fisher, 2002). A pattern of responses around attraction to computing emerged indicating that participants' interest in computing is broader than societal perception of computing. Five participants said they were attracted to IT because of the broad range of careers available to them. While participants did not generally find their program narrow and inflexible as did female students in other studies (Margolis & Fisher, 2002), nine participants had taken or wanted to take courses from different fields. They appeared to find ways to get the breadth they desired. This is consistent with findings of previous studies which found a narrow view of computing to be an obstacle for female students (e.g., Cohoon, 2001; Margolis & Fisher, 2002).

Participants desired a balance in life in terms of hours spent on a computer, alone versus social time and interests, and technical versus non technical studies. In their words: *"And I want a balance, not just work – to go out with friends etc. I'm outgoing."*, and *"I like programming but would really love a network administration position – work and social interaction ... I hope for a bit of both worlds."* This desire for balance is similar to the finding

of previous studies (e.g., Margolis & Fisher, 2002) that female students were discouraged by the perceived '24/7' workload of IT professionals.

Societal perception that programming does not include social interaction, along with participants' experience in their program with male peers who they feel do not like to socially interact, appear to be obstacles in their progress in computer studies. When asked *'In what areas of the program, if any, do you feel you are stronger than your classmates and in what areas, if any, do you feel you are weaker?'*, participants expressed a sense that they, and other females, are often better at and value social and communication skills more than males. As one participant noted: *"[I like] systems. I like the business aspect. I don't enjoy programming, sitting in front of a computer for hours, not engaged. I like to relate to people and talk to them. I like teamwork and collaborating. I excelled most at database courses."* Negative 'geek' images of computer professionals with no desire for social interaction were found to be obstacles to female participation in previous studies (e.g., Margolis & Fisher, 2002). This was also expressed by participants in this study and seemed to have a greater impact on the younger participants as all five of the participants who disagreed on the questionnaire that *'Software developers usually can easily get a date'* were members of the younger group. Further, more of the white participants (5 of 6) felt that communication and social skills were important for successful IT professionals (compared to 1 of the 9 visible minority participants). More white participants (4 of 6) raised the issue that their male classmates had poor social skills than visible minority participants (1 of 9). These findings are consistent with the 'hardcore' images of computer professionals during the 'dot com boom' in the late 1990s living in hotels and working around the clock in isolated cubicles. It

is also consistent with the received model described by Denning (2001) in which IT development is isolated from users and use.

A final societal obstacle identified by participants was the decline in the IT job market. When asked '*why do you think there are so few female students in your program?*' almost half (7) of the participants said that the availability of jobs was an important factor in their attraction to the program and in the retention of themselves and other females in the program. In the estimation of one student, *"girls are more interested in finding a job with programming and guys are more interested in how programs are made so they'll try to make their own (job)."* The downturn in jobs available in IT professions, especially programming which fell 14% annually from 2000 to 2002 in the U.S. (Sargeant, 2004) may have had a greater impact on overall female enrolment than male. One student alluded to this when she said, *"Females started when the job market was ok but then when it dropped, well they chose the program to get a job and make good money and they're pretty smart and want to get skills. They want a more secure job market and just want a practical job so they drop out."* This is consistent with the decline in participation of females found in participants' programs following the 'dot com bust'. It is also consistent with the findings of Margolis and Fisher (2002) that males tend to be interested in technology for technology's sake. A decline in job prospects may have less impact on those who are intrinsically interested in and motivated by technology.

Further, this employment driven motivation to study computer programming was more pronounced in the visible minority group than the white group, a group with potentially a greater need or motivation to be able to secure a job following graduation. It is interesting to

note that studies in the U.S. found that male students were motivated more often by the state of the job market than female students when choosing a college program (e.g., Montgomery, 2004).

4.3.3 Program Obstacles to Progress

One of the strongest themes throughout interviews was the inability of the program, especially in early semesters, to support the needs of participants who did not have strong IT backgrounds. This contributed to participants' struggle in early computer programming classes, particularly older participants (ages 28 to 39) and visible minority participants, both of whom expressed concern about their lack of computing background and felt a need to catch up to their classmates with better computer knowledge. Participants attributed their early struggles to several factors. Ten of the 15 participants raised the notion that males know more than females, or people perceive they know more, about computers and computer programming. This may be related to the participants' relative lack of IT background (nine participants reported they had not taken any relevant computer studies courses prior to entering their program). This supports the findings of previous studies that women tend to become interested in computing later than men and with less computer background (Cohoon, 2001; Hanson, 1996). Previous studies have found that pre-college computing courses increase chances of success in post secondary computer studies (Katz, Aronis, Allbritton, Wilson & Soffa, 2003).

Participants, especially older participants, often felt they had to *'catch up'* to the male students and gain confidence in their IT knowledge and *'feel like I can do it'*. Nine participants raised the issue that they felt they knew less about computer terminology than

their male classmates. In the words of one, *"Guys read all the computer magazines so know things like CPU speed etc. but the girls don't so the gened [general education] teachers could teach this. We would get more confidence."* Participants noted the status gained by male classmates with their peers when they could talk about some new computer device or capability. A lack of IT background and lack of time participants profess to spend on computers appear to contribute to a lack of confidence in their computing abilities and a feeling they are less advanced than their classmates, reservations about abilities expressed by female students in previous studies (Cohoon, 2001; Frenkel, 1990; Margolis & Fisher, 2002; Seymour, 1999).

Further, participants felt that some teachers expect students to have a strong background in IT. When responding to the interview question, *'Think of one of your favourite classes. Can you describe the teaching style and classroom environment in this class? Can you say why these teaching methods work well for you?'* a common theme that arose in response was how important it was for teachers to explain the basic concepts of computing. This may be related to their description of computer programming classes as intense, fast moving courses in which each concept depends on earlier or basic concepts that, if missed, do not allow one to proceed in learning. Participants also noted that textbooks in computer programming classes were often used as references requiring students to learn to find information on topics on their own. We do not know if these views are shared by male students.

Another program obstacle for participants was the tough first year computer programming courses that acted as gatekeepers to advancement in their studies. Participants' relationship to computer programming seemed lukewarm. While most participants said they programmed

for fun only occasionally, 11 participants showed an interest in programming as they agreed in the questionnaire that they *'like to experiment with each new programming language that comes along'*. Unlike their perception of their male classmates' intense interest in computer programming, most participants gravitated towards IT work that included, but was not exclusively, computer programming work. Even though they were enrolled in software development and computer programming programs, 13 of 15 participants indicated other areas of IT as their main area of interest and hope for future career. They mentioned database development and administration, systems analysis, Internet and web design and development, and IT management as future career choices. They often expressed interest, and felt females in general are stronger, in databases, graphics, systems analysis, and business courses.

Table 2 shows the 'specialist designations' chosen by students in the third year of their computer studies diploma program from 2003 to 2006. This data indicates that females are more than twice as likely to choose the database developer specialization as males and less likely to choose the programming-intensive software developer specialization. While specializations in systems analysis, business, or graphic design do not exist in their program, web design and development is present along with programming in the Java Internet Developer specialization, a designation favoured approximately equally by male and female students. These specialization preferences seem to support participants' observations around the differing curricular interests of males and females in their programs. See Appendix N (iii) for complete data on specializations.

Table 2
Specialist designations of graduating students from 2003/4 to 2005/6 in participants' programs.

2003/4 – 2005/6	Students Graduating	Database Developer	Java Internet Developer (started in 2004)	Software Developer
Females	300	67	13 (of 158)	18
Males	1348	121	72 (of 967)	142
Females choosing specialization		**22.3%**	**8.2%**	**6%**
Males choosing specialization		**9%**	**7.4%**	**10.5%**

Another obstacle for participants in their first year of studies was the amount of individual work (or practice) done alone on a computer. A pattern that emerged when participants described computer programming was the sense that it is an individual activity that must be done on one's own. Almost all of the participants (13 of 15) felt that *'knowing how to work independently'* is an important factor in their success in the program and agreed with the statement that *'software developers often prefer to work on their own'*. Some observed that male students are better at and prefer working on their own. As one student describes it:

> *"Males tend to find their own answers such as by searching the Internet. Females help each other and ask questions to get the answers. When I ask the boys how their assignment is going they say 'yes, it's almost done. I just need to do a little more research'. So they either give up or solve problems on their own. I don't know if it's pride or something. Whereas girls say 'no, I've got this problem' and discuss it or talk to faculty or friends about it."*

Further, more than half of the participants indicated a preference for working in groups at school rather than on their own (although they also indicated that they tend to take responsibility for more than their share of the work in groups and often are expected to

organize and coordinate the group's work, a reenactment perhaps of the gendered caregiver role). Older and visible minority participants tended to most often express role conflict and a sense of isolation, as found in previous studies (Thomas, 2001; Tinto, 1993). However by the upper years of their program, they reported that teamwork was prevalent in their systems and database classes.

Participants tended to describe programming as a very stressful activity. They often described how first year programming courses put a high emphasis on getting a program to work, contributing to this participant's sense of programming:

> *"Everybody likes computers but many quit after first semester. The reason is just the stress that programming brings. Maybe the nature of women is just not a match for it ... IPC [1st semester programming course] is too complicated for the initial programming course – too much stress."*

An examination of institutional data around student success in the programs of participants from 2003 to 2006 showed that a slightly lower percentage of females passed their first semester programming course than males but a slightly higher percentage of females passed their second semester programming course than males, both considered to be program 'weeding out' courses (see Table 3). Females were less likely to be removed from their program or placed on probation due to low academic standing (see Table 4). However, there is a consistent pattern from 2003 to 2006 of lower retention rates for female students. Table 5 shows the retention data after first semester from 2003/4 to 2005/6. See Appendix N (ii) for complete data on student success.

Table 3
Total computer studies students passing the 1st year computer programming courses from 2003/4 to 2005/6.

2003/4 – 2005/6	1st Semester Programming Course			2nd Semester Programming Course		
	Enrolled	Passed	Pass Rate	Enrolled	Passed	Pass Rate
Females	263	121	46.0%	244	119	48.8%
Males	1358	707	52.1%	1185	555	46.8%

Table 4
Total computer studies students removed from their program or placed on probation due to low academic standing from 2003/4 to 2005/6.

2003/4 – 2005/6	Total Enrolment	Removed from Program		On Probation	
Females	1226	16	1.3%	119	9.7%
Males	5765	109	1.9%	961	16.7%

Table 5
Retention of first year computer studies students from 1st semester in the fall to 2nd semester in the winter from 2003/4 to 2005/6.

	2003/4			2004/5			2005/6		
	Enrolled	Progressed	Retention	Enrolled	Progressed	Retention	Enrolled	Progressed	Retention
Females	73	32	43.8%	39	18	46.2%	36	12	33.3%
Males	268	170	63.4%	177	117	66.1%	152	102	67.1%

These findings are consistent with the 'imposter syndrome' of some females (Clance & Imes, 1978) and the feeling of female students in previous studies that they weren't as good at computing as males even though their academic progress was equivalent to their male peers (e.g., Irani, 2004).

The final program obstacle for participants in this study was the way different student interests, abilities and needs were handled in their programs. Very few participants (3 of 15) agreed in the questionnaire that *'things that are important to me in my everyday life often come up and are discussed in classes'*. Most social and interpersonal issues appear to be avoided in classes as all participants felt that differences of any sort were not generally (and usually ever) discussed at school. This remained true even though they were often the only female in their classes, a very visible indicator of their difference. While participants' male classmates may also have felt that things that are important to them are not discussed in their program, previous studies found that lack of naming and negotiating students' differences in classes had a particularly strong impact on the participation of students who are in the minority in their classes (e.g., Fine & Weis, 2003).

4.3.4 Factors that Mitigate the Impact of Obstacles

When choosing a program of study it appears that role models who can dispel stereotypes about the type of work and people in the IT professions were crucial to the involvement of participants in computer studies programs. In response to the question *'Can you tell me why you decided to study in this program?"* 11 of the 15 participants said they have at least one close family member (or in the case of an international student, their sponsor) who works in the IT profession. All reported that this had an impact on their choice of studies. Participants often said that they were encouraged to study IT by these family members. According to one, *"Both of my uncles are in IT and I looked up to them and they encouraged me."* And another: *"My aunt and uncles and at that time my fiancé were in computers. My aunt was making quite a lot of money because she graduated from Waterloo and was working for State Farm and she said it wasn't bad for females ..."*. This is consistent with the findings of

previous studies that parental support for females choosing computer studies programs and careers was an important influence in their choice (e.g., Meszaros, Laughlin, Creamer & Lee, 2006). Participants also expressed a need for more female teachers or other mentors and role models in the program with whom they could identify and from whom they could get support in finding a job in a male dominated industry. *"So we need females to do computers to show society that females can do computers. In my country females are not even human. Females don't study because they don't know they can – they must realize their potential."* And *"It [the program] would be better with more female faculty members. They relate to girls and we can ask them what industry is like."* This desire for mentors and role models was similarly expressed by female students in previous studies (Cohoon, 2002; Hornig, 1984; Margolis & Fisher, 2002).

Classroom environments that lessened the isolation of participants early in their studies appeared to support their participation, and especially the participation of those from the visible minority group. Almost half of the participants, most of whom were visible minority students, described a sense of isolation in their studies. Seven participants indicated that they have fewer friends than male classmates in the program and therefore have less support in their studies. One student expressed gratitude for the class scheduling that allowed first semester students to take all of their classes with the same classmates so she could get to know others.

Another factor that mitigated the impact of obstacles for participants was teaching methods that included plenty of encouragement and interaction, as well as an organized, structured, presentation of material. The teaching method indicated most often by participants as

important to their success was interaction in the classroom among faculty and students and the involvement of students in classroom lessons (10 participants raised this issue in interviews). *"I like interaction between teacher and student – asking questions and getting responses not just talk. That makes the students challenged and [they] listen and focus because he or she will know they are going to be asked."* Interaction and socially supported learning environments are described by findings of previous studies as 'girl-friendly' pedagogy (e.g., Lather, 1991; Littleton & Bannet, 1999; Mayer-Smith, Pedretti & Woodrow, 2000). These teaching methods may support students who feel isolated in their classes and counter silence on difference by allowing students to bring their own particular experiences and interests into the teaching and learning environment. They also build on participants' described strength in social skills and allow them to express their identity in a social environment, a need expressed most often by younger participants. However, preference for these teaching methods in the programs of participants may not be held only by females.

There seemed to be an overall appreciation by participants for faculty who presented programming in an organized way with support for planning out an approach to a problem. They felt their male classmates often took a different approach to programming. Seven of the 10 participants who answered the question *'Do you feel there is a difference in how males and females tend to approach computer programming?'* felt there was a difference. Four participants described this difference as one of planning versus a 'dive in and code' approach:

> *"The males students just jump right in and they're just doing what's in front of them and it's only when they're finished that they look and say 'oh. I missed something'. I now have to go back and recode, I didn't consider this. But*

women think 'ok, what are all the things I need to get started?' and 'how should I lay this out?' They do all the thinking about it first then start coding after that."

Participants who reported they had support for this planned approach to computer programming indicated that it helped them in early programming courses.

Teaching methods that appeared to mitigate participants' general lack of IT background were ones that supported them in learning basic concepts:

"My C course with D. F. was my favourite class. I had no prior knowledge of programming and he started at the basics. He allowed everyone to follow but he wasn't slow. He used examples and related it to us. I don't participate in class in many courses – it's intimidating since I don't have the background but in that class I always participated."

One participant raised this issue of teaching the fundamental introductory IT concepts on five different occasions in an interview. Again, students of both genders may prefer this teaching method.

4.3.5 Factors not Experienced as Obstacles

Female computer students in previous studies (Cohoon, 2001; Margolis & Fisher, 2002) expressed an interest in learning through hands-on applications and in experiencing a wide breadth of 'real-life' computer applications that allow them to keep their options open. The findings of this study supported these interests, with 'doing' in class raised by six participants as important to their learning, and the commonly expressed interest of participants in the breadth of possible computer applications and career possibilities. However, these did not

appear to be obstacles as participants generally thought their programs support these interests as they felt assignments and course work were relevant to the profession, reflected *'real life'* practices, and *'covered a wide range of applications of IT in society'*.

A noticeable difference between the findings of this and other studies (Clark, 1990; Clark & Teague, 1994) is that, unlike other studies, participants did not find their programs to be cutthroat and competitive. Lower grade levels required for admission into college rather than university programs and a traditionally less theoretical curriculum, along with reduced applications for admission in the past several years, may contribute to reduced competition for seats and grades in the participants' programs.

4.4 Personas

Fictional composites of the positions, viewpoints and experiences of the participants were created to express the findings in an authentic and powerful but subjective voice. These composites are presented as personas. Personas are hypothetical archetypes of a segment of the population. They became popular in the early 1990s when marketing techniques shifted from mass marketing to individualized customer relationships. Peppers and Rogers (1993) called this a shift from 'finding customers for products to finding products for customers'. Archetypes were created and used to personify a cluster of users or market segment identified by quantitative data. This helped businesses design products and services for different market segments. Similarly, personas are used in computer-based learning environments as lifelike animated pedagogical agents to increase the motivation and attention of students (Lester et al, 1997).

During the same time period personas were beginning to be used in computer systems design, initially by Cooper (e.g., 2004), to bring a 'tangible solidity' to software developers' sense of the expected users of a computer system. In systems design personas have names, faces and specific detailed goals and characteristics. This helps software developers combat a common tendency to design systems for all users and all possibilities leaving no user very satisfied. Further, the amorphous universal user usually ends up with preferences and learning styles very similar to those of the developers (Grudin & Pruitt, 2002). In defining personas designers have to decide precisely who the computer system is to support, which allows assumptions, pre-conceptions, and expectations about users to be challenged (Grudin, 2003). Personas are used in this study to help combat a similar tendency in an educational context to design curriculum or teach in ways that support a traditional learning style and view of our students, one that may end up reflecting our own learning styles, abilities and needs. Personas help bring a 'tangible solidity' to the needs and interests of different groups of participants.

Personas in the computer industry focus developers on how to 'achieve practical goals without violating personal goals' of users (Cooper, 2004). Similarly a focus on the specific personal and practical goals of personas presented here (rather than on the design of curriculum and learning activities to support the majority of students) is intended to provide some insight into the needs of different groups of students. For example, how does the program help or hinder each persona as they try to succeed in their program (a practical goal for all) without causing alienation from their mostly-male classmates (a personal goal for many).

Participants' experiences are described in the words of four personas, archetype female students drawn from a composite of the perceptions, experiences, words and life stories of participants with similar characteristics, backgrounds, and abilities. Each persona represents a demographic category by age (younger, older) and race (white, visible minority) in order to demonstrate some of the differences in experiences that were expressed by participants in each group (see Figure 3). Common experiences for each category and differences between categories were obtained by examining the number of participants who reported the experience (see Appendix L). Each experience described by a persona illustrates the strong presence or absence of a response in their category of participants usually supported by similar findings in questionnaire data accumulated by age and race (see Appendix M). Personas reflect participants' actual experiences, expressed in their own words wherever possible.

Figure 3
Demographic categories of participants represented by personas.

Categories	Younger	Older
White	***MacKenzie***	***Nancy***
Visible Minority	***Ayesha***	***Ling***

MacKenzie is a composite of the common experiences of the four younger (18-23 year old) white participants in this study. She represents the minority position in this study: those who are confident in their computing skills and like programming. Like many younger participants she is impacted by the social stereotypes of 'computer geeks'. Ayesha represents the experiences of the six younger visible minority participants, many of whom felt isolated

and struggled in their first semester of studies. Like many in her category, her home care duties conflicted with the demands of her studies.

There were five older women aged 28-31 in this study. Nancy represents the experiences of the two older white participants and Ling represents the three older visible minority participants. Nancy and Ling suffered from the greater adjustment and responsibilities that older participants tended to describe but demonstrate the resilience, perseverance, and strong study skills prevalent in their categories. Ling shows the awareness of difference and inequality most often expressed by visible minority participants.

4.4.1 MacKenzie

Everyone calls me Mac. I'm 20 and I grew up in Toronto. I only took one computer course in high school which was OK I guess. But I really learned about computers from my brother who was always taking our computer apart and putting it back together. He's a network admin now and my dad's a computer engineer. I went into computer studies too because my brother and dad both said I could do it. People say it's a male job but I was a tomboy when I was younger so I never really did traditional female things. My parents have always supported whatever I wanted to do. They said I could be anything I wanted to be and I should do what interests me. There is so much you can do with computers. They're used everywhere. You don't have to work in a 9 to 5 job at IBM, you can work anywhere, at home even in your pajamas. Computers are never-ending, a limitless machine. I want to do so many different things with them. And I want to keep my options open. I like my program a lot but I wish we had more options. I always wanted to take a Spanish course.

People think that we write code in a dark room somewhere. Girls don't want to do that. In high school they're told that computers are a guy thing. They're intimidated by computers. And the computer courses are mostly guys who think that they are more experienced and smarter at computers so girls don't take computer courses or they drop out. The guys here at college thought that too until they saw my grades then they shut up. For me computers are easy, they're logical. And I don't want to be treated any differently than the guys. It doesn't matter that I'm female. I can prove myself on my own.

You know the guys in my classes have terrible social skills. They hate APC100 [Applied Communications] but they so need it. They need to learn to pick up on their environment. They don't even know when someone is mad at them. I have to tell them. They don't realize they need these skills to get a job. I worked in a law office after high school so I learned to pick up on what others are thinking. But girls are just generally more social creatures. They love socializing and do well at APC. I'm always on MSN talking to my friends.

The guys in my program are scared of girls. They never date or go out except to a LAN party. But I go out with my friends at home. They're not into computers and they like to go out to a bar and dance. I can't imagine any of the guys at school dancing. The things that are important to me in life don't come up at school. I have my school life and my home life and I talk to my friends at home about the things that are important to me. But I sometimes play games with the guys at school between classes. Gaming's fun but not all the time like them. They're addicts!

I really love programming – it's so satisfying when my program finally works. It's hard work but it's also fun sometimes ... hard fun! You get to create things that will help people in the real world. Whenever we get a programming assignment the guys just dive in and code and when they're done they find out they've missed something and have to go back and recode it. But girls do all the thinking about it first, sometimes I lie awake at night thinking about how to approach a programming problem, then I only start coding when I understand the full picture. It makes us better analysts. I expect to be one some day.

4.4.2 Ayesha

I'm 22 and was born in the Middle East but my family moved to Canada when I was two. I share my computer with my younger brother who wants to use it all the time. My father works at a large technology company and I remember when he took me to 'take a kid to work day' and introduced me to all kinds of people on different floors doing different things. So I thought maybe there was a place there for me. But in my first year of studies I didn't ever say anything in class. My English isn't very good and the guys in my classes knew way more than I did. They read everything they can about computers and know about the latest gadgets and the other guys think that's cool. I'd only ever taken a course in Microsoft Office so I never knew what they were talking about. I didn't feel very confident which is why I never said anything. They spoke a different language than me. It was kind of lonely at first.

In high school the guys were always playing games so they take the computer courses so they can play even more. I don't really like gaming and I don't know many girls that do. Someone was actually playing in class and I'm like 'is that all you guys do is play games?' Even my classes are male-oriented. The questions are always answered by the guys. They ask about

how to make extra tweaks to their programs. The questions are not related to core material or to finishing the assignment before adding stuff on. So I always feel like I'm way behind.

When I get home from school I usually help my mother prepare dinner while my brother is playing games of course. Once dinner is cleaned up and I put my younger sister to bed I sit down in front of the computer. In first year I used to stare at the blank screen because I was tired and I didn't know how even begin to catch up. I didn't even know how to start my assignments and I was supposed to do them by myself so I didn't think I was supposed to ask anyone. The computer programming classes move so quickly and each concept depends on earlier concepts which I didn't know so I was stuck. Sometimes when I go to class the teacher talks about something but I haven't learned that topic so the whole lecture goes over my head because I don't know the basics. They think everyone has the same background in computers. And they don't follow the textbooks so I don't know what to read to catch up. My cousin learned C on his own by looking things up on the internet and trying them out but I need to be able to read about it before I try it.

So I ended up failing IPC. Programming takes practice and the guys practice more because they have time to work on computers. I'm in the computer field but my brother is the one who spends 8 hours a day on the computer. So he knows more stuff about computers than I do. And even if I did have time I'd rather do other stuff than just sit on a computer all day. Sometimes it's fine, but not all the time. I want other people to know me as a person too. Maybe Uncle Keshan was right after all – that males are more logical and more suited for computer studies.

So after first year I took a year off and worked in the front office at my mother's real estate company. I got to work on their website and helped people who use their online computer system. Max also worked there and he was in the computer engineering program and I think he liked me because he was always hanging around. He taught me computer terminology and what it all meant and I spent a lot of time trying things out so by the end of the year I felt like I could do it. I thought maybe I could be a web designer or internet developer so I went back to school to try to do that.

After I got through the first year programming courses things got a lot easier. In the systems and database classes we get to work in teams so we learn from each other and I can get help when I'm stuck. But the guys still like working on their own. They search for code on the Internet and try it out to learn how it works. We need more input. I ask questions to figure things out. But we always know it when there's a test. So working in groups is better for us. However one time the guys in my group wouldn't listen to what I thought we should do until the teacher told them I was right. They just think girls can't program.

I love the classes in which teachers ask us questions and we get to interact. Then I learn in class. I feel like I count. If not I have to go home and try to learn it on my own. My second time through IPC I had a teacher who encouraged me and responded to my questions. She waited for us and she started from scratch and went through everything really thoroughly. We did lots of walkthroughs and exercises together in class. It was fun too and I got a B+.

I'm usually the only female in my classes, or sometimes there's two of us but no one ever mentions it. One time our teacher was taking pictures of his classes and he showed us a

picture of his other section. One of my friends took a look and said 'oh my god look, there's no girls'. Our teacher hadn't even noticed. So you feel sort of invisible. Like everyone thinks we're the same as the guys. I bet it would be different of we had more female teachers. They'd understand what it's like and stand up for us.

4.4.3 Ling

I'm 35 and I have a degree in business administration from back home in China. I came to Canada four years ago with my husband and two children. My husband wanted me to study nursing. He thought that was a better career for women. I had to convince him that computer studies was the right thing for me. I didn't want to start all over. When I got here I found it really difficult to adjust at first to the way things are done in my program. Computer studies seems like a foreign world to me sometimes. And I'd never taken a computer course before so I had a lot of catching up to do. I felt really isolated at first and I struggled with programming. Now I get straight As but at first it was tough. One time a teacher said that there is lots of overtime and urgent situations in IT. They implied that females shouldn't be in computing since we have childcare duties. I wanted to quit.

In the evenings I work on the computer in the kitchen while my daughter sits beside me doing her homework. But I keep getting interrupted because she needs my help and attention and my husband is by himself, resenting the time I need to spend on the computer. So I feel that stress and then there's so much pressure to make your program work. I don't want to take the stress home to my family. And I don't even take a full load of classes so it takes me a lot longer but I still can't seem to get everything done. I would love to design a computer that

could clean the house and do the daily chores. But I'm not sure what all the cleaners would do then or how my son would learn how to contribute.

I'd like to have more people to work with. With individual work, if you don't have help sometimes you sit there for hours and you don't find the problem but if you have someone beside you who knows the problem you can move quickly from that point to another one. Group work definitely works better for me even though I usually do more of the work because the guys are out playing soccer or something. I've traveled thousands of miles to be here but the others just want to play games and don't care about grades but I do. Still, I like working in groups especially when everyone contributes - but it's not encouraged in all courses – systems yes but programming no.

I'm really strongly in favour of mentoring programs. If women who are working successfully in the field can work to encourage others it would be such a help. It would have helped me. We need someone who we can look up to, who can anticipate what we're going to experience and then help us deal with it. It's all the more important for females because we are essentially different in how we do things from males. We need all the more to bounce things off each other, to work together.

I feel pretty lucky because I had two coop work terms as a database administrator so I should be able to find a job. It's important - if I don't find one my family will have to move back home. Other females dropped out because they chose this program to make money and get a job but then there was a downturn in the job market. However the guys are so

interested in how programs are made that they'll stick with it and take their chances not getting a job when they graduate.

My friend Nancy thinks that social and communication skills are the most important to be successful as a programmer. She says "street-smarts are important not just book smarts, understanding the average person – just sitting in front of a computer you don't learn this". But I think working hard is more important. It's certainly worked for me. Nancy also thinks that cultural differences are valued in our program but I don't think they're even acknowledged let alone valued. I wonder why can't Nancy see that?

4.4.4 Nancy

I grew up in a small town outside of Ottawa and have a B.A. in history. I moved to Toronto after I graduated to take a job as an executive assistant in the provincial government. But the work wasn't very interesting so I took a career aptitude test and it showed I'd excel in technology or computing. So I decided to try computer studies even though I knew nothing about computers. I'm 30 so I'm older than the other students and I when I started I didn't have the basic knowledge and I did think well maybe I shouldn't be here. Someone said to me 'do you know what memory is?' and I replied 'well no'. My internal interest kept me going. I thought well I have to make a go of this so if I didn't understand what happened in class I'd go home and crack open the books and try to piece the parts together. And I had to do this by myself. Eventually I was catching up.

I really had to learn on my own in my first semester programming course. The teacher was so disorganized and confusing and many of the younger females got discouraged and

dropped out. A lot of the classes in which I've gained the most from a subject had female teachers. I find female teachers tend to be more organized and use a top-down approach rather than just a piecemeal, scattershot approach. I want to start with the theory. Tell me where it starts, tell me why I'm doing this and we can worry about the steps later. I need to know from the top down. But few male teachers seem to take this approach.

I find programming to be such an individual activity. I think computer programmers prefer to work on their own. I needed to work on my own to get through first year. But I prefer to work in teams. They're great when everyone works together and learns from each other and when it does work it's fabulous. I love it. But a lot of students won't work. Sometimes you end up doing the whole assignment by yourself. And the younger females don't want to spend hours behind a computer. They'd rather be interacting and relating to people – guys would rather hide behind the computer so they spend more time on it, even if it's mostly playing games. Once when I was on a trip on an airplane the guy next to me was on his laptop the whole time. I'd rather talk to people. But I like the idea of a laptop because then I can take it with me and work with others.

In another coop work term I found that girls are better analysts. They pick something apart and why it is happening. My male boss will see the closer details while I see the bigger picture, how things affect something else. He doesn't see everything that would happen. He only sees a part of it, often smaller things. Say for example he installs a piece of software. He sees immediate results not long term ones or forgets one server or a client with special needs. I try to think of everything that could be impacted. He calls it the 'finesse' – seeing the more difficult impacts on isolated areas. I find this type of whole-system approach to

problem solving in the systems analysis courses. Too bad systems wasn't earlier in the program as it would have given me some context to the programs I struggled with in the first semester.

I don't want computers to take over but I want them to help with daily life and household chores – useful inventions! I want to design software for people to communicate from all over the world - to help people who can't communicate. I know the guys in my class hate working with users but I really like it. I guess that's why I want a career in systems analysis and eventually management. I like programming but I don't want to just do programming. I like working on my own on a computer sometimes and with people other times. And I want to have a life too. If there were more females in my program we'd have a life - it would be more active, more interesting. There would be more extracurricular activities and things to do. We wouldn't just have computer clubs. But we don't need 'Women in IT' clubs either. The guys didn't think I could do anything at the start but once I proved myself they started including me. I don't want to be any different from everyone else.

Mackenzie, Ayesha, Ling, and Nancy express the compelling stories of participants in their respective categories by age and race. These stories portray how obstacles felt to participants and how they play out in their daily lives. Collectively they represent the female participants' points of view and experiences in their programs, and their desires, struggles, and coping strategies as females in a mostly male program and profession. Some experiences, such as struggling in early programming courses, are common to most participants but others, such as the pressures and responsibilities they felt and how they coped differ for different personas.

4.5 Chapter Summary

Female participation in the computer studies programs in this study has steadily declined each year from 1998 to 2006. Participants described obstacles to their participation and academic progress arising from society's view of computing and from their experience in their computer studies programs. The breadth of their interests and skills, and their desire for balance in their lives often appeared to clash with the heavy independent work requirement of their first year computer programming courses. These demands on their time combine with participants' household responsibilities and lack of both computer background and confidence in their computing abilities to discourage their participation in computer studies programs. Females dropped out of these programs at a higher rate than males even though they had caught up to male performance in programming by second semester, and were placed on probation and removed from their program due to low academic standing at lower rates than males. Active, socially supported learning in classes, along with role models and mentors, helped to mitigate society's view of computers 'as a guy thing' and of computing as 'programming in a dark room'. Their experience of obstacles appears similar to those reported by U.S. university computer science students although with more emphasis on practical considerations such as finding a job and balancing their time and energy in different aspects of their lives. Personas were created from a composite of the words, perspectives, and stories of participants to give a rich description of the ways obstacles were experienced in the lives of different categories of participants in the study.

CHAPTER 5

DISCUSSION and RECOMMENDATIONS

5.1 Chapter Overview

This chapter contains discussion of the findings for each research question and conclusions drawn from the findings. Possibilities for change are explored. Implications of the findings for industry practice and suggestions for further research are presented. Recommendations for changes to participants' programs to increase female participation based on the findings of this study are offered. Finally, the conclusions and contribution to further understanding of the research problem are described.

5.2 Discussion

The following sections relate the findings presented in chapter 4 to each research question.

5.2.1 Obstacles Identified by Participants

The first research question was: *What obstacles to their participation and academic progress are identified by female students enrolled in computer studies programs at an Ontario college?*

The process of attaining identity, of finding one's place and purpose in the world, cannot be underestimated in its impact on the choices of young people in society. The role of media and entertainment industries in shaping this sense of self and the world must be considered in a discussion of gendered choices of professions. Societal influences on the career choices of females combine with personal context and characteristics of computer studies programs to steer them away from computing. Participants in this study referred to the portrayal of

computer professionals as geeks 'writing code in a dark room' all day. This was incongruent with their view of themselves and their desire for a balance between independent work and that involving social interaction. Further, the impression that computing is 'a guy thing' in high school, along with a lack of female role models, makes positive identity building in computer studies programs difficult for the female participants. They seemed to feel that their male classmates had successfully built on their interest in gaming to acquire self efficacy in computing, or at least give the impression of confidence and capability. There was no such strong draw to computers for the female participants. This seems to result in their reported lack of confidence in their computing abilities, particularly early in their studies. Participants expressed an interest in broad and creative uses of computers that are relevant to their lives. Perhaps the increasing access to creative applications of computing in young people's lives, such as audio and visual recording, editing, and publishing, will introduce future female computer studies students to computing in the way that games are the introduction for many young males. Given participants' interest in social interaction in learning and lack of interest in spending more isolating time on a computer, the progression and popular use of Web 2.0 applications such as Facebook and YouTube that support sharing, collaboration, and communication may also support future female interest and confidence in their computing abilities.

The type and number of jobs available impacted the motivation of some participants to study computing. The isolated, detached, and exclusively rational work perceived by participants to be practiced in the IT profession did not appear to fit the connected, interpersonal, and practical experiences of the caregiver, a role experienced by many participants. This view of computing work appears to be impacted by both dominant industry models and the approach

to teaching programming in their programs. The decline in jobs in computing was named by participants as a disincentive for females. This decline is partially due to the trend in North America to 'far source' programming or 'coding' jobs, a characteristic of globalization (e.g., Mann, 2004; Matloff, 2004). Other than lowering job prospects for programmers in Canada, sending software development to geographically dispersed countries ensures developers will not get the interaction with users desired by participants. It also isolates development from use, and from understanding or incorporating business and users' needs and values, a strength of female participants. This is consistent with IT industry development models that embrace isolation of development and use and thereby support far sourcing, and the corresponding decline in female participation.

It is interesting to note that the areas of computing in which participants felt females are stronger and have more interest than males (e.g., systems analysis, database administration) appear to be those with stronger local career prospects than programming, which is either being far sourced or performed locally by foreign workers. Norman Matloff describes this situation:

> "The reduction in programming jobs open to U.S. citizens and green card holders is permanent, not just a dip in the business cycle. Students who want technological work must have less of a mindset on programming and put more effort into understanding computer systems in preparation for jobs not easily offshored (such as system and database administrators)." (Matloff, 2004, p. 29)

There is the possibility that the apparent association of computers with masculine identity for participants might diminish as areas of the local IT profession which require business and interpersonal skills increase in value.

5.2.2 How Obstacles are Experienced in Programs

The second research question was: *How do female computer studies students at an Ontario college experience identified obstacles in their programs?*

The programs' characteristics and environment contributed to obstacles to the progress of participants. Their experience in their programs of computer programming practiced exclusively as an independent task, especially in first year courses, emerged as an obstacle for participants in this study. This perception may be due to the way their male classmates approach programming as much as the way their computer studies programs structure their programming work. However, curriculum and teaching methods in first year courses, especially programming classes, that required strong IT backgrounds or high comfort levels with independent inquiry proved to be an obstacle for some participants.

Institutional data showed that females struggled slightly more than males in their first semester programming course but surpassed them by second semester. However, the damage was done as many females chose to leave computer studies on their own after first semester, notably at approximately the same rate that they were failing their programming course. Given they are leaving at a much faster rate than males that can't be explained by lower grades, they appear to be more easily discouraged by academic struggle early in their studies. The program emphasis in first year on computer programming became an obstacle for participants, whether due to their initial struggles in programming, their perception that it required exclusively independent work, their lack of confidence in their programming ability, or the lack of introduction to other areas of the curriculum in which those who persisted found they had more strength and interest. This is consistent with a study in Ontario which

found that reducing the IT professions to computer programming inhibits the participation of females (Cukier, 2003).

Participants in this study were motivated by practical benefits of computing that helped people. Participants did not find this pragmatic, people-centered (rather than technology-centered) approach to computing early in their studies when they were struggling with the technical aspects of computing and would have benefited from a motivation to persist.

5.2.3 The Role of Age and Race

The third research question was: *To what extent do demographic factors play a role in the identification and experience of obstacles for female students in computer studies programs at an Ontario college?*

Participants' personal contexts mediated the influence of societal and program factors that impacted their academic progress in their programs. A lack of recognition of different genders, races and ages, and corresponding abilities, interests, and needs, appears to have contributed to the marginalization felt by some participants in their programs. This lack of validation was expressed by one participant as *'feeling invisible'*. Silence on social difference appears to reflect current education and industry practice. This seemed to have a pronounced impact on visible minority participants in this study who tended to feel more isolated, and were more aware of cultural and gender differences and inequality than white participants. The positive impact of directly addressing difference on marginalized populations in schools has been described in previous studies of high school classes (Delpit, 1988; Fine, Wise & Powell, 1997). Acknowledging differences among students may help them view obstacles

they face due to their difference in a systemic or structural way rather than as a personal or individual problem.

Further, there were a few apparent differences in participants' perceptions by age and race. White participants' pronounced attention on social skills, and their complaint that social skills did not appear to be valued by their male classmates and in their programs, may make the 'geek' image of computer professionals a greater obstacle for white participants than for visible minority participants. Visible minority participants were more discouraged by a weak job market, indicating that getting a job is a stronger motivation for them than for white participants. Visible minority participants were also more likely to feel isolated. Differing reliance on social skills, versus the hard work described by visible minority participants as a requirement for success, may arise from experiences in different social positions of how to succeed in life. Older participants were more likely to feel they were behind their classmates in their computer knowledge, but had enough focus and study skills to catch up. Younger participants had a greater need to express themselves in their work so the ability to participate in class was of particular encouragement to these participants.

5.2.4 How Programs Mitigate or Contribute to Obstacles

The fourth research question was: *In what ways do computer studies programs at an Ontario college contribute to or mitigate obstacles to the academic progress of female students?*

Prior to enrolling in computer studies, a trusted and knowledgeable role model from the IT industry who countered the perception that 'computers are a guy thing', showed participants the breadth of computing work, and who helped them feel they could fit and succeed in an IT

profession, had a large influence on their decision to study computing. Participants expressed a desire for more role models, mentors, and support in their programs, including active teaching methods that recognized different computing backgrounds and approaches to problem-solving. This supports the findings of previous studies which found that female participation increased when these factors were addressed (Frieze, Blum, Hazzan & Dias, 2006).

5.3 Implications for the IT Industry

The participants' computer studies programs did not appear to motivate these future IT professionals to work towards bridging the 'chasm' between the development and use of technology in society (as described by Denning, 2001). Programming was done independently and social skills were not highly valued. To reverse the tendency of systems development and IT policy to value technical efficiency over social or business needs (e.g., Ackerman, 2000; Hanseth & Braa, 1999), computer studies programs need to help students understand and incorporate diverse users' needs. This type of training would build on the strengths and interests of the participants, which may help females to persist in these computer studies programs. The IT industry would benefit from professionals, such as the participants, who prefer to gain a balance of technical and people skills, value a practical purpose for computing, and who are interested in understanding and incorporating users' needs throughout systems development. This might reduce the 'productivity paradox' that an industry that favours 'technology for technology's sake' over practical use engenders. Females and others who value and are trained in alternative perspectives could help balance the industry, increasing the effectiveness of products and confidence in the profession. However, to attract these sorts of people to the industry, an effort must be made to provide

the role models and mentors needed by participants, and, through their role on college advisory committees, influence computer studies programs to take broader and more inclusive approaches to both programming and computer studies.

5.4 Suggestions for Further Research

5.4.1 Broader Range of Participants

Several extensions to this study within the current institution would further probe student experience in the program and complement their insight with the experience of those in other roles in the program. A survey of the perceptions of both male and female students would explore different experiences of students by gender. Interviews with faculty, staff, and school administrators, especially those who have witnessed the recent decline in female enrolment, may provide further insight into the nature of the problem and potential interventions. Design of instruments should explore differences, rather than similarities, among female students along with the interaction of these differences with existing conditions or characteristics in the societal, program and personal environments. Interviews with first year students might provide a different insight into their struggles in first year and would include the perspectives of those who are getting discouraged and eventually drop out.

Further, interviews with non traditional participants are also recommended: students and faculty of other social minority status than gender, liberal arts faculty who teach general education subjects to computer studies students, and computer studies faculty who do not have a traditional IT background. Interviews with non traditional students and faculty might elicit insights as they may more easily see, from their 'double vision standpoint', the assumptions, ambiguities and cracks in the existing approach to computer studies programs.

Participant observation in classes and social activities within the program might, through the interrelations abundant in these environments, provide insight into how female students become discouraged in computer studies programs.

Further study should include students who dropped or transferred out of computer studies programs. These students might provide insight into obstacles they faced while enrolled in computer studies. It is also recommended that female students who did not proceed from introductory to advanced computer studies courses in high school, as well as those who did not choose to enroll in post-secondary computer studies programs, be interviewed to provide insight into the ways potential female computer studies students are discouraged from choosing this area of studies.

5.4.2 Extend to Other Colleges

Further research is needed to establish whether the societal influences, program characteristics, and elements of their personal context identified by participants as factors impacting their participation and progress hold true for female students in college computer studies programs across the province. The small number of participants from a single college limited this study. However, a similar in-depth study of computer science students at the University of Virginia became the basis for a study of computer science students at 18 universities across the U.S. (Cohoon, 2001). Such a research strategy might identify common and local perspectives of students at different colleges in Ontario and identify which interventions are most effective with which students. Does the more rigorous admission criteria for degree programs initially level the playing field somewhat for female students who gain admission to degree, rather than diploma, programs? Does the more rigorous

admission criteria prove to be more of a barrier to enter computer studies degree programs for females than males? Are different experiences reported by female students in the smaller and less ethnically diverse colleges outside of the Greater Toronto area? Are decreases in female participation and success in computer studies uniform across the province? If not, an examination of the outlying programs may isolate practices that appear to significantly support or hinder participation and success of females in computer studies programs.

Further study is recommended into whether such areas of interest to participants as database development, systems analysis, and web design and development are common to female students in high schools and colleges across Ontario. A gender analysis of the 40 faculty teaching in the programs in this study shows that the vast majority of male faculty (27 of 31) teach in the more technical courses: programming, operating systems and data communications. The majority of female faculty (7 of 9) teach mostly courses in database development and systems analysis and design. There is the potential that the presence of female faculty in these areas of the curriculum influenced the career interests expressed by participants in this study. Further study of female faculty in computing across Ontario colleges would give insight into their areas of expertise and what influenced their interest in these aspects of computing.

5.4.3 The Broader Context

An examination of college administrative obstacles to the participation and academic progress of females in post secondary education might provide further insight into non-academic reasons for declining female participation in computer studies. For example, participants in this study with family responsibilities expressed a need for flexible, reduced

load timetables. In Ontario, public grant funding is allocated to colleges for fulltime students (greater than 2/3 of a full course load), penalizing colleges for supporting reduced load students. Subsequently, colleges' methods of tuition calculation require reduced load students to pay significantly more for their education than full load students, including those with parental responsibilities who cannot take a full load of courses as they raise children. Other benefits, such as positions on the President's Honour List and funding from the Ontario Student Assistance Plan, also favour students carrying a full load of courses. Systemic obstacles to full access to 'lifelong learning' should be studied for their potential impact on those in caregiver roles, traditionally female roles in society.

A deeper examination of societal and industry influences such as the discourses surrounding the IT profession and the education and technology sectors in Canada could provide insight into external influences on students' choices. This examination would illuminate some of the ways in which a narrow definition of the IT profession and professionals is fostered. Temporary increases in female enrolment often accompany changes in the way students are recruited and supported in male dominated science and engineering programs. The success experienced by Carnegie Mellon University in increasing the percentage of females in the freshman computer science class to 42% in 2000 has not been sustained in recent years. A recent report (Carnegie Mellon Institutional Research and Analysis, 2005-2007) shows that only 22% of the freshman class were female in 2005 and 21% were female in 2006. Sustained increase in female enrollment may require a shift in societal and industry discourse.

Research is needed to illuminate the ways in which the media and entertainment industry portray computing work and computer professionals in games, industry heroes created, and in how and what types of issues are covered (e.g., the hyper-dialogue around Y2K and the dot com boom). Research on the impact of discourse in the media around technological determinism (King, 2003) and technophobia on the career and study choices of female students is recommended to better understand their declining interest in computer studies.

Examination of industry trends and behaviour is also recommended to provide additional understanding into how the IT industry has evolved in a way that is of declining interest to females. Further research should explore the influence of professional and accreditation bodies such as CATA and CIPS, a relative lack of industry regulation, and labour and economic patterns such as outsourcing, and 'farsourcing' in a globalized economy. Some Soviet countries such as Armenia report high female participation in computing (Gharibyan & Gunsaulus, 2006). A study of labour conditions and social perspectives around computing in such countries with high female participation is suggested to provide a rich comparative analysis.

5.5 Recommendations for Computer Studies Programs

The mission statement of the college in which participants were enrolled is "to contribute to Canadian Society by being a *transformational* leader in providing students with career-related education and training" (italics added). Additionally, the academic plan of the college in which the participants were enrolled states that: "the college will foster an approach to teaching and learning that reflects the diversity and multi-cultural nature of the student body". Colleges are also directed by the Ontario Human Rights Code which states that: "You

have the right to be free from discrimination and harassment in shops, restaurants, transit, hospitals, schools, ... Discrimination means unfair treatment because of your race, sex, ...".[4] Recommendations around interventions are limited to this particular college's programming and activities, many of which currently appear to reflect conditions prevalent in the broader IT industry. Recommendations for program change are based on the 'transformational' role of this college, interpreted to apply to both student and industry perspectives, as well as on the academic direction to embrace diversity at the college. Based on the participants' perceptions and experiences, recommendations are described for possible interventions in the particular college and programs studied. Recommendations are multiple as participants' experience of obstacles in their studies reflect differences in abilities and needs. Most previous research studies also recommend a multi-strategy approach to address the problem of declining female participation in computer studies (e.g., Margolis and Fisher, 2002).

Although more study is needed to understand how broadly findings from this study apply, the following recommendations for initiatives may help the Ontario college computer studies programs in which participants in this study were enrolled increase the participation and retention of female students, at least in the short term.

5.5.1 Attracting Females to Computer Studies

It is recommended that aspects of computing that involve the interface with humans and the breadth of available IT jobs be emphasized in high school in order to attract more female students to computer studies. Business and social applications of computing, and database, systems, and website design should be emphasized when marketing the program to potential

[4] http://www.ohrc.on.ca/english/guides/complainant-guide.shtml, retrieved 1/10/2006.

applicants. These areas were of interest to participants and recent studies in Canada expose the breadth of work in the IT profession and document the number and breadth of IT jobs available to graduates (e.g., the Software Human Resource Council's *Analysis of Labour Force Survey Data for the Information Technology Occupations 2000-2004* report[5]). Denning (2001, p.15) states that "the IT profession must embrace its boundaries with other fields to assure a constant stream of life-giving innovations". These labour reports should be distributed to parents and families as they had a strong influence in this study on the career choice of participants. The reports should also go to IT teachers and guidance counselors to help them encourage students who have a broader range of interests than just computer programming to consider computer studies. Workshops with high school computing teachers should be considered to provide approaches to their subjects (curriculum, teaching methods, evaluation) that are diverse and inclusive. Carnegie Mellon University successfully used this strategy in the late 1990s to attract more female students to computer science programs at their University (Frieze & Blum, 2002).

Mentoring programs, with female classmates, faculty, or industry advisors, are recommended to address the isolation of female students and support their adjustment in the crucial first year of studies. When speaking to high school classes about the breadth of computer studies programs and the range and number of IT jobs available, female faculty and industry members provide role models and counter the perception of computer professionals as geeks who 'program in a dark room somewhere'. However, the way that different female students cope with their minority position in their classes must be considered in interventions meant to support female participation. For example, while 11 of the participants thought a female-only

[5] http://www.shrc.ca/lmi/reports/report_wolfson_2005.html retrieved 1/10/2006.

club would be a good idea, two participants expressed a need to prove themselves without any *'special treatment'*. Interventions that bring attention to female students' difference must not further alienate them from their classmates or erode their efforts to demonstrate they deserve to participate.

5.5.2 Retaining Females in Computer Studies

5.5.2.1 Curriculum

In programs which require an early computer programming course, it is recommended that a course be available that teaches basic and introductory concepts to students who do not have a background in programming or IT terminology. This is consistent with the strategies of institutions such as Carnegie Mellon University and the University of Waterloo in Ontario who have introduced several courses in first year with different levels and approaches to computer programming. This type of intervention is recommended for the programs of participants in this study to address their lack of computer background and knowledge of terminology, their large initial adjustment to a mostly male environment (pronounced for visible minority participants), and their struggles in early programming courses.

Traditionally the 'hello world' program is the first computer program taught, an approach to computer programming that starts with the details of the internal syntax of a small program. To appeal to students who are motivated by computing for a practical purpose and use, it is recommended that initial programming courses be created that introduce students to computer programming from the position of the program's usefulness to society, its impact on users, and conceptually from a big picture point of view, as well as with an explanation of the syntax. Hands-on labs and assignments that support structured experimentation in early

programming courses are needed for students who do not already know how to 'dive in and code'. Grades should be assigned to an interim program plan as well as to the degree to which different users' needs are incorporated into the program design rather than just to the final result of programming assignments. Assigning value in program work to skills required to understand and satisfy users' needs might help participants build on their expressed interests and strengths.

A strategy that allows students to build confidence, learn computer terminology and fundamentals ('catch up'), and try a bit of programming before attempting a full programming course is to delay these courses until later years of the program. This allows for a less intensive and more balanced first year of study, with more group work in classes and a broader range of exposure to IT courses in areas of interest to many females. Further, a non-programming introduction to computing may counter the prevalent impression that IT careers are exclusively about computer programming (Cukier, 2003; Lewis, 2007). To increase female participation, new program development in computer studies should be considered in areas that require both technical and interpersonal skills, are interdisciplinary in nature, and are not exclusively centered around computer programming and software development.

Strategies should be developed to counter the perception of participants in this study that they have lower ability in computing than their classmates. Giving students access to their standing in the class may provide females with a more accurate perception of their relative abilities. An organization such as the Women@SCS group at Carnegie Mellon University that provides alternative societal narratives around women and computing has supported increased female participation there (Frieze & Blum, 2002). This strategy is consistent with

successful interventions around the imposter syndrome that found role-playing positive versions of one's own, and other females', abilities can overcome internalized negative messages from society about the abilities of females and supports a stronger sense of self (Clance & Imes).

Another recommended strategy is to establish a first year course that consists of lectures from different faculty across the breadth of IT disciplines to introduce students early on to areas of computing other than computer programming. This strategy was successfully employed by Carnegie Mellon University to increase female participation and success in computer science programs (Frieze & Blum, 2002). In addition, bringing female IT professionals into classes to speak to students about the content and nature of their jobs and work environment is recommended to counter the perception that their jobs are isolated and lack human interaction, and to provide role models for female students in this study.

5.5.2.2 Teaching

Faculty members, especially those who teach first semester and programming courses, might benefit from support and training in how to effectively incorporate group work of many different kinds into their courses and how to nurture and encourage student participation and interaction in class. Teaching assignments should place teachers who are highly skilled in the use of interactive and engaging teaching and learning methods in first year subjects.

A possible approach to supporting the participation of female students in computer studies programs arising from this study is grouping the few female students into one or several classes. This might mitigate some participants' feelings of isolation, that they had fewer

people in their classes with whom they could work than had the male students, and that they sometimes appeared to be intimidated by their male classmates' grasp of computer terminology and previous programming ability. Placing students in groups instead allows isolated students to begin building a social network of support in school, values social skills, and allows students who have strong people skills to build on their strengths. It is recommended that first year timetables be arranged to group female students together in some classes to diminish potential isolation caused by their position as the only female in the class.

Development of training programs is recommended to expose faculty and staff to some of the challenges, interests and perspectives around computer studies voiced by participants. This supports self reflection and potential change in practice that meets the needs, and values the strengths and interests, of students outside of the norm. This sort of training for faculty would reduce the likelihood of discouraging comments such as the one recounted by a participant in which her teacher implied that childcare makes females unfit for computing.

5.6 Conclusions

Obstacles faced by female students at an Ontario college are similar to those expressed in previous studies by female computer science students at American universities. Participants in this study did not feel quite as shut out of the clubhouse as did those in the U.S. studies, but they did share an initial lack of confidence in their programming ability, an interest in useful applications of computing that can help people, and a broad interest in different areas of computing. They also were similarly discouraged by their perception of a lack of social skills in their male classmates, and found role models and mentors encouraging. Some of

these shared perspectives may rest on common socialization processes for young people in North America, and some reflect the influence of common characteristics of the IT industry in both countries.

This study adds to the literature by exploring the characteristics of participants' programs, societal influences, and aspects of the personal context of participants that impact and shape obstacles to their academic progress. Curriculum and pedagogy in participants' programs appear to perpetuate some of the obstacles faced by participants, and mitigate others. An approach to programming as independent work perpetuates the 'coding in a dark room' image. A focus on technical aspects of programming without an obvious use for a program in early courses is not motivating for participants and does not build on their expressed strengths of applying IT to business problems, communication, and working with users. A lack of group work in early years, and lack of value on communication and social skills in the curriculum, devalue participants' interests and strengths and leave them feeling that their interests do not fit in computer studies. This may particularly be an obstacle for the white participants who placed a high value on social skills. However, faculty who teach in inclusive ways, allowing for different backgrounds and approaches to computing and problem-solving, are highly encouraging to participants, especially older participants. Active teaching methods that allow participants to participate in class and apply their knowledge were also important to their academic progress, with a pronounced impact on the younger participants.

The perception that it would be difficult to find an IT job upon graduation was discouraging for participants, especially visible minority participants. As the IT industry evolves and the number and types of IT jobs available in North America change with the impact of

globalization, an increase in jobs with the type of work that interests the participants in this study might increase overall female participation in these computer studies programs. Attracting, supporting, and retaining more students in post secondary computer studies programs with the interests, strengths, and abilities of the participants in this study will contribute to a broader and more balanced approach to computing in the IT industry that reflects the aspirations and sensibilities of a broader range of society.

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Appendix A: Mapping Instrument Questions to Research Questions

Research Question 1: What obstacles to their participation and academic progress are identified by female students enrolled in computer studies programs at an Ontario college?

Questionnaire:

- Background with computers and computing (Appendix D #8,9)
- Confidence in own computing skills (Appendix D #10)
- Experiences that contributed to success in studies (Appendix E #1,3)
- Experiences that hindered success in studies (Appendix E #2)
- Role of encouragement, support, and role models in interest and success in program (Appendix E #1,2)
- Interest in and value of working closely with users (Appendix F #1)
- Experience of competition and creativity in program (Appendix F #1)

Interview:

- Attraction to computer studies: look for social purpose of computing versus pushing technological boundaries (Appendix B #A1)
- Sense of the nature of IT (Appendix B #A2)
- Likes and dislikes of software development (Appendix B #C2, 3)
- Experience of learning styles and cognitive strengths in program: look for connected or autonomous ways of knowing (Appendix B, D)
- Experience and interest in applying computer studies to and taking courses in other disciplines (Appendix B #C5)
- Sense of 'fit' in computer studies : identity, computing culture, adjustment, and image of a software developer (Appendix C #A2,3; D #1)
- Confidence in abilities and match to program (Appendix C #A4)
- Type of work and work environment anticipated and desired (Appendix B #C1; C #B3)

Question 2: How do female computer studies students at an Ontario college experience identified obstacles in their programs?

Questionnaire:

- experience with, and access to, computers (Appendix D #1-7; B #A3)
- Experience of pedagogy in their program – separate versus connected knowing, collaborative/explanatory versus individual/goal-oriented work (Appendix F #1)
- Interest in and view of working with users, participatory design practices including design-in-use (Appendix F #1; C #C4)
- Awareness, attitude towards impact of IS on users and other social systems (Appendix F #1)
- Feelings about symbolism in program (Appendix F #1)

Interview:

- Conceptual model of the nature of IT (Appendix B #A2; F #1)
- Experience of how difference and emotions is dealt with in program and classroom (Appendix B #B3,4)
- Build on own interests in schoolwork (Appendix B #C4)
- Experience of and interest in applying IT in a range of areas (Appendix B #C4; F #1)
- Curriculum match to interests (Appendix B #C2,3)
- Subjective experience, abilities used in program (Appendix B #B1)
- Image of software developers and own 'fit' (Appendix C #A2-4)
- Support systems in place (Appendix C #A5; E #3)
- Imagining technology: look for to transcend or to communicate/coordinate (Appendix C #B1)
- Experience of gender in program (Appendix C #A1)
- Perception of difference between males and females in program (Appendix C #A3, B2)

Question 3: To what extent do demographic factors play a role in the identification and experience of obstacles for female students in computer studies programs at an Ontario college?

Difference by demographic factors recorded on the questionnaire were examined as well as differences within demographic categories. Students' perspectives on differences in interest, motivation and learning by gender and other demographic factors was further explored in interviews.

Question 4: In what ways do computer studies programs at an Ontario college contribute to or mitigate obstacles to the participation and academic progress of female students?

Questionnaire:

- Position of users in design of program/system, participatory design methods used (Appendix F #1)
- How social context of IT and interrelated systems are addressed (Appendix F #1)
- Feelings about IT symbolism, how addressed (Appendix F #2)

Interview:

- Real world examples of interest to females (Appendix B #C4)
- Pedagogy used in program: look for universal versus particular and connected versus separate knowledge creation, collaboration, problem-solving, subjective knowledge, individual versus group work, use of emotions (Appendix B #B1,2)
- How professional and work environment is characterized (Appendix B #C1)
- Breadth of curriculum (Appendix B #C5,6; F #1)

Appendix B

Interview Part I - Experience of the Computer Studies Program

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Part A: Interest in Computing

1. Can you tell me **why you decided to enroll in a computer studies program**?

(listen/ask about influential experiences, mentors, peers/parents/teachers, role models & gender&relationship to them, opportunity to apply to other interests, opportunity to be creative, gadgetry/pushing limits of technology, social purpose/benefit to others, aspirations).

2. Describe **how computers were used in your family** by yourself or others when you were growing up. Can you tell me a story or incident that involves the computer?

(Listen for framework used to make sense of technology, prompt for assumptions of neutrality – accidental or tool, shaped by other forces, valorizing, transcendence, difficult and multiple or seamless and singular)

3. Building on questions in the questionnaire, **how do you spend your time on a computer** other than doing schoolwork? As far as you know are your classmates doing similar things?

Part B: Pedagogy

1. a) Think of **one of your favourite classes**. Can you describe the **teaching style and classroom environment** in this class? Can you say why these teaching methods work well for you?

(listen/prompt for independent and goal-oriented or learning as a group using exploratory techniques, participation/discussion, different possible solutions)

b) Now think of one of your **least favourite classes**. Can you describe the **teaching style and classroom environment** in this class? Can you say why these teaching methods do not work well for you?

(listen/prompt for independent and goal-oriented or learning as a group using exploratory techniques, participation/discussion, different possible solutions)

2. Do you find that **working together is encouraged or discouraged** in your classes (or both)? How? Can you provide an example? **Which do you prefer**?

3. Are issues **around gender or differences between males and females discussed** in your classes? What about in the hallways, labs, cafeteria, bus stop etc.? Can you describe an example of when an issue has come up and how it was discussed and/or resolved? What about other **differences between people? (such as race, ethnicity or culture)** *(listen for naming, recognizing, confronting and negotiating difference)*

4) Some schools have **women in technology** clubs that allow female students to get to know and support each other? Would you be interested in this type of club in your program?

Part C: Curriculum

1. If you were going to **describe a typical job in software development** to a high school student who is trying to decide on a future career, what would you say it is?

2. What do you **like most about your studies** in your program?

3. What do you **like least about your studies** in your program?

4. a) Do you find your classes and assignments **reflect real-world problems that are interesting and relevant to you**? (Can you think of an example that was of particular interest to you? What about one in which you weren't very interested?)

5. Do you find the **curriculum too broad or too narrow** for your liking, or is it ok for you as it is? Are there any areas not allowed for in the curriculum of your program in which you'd **like to take a course if you could**, whether within software development or completely outside of computing?

6. If you could **change one thing about your program** what would it be? Is there anything else you'd like to change?

Appendix C

Interview Part II - Reflections on Computer Studies and your Future in IT

Part A: Female in Computer Studies

1. How are you **experiencing being a woman in your program**? Can you think of any incidents that happened that were related to being female in the program?

2. Do you feel that you **'fit' well** in your program? Can you identify **which parts** of yourself do and which do not?

3. What are the qualities **that you think make a good software developer**? In general do you feel you **fit these qualities?** Do you feel there is a **difference in how males and females tend to approach computer programming**? If so, describe the difference(s).

4. In what **areas of the program**, if any, do you feel you are **stronger than your classmates** and in what areas, if any, do you feel you are **weaker**?

5. What **support systems** do you lean on for help of any kind while in your program?

(listen for peers, role models, gender of all, intensity)

6. Why do you think **there are so few female students** in your program?

Part B: The Future

1. Think about your own computer or having your own computer. Ignoring reality and any physical or technical constraints, **imagine for a moment a future in which your computer could do anything you want it to**. What would you like it to do? How would you use it? What would it look like?

2. Now, imaging ten years down the road and your computer programming and analysis program at that time. **Imagine that there are as many women in the program as men.** What **are the differences** you imagine between the **program** now and then?

3. Describe what you think would be a perfect job for yourself when you graduate. What is important to you in your future work?

(prompt: Describe how you would spend your time in your perfect job? e.g., working with whom, on what, in what type of work environment)

And finally ... Is there anything else you would like to say or can think of that might help us ensure that all students, especially all female students, feel welcome and supported in your program?

Appendix D

Questionnaire Part I - Your Computing Background

In this questionnaire we would like to find out about your access to and experience with computers outside of your coursework. This helps give us a sense of your computing background and IT support while studying in the computer programming and analysis program.

Please check the appropriate answer or fill in the blank for each question.

1. **Do you have access to a computer at home?** *Yes* _____ *No* _____

2. **If you have access to a computer at home, do you share it with anyone else?**

   Yes _____ *No* _____

3. **If you share access to a home computer, how often are you able to use it?**

   None _____ *Some* _____ *All* _____ *of the time that I need it*

4. **Do you have access to the Internet at home?** *Yes* _____ *No* _____

5. **On average, how many hours do you spend at a computer each week?**____ *hours*

6. **Would you prefer to spend more or less time at the computer if you could?**

   Less _____ *Same* _____ *More* _____

7. Outside of your coursework, in which of the following ways do you use a computer:
(check the most appropriate column for each type of activity)

	Never	*Occasionally*	*Often*
Single player games			
Multi player games			
Simulated environments such as MUDs or MOOs			
Chat (or IRC)			
Email			
Surf the web			
Build websites			
Programming for fun			
Use office software			
Set up networks			
Other (please specify):			

8a. Check the highest level of post-secondary education you attained prior to entering your program:

University degree(s): _____

One or more years of university experience: _____

College diploma(s) or certificate(s): _____

One or more years of college experience: _____

Other (specify): _____

8b. If you have previous post-secondary experience, what program(s) of post-secondary study were you enrolled in?

8c. If you have previous post-secondary experience, what was the last academic year in which you were enrolled before entering your program? _____

9. List the computer studies classes, if any, you have taken in high school or during or after high school prior to entering this program.

10. How would you describe your skill level in the following areas?
(check the most appropriate column for each area of skills)

	Beginner	***Intermediate***	***Expert***
Programming			
Business skills			
Teamwork			
Writing			
Social skills			
Organizational skills			

Appendix E

Questionnaire Part II - Your Experience in a Computer Studies Program

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1. How importance was each of the following factors, if at all, in encouraging you to continue in your program?

	Not a factor	*A minor factor*	*An important factor*
Supportive school environment			
Encouraging helpful faculty			
Knowledgeable faculty			
Helpful advisors			
Academic success			
Challenging coursework			
Learning applicable skills			
Breadth of curriculum			
Interesting, enjoyable classes			
Coursework that uses real-world relevant problems			
Ability to use and build on own experience			
Helpfulness and attitudes of other students			
Ability to experiment or tinker with software			
Diversity of students in classes			
Flexible scheduling			
Good choices of optional courses			
Opportunity to be creative			
Other (please specify):			

2. How important was each of the following factors, if at all, in contributing to a discouraging experience for you in your program?

	Not a factor	*A minor factor*	*An important factor*
Inflexible scheduling of classes			
Faculty's lack of knowledge			
Poor faculty communication			
Inaccessible or unapproachable faculty			
Disorganized or unprepared faculty			
Discouraging experiences with faculty			
Poor quality of academic advisement			
Poor quality of student services			
Attitudes of other students			
Diversity of students in classes			
Grading or academic regulations			
Unclear expectations			
Negative images of software developers			
Having to learn by oneself			
Difficulty of course material			
Lack of real-world relevance of coursework			
Lack of opportunity to participate in class			
Time spent on coursework			
Initial adjustment to school culture			
Competitiveness			
Other (please specify):			

3. How important was each of the following, if at all, in overcoming discouraging experiences in your studies?

	Not a factor	*A minor factor*	*An important factor*
Help from faculty			
Help from male students			
Help from female students			
Support from friends or family			
Knowing how to learn independently			
Sense of pride or accomplishment			
Focus on future goals			
Diligence and persistence			
Class discussions			
Other (please specify):			

We wish to acknowledge the adaptation of questions on this questionnaire from the work: Gendered Attrition in I. T. (J. McGrath Cohoon, J. Cohoon, and S. Turner, University of Virginia).

Appendix F

Questionnaire Part III - Views on your Program, Discipline and Future Career

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We would like to finish this interview by asking you about your overall views on computer programming and analysis, classroom experience, and how you envision your future with IT. This will help us understand the nature of your interest in computers and how this program meets or misses your interests and goals.

1. Check the column that best describes how you feel about each of the following statements:

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
1. I enjoy figuring out how IT can make someone's life easier.					
2. The design of IT systems should be considered separately from political or workplace issues.					
3. In evaluating what someone says, I focus on the quality of their argument, not on the person presenting it.					
4. Working with others on coursework is encouraged in this program.					
5. I like to experiment with each new programming language that comes along.					
6. Users need to adapt to systems built for them because reprogramming parts of a system is difficult.					
7. I would like to take more courses from outside of computer studies.					
8. Expectations of students in this program are generally clear and explicit.					
9. I enjoy competing with others to try to develop the best possible software.					
10. Software developers often prefer to work on their own.					

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
11. I value the use of logic and reason over the incorporation of my own concerns when solving problems.					
12. An important part of my education has been learning to understand people who are very different from me.					
13. It is not enough for a program to meet program specifications. It must also work the way different users want to use it.					
14. The things that are important to me in my everyday life often come up and are discussed in class.					
15. At first it was difficult to adjust to the ways things are done in my program.					
16. I enjoy developing software that meets people's needs.					
17. I feel that I fit well in this program.					
18. Software developers generally have few friends.					
19. Cultural differences are valued in this program.					
20. Software development is an iterative process of development and use with each impacting the other.					
21. Faculty are aware of how IT is used in different industries.					
22. I like to understand where other people are 'coming from', what experiences have led them to feel the way they do.					
23. I would like more opportunities in this program to specialize within an area of software development.					
24. Assignments cover a wide range of applications of IT in society.					
25. I wish to have a job that does not require me to work many overtime hours.					
26. Computer studies seems like a foreign world to me sometimes.					
27. Software developers usually can easily get a date.					

28. Descriptive IT language like 'Xtreme programming', 'killer apps' and 'virtual reality' makes programming more fun.					
29. Software is neutral and unbiased.					

2. Rate your interest in a job in the IT industry that focuses on the following:
(check the most appropriate column for each type of work)

	Low Interest	*Medium Interest*	*High Interest*
Building a compiler for a new language			
Working on educational software (such as Blackboard)			
Working on virtual reality software			
Working on animation software			
Hacking security systems to find holes			
Contributing to an open source software project			
Designing software for people with disabilities			
Working on e-commerce systems for a major bank			
Designing software with which people communicate and collaborate			
Designing gaming software			

Demographic Information
In this section we would like to know a bit about yourself so that we can better understand the interests and needs of different students.

1. What is your age? _____

2. Do you identify as a visible minority?
(often defined to include: Aboriginals, Chinese, South Asians, Blacks, Arabs, West Asians, Filipinos, Southeast Asians, Latin Americans, Japanese, Koreans)

Yes _____ *No* _____

3. In the event that the researcher is unsure of an interpretation of your responses in this interview, are you willing to be contacted by email at a later date for clarification?

Yes _____ *No* _____

Thank you for your time, thoughts and consideration in this research.
A report of the research findings will be emailed to you upon completion of the study.

Appendix G

Research Session Script

	Time *(minutes)*
Introduction and Consent Form	5

We would like to better understand barriers faced by female students in computer studies programs. As female participation in computer studies programs has significantly decreased over the past decade in Canada, factors that support or inhibit female participation in computing are of particular interest. As a female student in this program you have valuable insight into how barriers may occur and what support is most useful. Your experience is a crucial part of this project. This interview is meant to explore your view of computer studies and your sense of your place in it. We are interested in which experiences you have found to be motivating and which discouraging in your studies. Your experience will help us identify ways in which computer studies programs can welcome and support all students.

Questionnaire Part I: Your Computing Background	10
Interview Part I: Experience of the Computer Studies Program	25
Part A Interest in Computing	
Part B Pedagogy	
Part C Curriculum	
Questionnaire Part II: Your Experience in a Computer Studies Program	10
Break	10
Interview Part II: Reflections on Computer Studies and your Future in IT	20
Part A Self	
Part B Reflections on Computer Programming and Analysis	
Part C The Future	
Questionnaire Part III: Views on your Program, Discipline and Future Career	10

Thank you

Appendix H

Invitation to Participate

The following is the initial recruitment email to be sent by the Chair responsible for computer studies programs to each female student in upper years of their programs:

-------- Original Message --------

Subject:	What would help support more female students in CPA?
Date:	Wed, 23 Feb 2005 15:28:00 -0500
From:	
To:	

Hello,

A faculty member in the School of Computer Studies is conducting a research study as part of a Masters thesis in the Faculty of Information Studies at the University of Toronto. This study hopes to shed some light on why the number of women in the CPA program is declining, a trend that is occuring across Canadian and U. S. colleges and universities. This study is of interest to Seneca College and the School of Computer Studies as it is our wish to ensure equitable access to success for all students. We are particularly interested in any barriers that may be experienced by female students in the CPA program and any support that you feel may be helpful. Your views and experience are critical to our understanding of the declining participation of female students in the CPA program. I invite you to contribute your thoughts and experience to this study by participating in an individual interview with the researcher, Jocelyn Piercy, to be scheduled at your convenience. The interview is anticipated to take 90 minutes. If you are interested in participating, please fill out the consent form attached and send it to the researcher at She can then set up a date and time that works for you, either before exams, if you are not yet buried in work, or after your exams are completed. You are free to withdraw your consent to be interviewed at any time without penalty or explanation. Thank you for your interest and consideration of this study. Good luck with the rest of the semester and exams.

Appendix I

Follow-up Announcement of Study

The following is an announcement faculty teaching required courses in 2nd and 3rd year of computer studies programs were asked to read in class:

Many of you may have a received an email from XXXX XXXX, the Chair of the School, regarding a study of the declining enrollment of female students in computer studies programs. The goal of this research is to better understand the obstacles faced by female students in computer studies programs. Students' experience, thoughts and views of software development are critical to ensuring that computer studies programs are welcoming and accessible to all students. We encourage you to participate in this study by filling out the consent form attached to the email you received and sending it to the researcher, Jocelyn Piercy, to make your experience and views count.

Appendix J

Follow-up Invitation to Participate

The following is a follow-up recruitment email to be sent by the Chair responsible for computer studies programs to female students in upper years if their programs who did not respond to the initial invitation to participate email:

Subject: Request for help understanding the declining number of female students in CPA
Date:
From:
To:

Hello,

You may have heard in one of your classes this week about a research study that hopes to shed some light on why the number of women in the CPA program is declining, a trend that is occuring across Canadian and U. S. colleges and universities. We are very interested in hearing your views and experience as a female student in the CPA program. We invite you to contribute your thoughts and experience to this study by participating in an individual interview with the researcher, Jocelyn Piercy, to be scheduled at your convenience. The interview is anticipated to take approximately 90 minutes. If you are interested in participating, please respond to She can then set up a date and time that works for you once your exams are done. You are free to withdraw your consent to be interviewed at any time without penalty or explanation. Thank you for your interest and consideration of this study. Good luck in your exams.

Appendix K

Consent Form

Research: Participation of Female Students in a Computer Studies Program at an Ontario College: What Stands in Their Way?

Faculty of Information Studies, University of Toronto, Master of Information Studies thesis research project

Researcher: Jocelyn Piercy

Name of Student Participant: (please print) _____

I understand that the purpose of this research study is to explore the interests, perceptions and experiences of computer studies students in an Ontario college that identify or relate to barriers to success in their program. As female participation in computer studies programs has significantly decreased over the past decade in Canada, factors that support or inhibit female participation in computing are of particular interest in this study.

I understand that this study is not part of the requirements for my program and that participation in the research study is voluntary. I may withdraw from the interview at any time and for any reason(s) without explanation or penalty of any kind. I am free to not answer any question(s) that I do not wish to answer. I understand that my decision to participate or not participate in this study will in no way affect my course grades or treatment in my program and my participation in this interview will not be known by anyone other than the researcher.

I understand that the findings from the study may be presented or published in appropriate professional or research publications and conferences and no participant will be identifiable in any way in publications or other communication. A report of the research findings will be emailed to me upon completion of the study.

I **do** / **do not** *(delete one)* agree to be interviewed by the researcher on campus.

I **do** / **do not** *(delete one)* agree to have this interview audiotaped. Any tapes made during the interview will be transcribed by the researcher and destroyed shortly after the interview.

Participant's Signature _____ **Date:** _____

If you have any questions or concerns about this study, contact Jocelyn Piercy at

For questions regarding rights of research participants, contact Dr. Katharine Janzen, Assoc. Vice President Research & Innovation at (416) 491-5050 ext 2080 or katharine.janzen@senecac.on.ca .

Appendix L: Frequency of Codes

(i) **Organized by Research Questions**

Codes	Participants															Frequency	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Participants	Responses
Research Question 1: Societal Barriers																	
1. Participants' Computer Background:																	
a) Attraction to Computer Studies																	
attraction to studies: IT is broad/many possibilities	1	0	1	0	0	0	0	1	2	0	0	0	0	0	0	4	5
reason for study: I was good at computers	0	0	0	0	1	0	1	0	1	1	0	1	0	0	0	5	5
reason for study: interested in what's behind the applications	0	0	1	0	0	1	0	2	0	0	1	0	0	0	0	4	5
reason for study: to play/develop games	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3
b) Experience with Computing prior to College																	
encouraged to enter computer studies	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	3	3
close family member(s) in IT	1	1	1	1	1	1	1	1	1	0	0	1	0	0	3	11	13
indirect route from high school to computer studies	0	0	1	0	1	1	1	1	0	1	0	1	0	0	1	8	8
no background in IT	0	0	1	1	1	1	1	1	0	3	0	1	1	0	0	9	11
2. Society's Perception of Gender Differences in Computing																	
females taught not to compete, especially with men	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
males are more logical	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2
males spend more time on computers	1	0	0	0	0	0	1	1	0	0	2	2	0	2	0	6	9
perception of computers/program is narrow/coding only	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	2	3
computers/technology are seen as a 'guy thing'	1	0	2	0	0	1	0	0	1	0	0	0	1	0	1	6	7
I don't want to be treated as different	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	2
males are better at computers/technology	3	1	0	3	0	2	1	2	0	0	5	1	1	2	0	10	21
mentors important for females in male-dominated profession	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
more females in computing = more comfort, power, rights	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
more responsibilities, less time for computers	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	2	3
theory/concepts are seen as a female thing	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
3. Interests, Strengths/Weaknesses, and Aspirations of Females																	
females more organized/attention to detail than males	1	0	3	0	1	0	0	0	0	0	0	0	0	0	0	3	5
females more responsible/work harder	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	4	4
females value social/communication skills	4	2	0	0	2	1	0	2	0	0	0	0	0	0	2	6	13
I am not interested/time for games	0	0	0	2	1	1	1	0	1	0	1	0	0	1	1	8	9
I am strong at communication	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	2
I create websites	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	3	3
I want to be creative	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	3	3
I want to learn new and different things	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	5	5
I want to work in a team/good environment	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	5	5
desire both technical & social interaction at work	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	3
females want balance	0	1	2	0	1	0	0	1	0	0	1	0	0	0	0	5	6
females have broader interests/interconnected/inclusive perspective	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	3	3
females initially need to follow own interests	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	3	3
groupwork - I like a balance with individual work	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
I don't want to work too many hours	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
I have broad interests	3	0	2	0	1	0	0	0	1	0	0	0	0	0	0	4	7
I like groupwork/working together	0	0	1	0	0	2	1	0	1	2	0	3	0	0	1	7	11
I like to be challenged	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	3	3
I like to surf the web/do research	0	0	1	0	1	1	1	0	0	1	1	0	0	0	0	6	6
I like to use chat/email/discussion boards/friendster	1	2	1	0	1	1	1	0	1	1	1	1	1	0	1	12	13
I prefer working on my own	0	0	0	0	0	1	0	2	0	0	0	0	1	0	0	3	4
I value/have good social skills	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	3
I want more/like breadth/variety of courses	0	2	0	0	0	2	0	0	1	0	1	0	0	1	0	6	7
I want to express myself/be known as a person	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	3	4
interested in programming to get a job not for itself	0	0	1	1	1	0	0	0	0	0	1	2	0	0	1	6	7
male students are geeks: have poor social skills	5	1	2	0	0	0	0	1	1	0	0	0	0	0	0	5	10
males play more games	3	1	0	1	0	2	0	1	0	0	3	0	0	2	0	7	13
more females = more interaction in class	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
more females means more fun and balanced	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Research Question 2: Program/Profession Barriers																	
4. Competing Interests and Strengths of Females																	
I am weak at programming	0	0	1	0	0	3	0	0	0	1	1	0	0	2	0	5	8
I want to be a programmer	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
I want to be in business/systems analysis	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	3	3
I want to be in management	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	4	4
I want to be in web development	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	6	6
I want to do computing that helps people	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	2
I want to do graphic design	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
more females in computing = more useful inventions	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
choice/options are important to me	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	3	3
females are interested in graphics/animation/visual design	0	0	0	2	1	0	0	0	0	2	0	0	0	1	1	5	7
females are interested in systems analysis	0	0	2	0	1	2	0	0	0	0	0	0	0	1	0	4	6
females are interested in/need business curriculum	1	0	4	0	2	2	0	0	0	0	4	0	1	0	0	6	14

females are interested/stronger in database	0	0	0	1	0	2	0	0	3	2	1	0	0	1	2	7	12
I am not interested in gened/english courses	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	4	4
I have interest/strength in programming	1	1	0	0	2	0	1	1	0	0	0	0	1	0	2	7	9
I have interest/strength in web development	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2	3	4
I like/remember visual applications	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2
I need to catch up to classmates/know more about computer terminology	0	0	0	3	0	0	0	1	0	2	2	1	0	0	0	5	9
I need to gain confidence/feel like I can do it	0	0	1	1	0	1	0	4	0	0	0	0	0	1	2	6	10
I want to be a games designer	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
I want to be in database	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	4	4
I want/like breadth of technical courses	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	4	4
males better at working independently	3	0	0	0	1	0	0	0	0	0	0	0	0	1	0	3	5
males more interested in datacommunications	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
no gender difference in approach to programming	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	3	3
older students better at using resources, younger at front end	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
plan program design; males jump in and code	0	0	2	0	0	1	0	0	0	1	0	0	0	0	1	4	5
6. Characteristics of Computing and Computer Professionals																	
programming is hard - broader in scope, no rules/doesn't follow textbook	0	0	0	0	0	0	0	0	1	2	1	0	0	1	0	4	5
programming is hard - moves fast and depends on beginning concepts	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	3	3
programming is hard - stressful/pressure, time	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	3	4
computer professionals can help others/create useful things	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	3	4
computer professionals need to be able to work with/ get help from others	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	2
computer professionals need to be able to work/think independently	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	4	4
computer professionals need to be balanced, have non computer interests	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	3	3
computer professionals need to be creative	0	0	1	0	1	0	1	0	1	1	0	0	0	0	0	5	5
computer professionals need to be organized/time management	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	3
computer professionals need to be patient/persistent/focused	0	0	1	0	1	1	1	1	0	2	0	0	1	1	0	5	9
computer professionals need to have good communication/social skills	1	1	2	0	0	0	0	0	1	1	2	0	0	0	0	6	8
computer professionals need to have problem-solving/logic skills	0	1	0	0	1	1	1	1	1	2	1	0	0	0	0	6	9
computer professionals need to work hard	0	0	0	1	0	0	0	1	0	0	0	1	1	1	0	5	5
computers should be portable	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	4	4
computers should do voice recognition	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	2
computers should help in daily life/household chores	0	0	0	1	1	0	1	1	0	0	0	1	0	0	1	6	6
computers should transcend time/space in games/fantasy	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
computers shouldn't take over/make us dependent on them	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
computing includes graphic design/visual	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
computing includes internet/websites	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	3	3
computing is broad and flexible	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2
computing is creative	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
computing is programming	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2
programming is challenging, exciting, 'hard fun'	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	3	3
programming is individual/independent work	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	6	6
Research Question 3: Mitigating Factors in Programs																	
8. Participants' Experiences within their Programs																	
I am often in a leadership position in groups	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	2
I end up doing all of the work in groupwork	1	1	1	0	0	0	0	1	0	1	0	1	0	0	0	6	6
isolated, less friends/support than males	1	0	0	0	1	1	0	1	1	0	1	4	0	0	0	7	10
1st semester difficult	0	0	0	2	2	0	1	1	1	3	0	3	0	0	1	8	14
assignments/examples are 'real world'	1	1	0	0	0	0	0	0	2	0	0	1	0	0	0	4	5
assignments/examples are relevant to real world	1	1	0	0	0	0	1	1	0	1	1	1	0	1	1	8	9
classroom interaction/involvement important	2	0	0	1	1	1	1	0	1	1	0	1	1	0	2	10	12
database/systems has more groupwork,programming more independent work	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	4	4
difference rarely/never discussed in program	1	1	1	0	0	0	0	0	1	1	0	1	1	1	0	8	8
disorganized/mistakes in teaching hurts	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	6	6
examples/doing is important in class	0	0	0	0	0	1	1	0	2	1	0	0	0	1	2	6	8
explaining basic concepts important/expect us to have background	0	0	0	1	0	1	0	0	0	5	1	1	0	0	0	5	9
female club would be supportive	1	1	2	1	1	0	1	0	1	0	1	1	0	1	1	11	12
female teachers/role models needed	0	0	1	0	0	1	0	1	0	0	1	0	0	0	1	5	5
females not treated equally in program	0	0	0	1	0	3	0	0	0	0	1	0	0	0	0	3	5
females treated equally in program	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	3	3
friendly/encouraging/accessible classroom environment is important	1	1	0	0	2	1	1	1	1	1	1	0	0	1	0	10	11
groupwork/working together is encouraged	1	1	1	0	0	1	0	0	1	1	2	1	0	1	1	10	11
I fit in program	1	1	0	1	1	0	1	1	0	0	0	1	1	1	0	9	9
I get support from family	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	3	3
I get support from friends	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	4	4
I get support from teachers	0	0	1	1	0	0	1	0	0	1	1	0	0	1	1	7	7
I get/need support from classmates	0	0	0	0	0	0	1	0	1	0	1	1	1	1	0	6	6
I separate home and school lives	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2
large assignments are overwhelming, more small work is encouraging	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	4	4
large workload in program	0	1	0	0	1	0	0	0	1	0	0	1	1	0	0	5	5
need to prove ourselves in IT before accepted	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	3	3
program disadvantage women with children	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	3
school culture/systems not explicit	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
teacher interest/energy important in class	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	4	4

Appendix L: Frequency of Codes by Age and Race
(ii) Totals

Codes	Younger (10)		Older (5)		White (6)		Visible Minority (9)	
	Participants	%	Participants	%	Participants	%	Participants	%
Research Question 1: Societal Barriers								
1. Participants' Computer Background:								
i) Attraction to Computer Studies								
attraction to studies: IT is broad/many possibilities	2	20%	2	40%	3	50%	1	11%
reason for study: I was good at computers	2	20%	3	60%	2	33%	3	33%
reason for study: interested in what's behind the applications	2	20%	2	40%	1	17%	3	33%
reason for study: to play/develop games	2	20%	0	0%	1	17%	1	11%
ii) Experience with Computing prior to College								
encouraged to enter computer studies	2	20%	1	20%	1	17%	2	22%
close family member(s) in IT	7	70%	4	80%	4	67%	7	78%
indirect route from high school to computer studies	3	30%	5	100%	2	33%	6	67%
no background in IT	4	40%	5	100%	2	33%	7	78%
2. Society's Perception of Gender Differences in Computing								
females taught not to compete, especially with men	0	0%	1	20%	1	17%	0	0%
males are more logical	1	10%	0	0%	0	0%	1	11%
males spend more time on computers	4	40%	2	40%	2	33%	4	44%
perception of computers/program is narrow/coding only.	1	10%	1	20%	1	17%	1	11%
computers/technology are seen as a 'guy thing'	5	50%	1	20%	3	50%	3	33%
I don't want to be treated as different	1	10%	1	20%	1	17%	1	11%
males are better at computers/technology	8	80%	2	40%	3	50%	7	78%
mentors important for females in male-dominated profession	0	0%	1	20%	1	17%	0	0%
more females in computing = more comfort, power, rights	0	0%	1	20%	0	0%	1	11%
more responsibilities, less time for computers	1	10%	1	20%	1	17%	1	11%
theory/concepts are seen as a female thing	0	0%	1	20%	1	17%	0	0%
3. Interests, Strengths, Weaknesses, and Aspirations of Females								
females more organized/attention to detail than males	1	10%	2	40%	2	33%	1	11%
females more responsible/work harder	3	30%	1	20%	3	50%	1	11%
females value social/communication skills	4	40%	2	40%	2	33%	4	44%
I am not interested/time for games	7	70%	1	20%	2	33%	6	67%
I am strong at communication	1	10%	1	20%	1	17%	1	11%
I create websites	2	20%	1	20%	1	17%	2	22%
I want to be creative	1	10%	2	40%	1	17%	2	22%
I want to learn new and different things	2	20%	3	60%	4	67%	1	11%
I want to work in a team/good environment	4	40%	1	20%	2	33%	3	33%
desire both technical & social interaction at work	3	30%	0	0%	2	33%	1	11%
females want balance	2	20%	3	60%	2	33%	3	33%
females have broader interests/interconnected/inclusive perspective	1	10%	2	40%	2	33%	1	11%
females initially need to follow own interests	2	20%	1	20%	0	0%	3	33%
groupwork - I like a balance with individual work	1	10%	0	0%	1	17%	0	0%
I don't want to work too many hours	1	10%	0	0%	0	0%	1	11%
I have broad interests	2	20%	2	40%	3	50%	1	11%
I like groupwork/working together	4	40%	3	60%	3	50%	4	44%
I like to be challenged	0	0%	3	60%	1	17%	2	22%
I like to surf the web/do research	3	30%	3	60%	2	33%	4	44%
I like to use chat/email/discussion boards/friendster	8	80%	4	80%	5	83%	7	78%
I prefer working on my own	2	20%	1	20%	0	0%	3	33%
I value/have good social skills	2	20%	0	0%	2	33%	0	0%
I want more/like breadth/variety of courses	5	50%	0	0%	3	50%	2	22%
I want to express myself/be known as a person	3	30%	0	0%	3	50%	0	0%
interested in programming to get a job not for itself	3	30%	3	60%	1	17%	5	56%
male students are geeks: have poor social skills	3	30%	2	40%	4	67%	1	11%
males play more games	6	60%	1	20%	3	50%	4	44%
more females = more interaction in class	0	0%	1	20%	1	17%	0	0%
more females means more fun and balanced	0	0%	1	20%	0	0%	1	11%
Research Question 2: Program/Profession Barriers								
4. Computing Interests and Strengths of Females								
I am weak at programming	3	30%	2	40%	3	50%	2	22%
I want to be a programmer	0	0%	1	20%	0	0%	1	11%
I want to be in business/systems analysis	1	10%	2	40%	1	17%	2	22%
I want to be in management	3	30%	1	20%	2	33%	2	22%
I want to be in web development	5	50%	1	20%	1	17%	5	56%
I want to do computing that helps people	1	10%	1	20%	1	17%	1	11%
I want to do graphic design	1	10%	0	0%	0	0%	1	11%
more females in computing = more useful inventions	1	10%	0	0%	0	0%	1	11%
choice/options are important to me	3	30%	0	0%	1	17%	2	22%
females are interested in graphics/animation/visual design	3	30%	2	40%	2	33%	3	33%
females are interested in systems analysis	2	20%	2	40%	2	33%	2	22%
females are interested in/need business curriculum	4	40%	2	40%	2	33%	4	44%
females are interested/stronger in database	6	60%	1	20%	3	50%	4	44%
I am not interested in gened/english courses	3	30%	1	20%	2	33%	2	22%
I have interest/strength in programming	5	50%	2	40%	2	33%	5	56%
I have interest/strength in web development	3	30%	0	0%	0	0%	3	33%
I like/remember visual applications	1	10%	1	20%	1	17%	1	11%
I need to catch up to classmates/know more about computer terminology	2	20%	3	60%	1	17%	4	44%
I need to gain confidence/feel like I can do it	4	40%	2	40%	2	33%	4	44%
I want to be a games designer	1	10%	0	0%	1	17%	0	0%
I want to be in database	2	20%	2	40%	1	17%	3	33%
I want/like breadth of technical courses	3	30%	1	20%	3	50%	1	11%
males better at working independently	2	20%	1	20%	2	33%	1	11%
males more interested in datacommunications	1	10%	0	0%	0	0%	1	11%
no gender difference in approach to programming	2	20%	1	20%	1	17%	2	22%
older students better at using resources, younger at front end	0	0%	1	20%	0	0%	1	11%
plan program design; males jump in and code	2	20%	2	40%	2	33%	2	22%
5. Characteristics of Computing and Computer Professionals								
programming is hard - broader in scope, no rules/doesn't follow textbook	3	30%	1	20%	3	50%	1	11%
programming is hard - moves fast and depends on beginning concepts	2	20%	1	20%	2	33%	1	11%
programming is hard - stressful/pressure, time	2	20%	1	20%	1	17%	2	22%
computer professionals can help others/create useful things	2	20%	1	20%	1	17%	2	22%
computer professionals need to be able to work with/ get help from others	1	10%	1	20%	0	0%	2	22%
computer professionals need to be able to work/think independently	3	30%	1	20%	2	33%	2	22%
computer professionals need to be balanced, have non computer interests	3	30%	0	0%	2	33%	1	11%
computer professionals need to be creative	2	20%	3	60%	3	50%	2	22%
computer professionals need to be organized/time management	3	30%	0	0%	2	33%	1	11%
computer professionals need to be patient/persistent/focused	4	40%	4	80%	3	50%	5	56%
computer professionals need to have good communication/social skills	4	40%	2	40%	5	83%	1	11%
computer professionals need to have problem-solving/logic skills	5	50%	3	60%	3	50%	5	56%
computer professionals need to work hard	3	30%	2	40%	1	17%	4	44%

computers should be portable	4	40%	0	0%		3	50%	1	11%
computers should do voice recognition	1	10%	1	20%		2	33%	0	0%
computers should help in daily life/household chores	3	30%	3	60%		0	0%	6	67%
computers should transcend time/space in games/fantasy	2	20%	0	0%		2	33%	0	0%
computers shouldn't take over/make us dependent on them	1	10%	0	0%		0	0%	1	11%
computing includes graphic design/visual	1	10%	1	20%		1	17%	1	11%
computing includes internet/websites	2	20%	1	20%		0	0%	3	33%
computing is broad and flexible	0	0%	1	20%		1	17%	0	0%
computing is creative	0	0%	1	20%		1	17%	0	0%
computing is programming	1	10%	1	20%		0	0%	2	22%
programming is challenging, exciting, 'hard fun'	0	0%	3	60%		1	17%	2	22%
programming is individual/independent work	4	40%	1	20%		1	17%	4	44%
Research Question 3: Mitigating Factors in Programs									
6. Participants' Experiences within their Programs									
I am often in a leadership position in groups	1	10%	1	20%		1	17%	1	11%
I end up doing all of the work in groupwork	2	20%	4	80%		4	67%	2	22%
isolated, less friends/support than males	4	40%	3	60%		2	33%	5	56%
1st semester difficult	4	40%	4	80%		2	33%	6	67%
assignments/examples are 'real world'	3	30%	1	20%		3	50%	1	11%
assignments/examples are relevant to real world	6	60%	3	60%		4	67%	5	56%
classroom interaction/involvement important	7	70%	3	60%		3	50%	7	78%
database/systems has more groupwork,programming more independent work	2	20%	2	40%		0	0%	4	44%
difference rarely/never discussed in program	5	50%	3	60%		6	100%	2	22%
disorganized/mistakes in teaching hurts	5	50%	1	20%		3	50%	3	33%
examples/doing is important in class	5	50%	1	20%		3	50%	3	33%
explaining basic concepts important/expect us to have background	3	30%	2	40%		1	17%	4	44%
female club would be supportive	8	80%	3	60%		5	83%	6	67%
female teachers/role models needed	3	30%	2	40%		1	17%	4	44%
females not treated equally in program	3	30%	0	0%		0	0%	3	33%
females treated equally in program	3	30%	0	0%		3	50%	0	0%
friendly/encouraging/accessible classroom environment is important	7	70%	3	60%		5	83%	5	56%
groupwork/working together is encouraged	7	70%	3	60%		6	100%	4	44%
I fit in program	6	60%	3	60%		3	50%	6	67%
I get support from family	3	30%	0	0%		2	33%	1	11%
I get support from friends	4	40%	0	0%		2	33%	2	22%
I get support from teachers	5	50%	2	40%		3	50%	4	44%
I get/need support from classmates	5	50%	1	20%		2	33%	4	44%
I separate home and school lives	2	20%	0	0%		1	17%	1	11%
large assignments are overwhelming, more small work is encouraging	2	20%	2	40%		2	33%	2	22%
large workload in program	3	30%	2	40%		2	33%	3	33%
need to prove ourselves in IT before accepted	2	20%	1	20%		1	17%	2	22%
program disadvantage women with children	0	0%	1	20%		0	0%	1	11%
school culture/systems not explicit	0	0%	1	20%		1	17%	0	0%
teacher interest/energy important in class	2	20%	2	40%		2	33%	2	22%

Appendix L (iii): Codes Relevant to Themes	Frequency	
Codes	**# Participants**	**# Responses**
1. Breadth of Participants' Interests and Strengths		
attraction to studies: IT is broad/many possibilities	4	5
I have broad interests	4	7
I want to learn new and different things	5	5
females have broader interests/interconnected/inclusive perspective	3	3
I want more/like breadth/variety of courses	5	7
I want/like breadth of technical courses	4	4
females value social/communication skills	6	13
interested in programming to get a job not for itself	6	7
choice/options are important to me	3	3
I want to be a programmer	1	1
I want to be in business/systems analysis	3	3
I want to be in management	4	4
I want to be in web development	6	6
I want to do computing that helps people	2	2
I want to do graphic design	1	1
I want to be a games designer	1	1
I want to be in database	4	4
I have interest/strength in programming	7	9
I have interest/strength in web development	3	4
I like/remember visual applications	2	2
females are interested in graphics/animation/visual design	5	7
females are interested in systems analysis	4	6
females are interested in/need business curriculum	6	14
females are interested/stronger in database	7	12
2. Role of Mentors and Role Models in Participants' Success		
encouraged to enter computer studies	3	3
close family member(s) in IT	11	13
mentors important for females in male-dominated profession	1	1
more females in computing = more comfort, power, rights	1	1
female club would be supportive	11	12
female teachers/role models needed	5	5
I get support from teachers	7	7
3. Participants' Perceived Computing Inferiority		
indirect route from high school to computer studies	8	8
no background in IT	9	11
males are better at computers/technology	10	21
computers/technology are seen as a 'guy thing'	6	7
I need to catch up to classmates/know more about computer terminolog	5	9
I need to gain confidence/feel like I can do it	6	10
explaining basic concepts important/expect us to have background	5	9
males are more logical	1	2
I am weak at programming	5	8
4. Time Required for Computing & Not Available to Participants		
males spend more time on computers	6	9
large workload in program	5	5
more responsibilities, less time for computers	2	3
computers should help in daily life/household chores	6	6
I am not interested/time for games	8	9
5. Participants' Desire for Balance		
I want to work in a team/good environment	5	5
desire both technical & social interaction at work	3	3
females want balance	5	6
females initially need to follow own interests	3	3
groupwork - I like a balance with individual work	1	1
I don't want to work too many hours	1	1
more females means more fun and balanced	1	1
6 Discouraging Image of Computing/IT Profession		
perception of computers/program is narrow/coding only.	2	3
male students are geeks: have poor social skills	5	10
males play more games	7	13
programming is individual/independent work	5	5
males better at working independently	3	5
7. Participants' Desire for Active Learning		
classroom interaction/involvement important	10	12
friendly/encouraging/accessible classroom environment is important	10	11
groupwork/working together is encouraged	10	11
I like groupwork/working together	7	11
I end up doing all of the work in groupwork	6	6
database/systems has more groupwork, programming more independe	4	4
isolated, less friends/support than males	7	10
I get/need support from classmates	6	6
examples/doing is important in class	6	8
assignments/examples are relevant to real world	9	9
8. Participants' Struggle in First Year Programming Courses		
1st semester difficult	8	14
programming is hard - broader in scope, no rules/doesn't follow textboo	4	5
programming is hard - moves fast and depends on beginning concepts	3	3
programming is hard - stressful/pressure, time	3	4
computing is programming	2	2
programming is challenging, exciting, 'hard fun'	3	3
programming is individual/independent work	5	5
males better at working independently	3	5
males more interested in datacommunications	1	1
no gender difference in approach to programming	3	3
plan program design; males jump in and code	4	5

Appendix M: Questionnaire Responses
(i) Totals

Questionnaire **- Your Computing Background**

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1. Do you have access to a computer at home? *Yes* **15** *No* _____

2. If you have access to a computer at home, do you share it with anyone else?

Yes **4** *No* **11**

3. If you share access to a home computer, how often are you able to use it?

None _____ *Some* _____ *All* **8** *of the time that I need it*

4. Do you have access to the Internet at home? *Yes* **15** *No* _____

5. On average, how many hours do you spend at a computer each day? **7.5** *hrs*

6. Would you prefer to spend more or less time at the computer if you could?

Less **3** *Same* **9** *More* **3**

7. Outside of your coursework, in which of the following ways do you use a computer: *(check the most appropriate column for each type of activity)*

	Never	*Occasionally*	*Often*
Single player games	**3**	**7**	**4**
Multi player games	**8**	**4**	**2**
Chat (or IRC)	**0**	**5**	**9**
Email	**0**	**4**	**11**
Surf the web	**0**	**4**	**11**
Build websites	**2**	**8**	**4**
Programming for fun	**3**	**8**	**3**
Use office software	**0**	**7**	**7**
Set up networks	**7**	**6**	**1**
Other (please specify): graphics		**2**	

8a. Check the highest level of post-secondary education you attained prior to entering your program:

University degree(s): **2**

One or more years of university experience: **4**

College diploma(s) or certificate(s): _____

One or more years of college experience: **3**

Other (specify): _____

8b. If you have previous post-secondary experience, what program(s) of post-secondary study were you enrolled in?

3 1 yr Computer Science at University
3 Bachelor of Arts
1 Science degree

8c. If you have previous post-secondary experience, what was the last academic year in which you were enrolled before entering your program?

5 in past 2 yrs,
3 10-15 yrs ago

9. List the computer studies classes, if any, you have taken in high school or during or after high school prior to entering this program.

6 taken at least one programming course

10. How would you describe your skill level in the following areas?
(check the most appropriate column for each area of skills)

	Beginner	***Intermediate***	***Expert***
Programming	**4**	**9**	**2**
Business skills	**6**	**7**	**2**
Teamwork	**2**	**7**	**6**
Writing	**4**	**9**	**2**
Social skills	**2**	**7**	**6**
Organizational skills	**0**	**8**	**6**

Questionnaire: Your Experience in a Computer Studies Program

1. How importance was each of the following factors, if at all, in encouraging you to continue in your program?

	Not a factor	*A minor factor*	*An important factor*
Supportive school environment			15
Encouraging helpful faculty		1	14
Knowledgeable faculty			15
Helpful advisors		4	11
Academic success		4	11
Challenging coursework		5	10
Learning applicable skills		2	13
Breadth of curriculum		5	9
Interesting, enjoyable classes		2	13
Coursework that uses real-world relevant problems	1		14
Ability to use and build on own experience		2	13
Helpfulness and attitudes of other students	3	5	7
Ability to experiment or tinker with software		5	10
Diversity of students in classes	7	6	1
Flexible scheduling		5	10
Good choices of optional courses	1		14
Opportunity to be creative	2	2	11
Other (please specify):			

Note that questions 1 and 2 of this questionnaire might have been interpreted as "if they existed, would you find the following factors encouraging (Q1) or discouraging (Q2) in your studies".

2. How important was each of the following factors, if at all, in contributing to a discouraging experience for you in your program?

	Not a factor	*A minor factor*	*An important factor*
Inflexible scheduling of classes	**3**	**7**	**5**
Faculty's lack of knowledge	**3**	**4**	**8**
Poor faculty communication	**4**	**6**	**5**
Inaccessible or unapproachable faculty	**5**	**3**	**7**
Disorganized or unprepared faculty	**2**	**4**	**9**
Discouraging experiences with faculty	**4**	**3**	**8**
Poor quality of academic advisement	**7**	**5**	**3**
Poor quality of student services	**8**	**6**	**1**
Attitudes of other students	**6**	**5**	**4**
Diversity of students in classes	**9**	**5**	**1**
Grading or academic regulations	**3**	**7**	**5**
Unclear expectations	**4**	**5**	**6**
Negative images of software developers	**6**	**6**	**3**
Having to learn by oneself	**5**	**2**	**8**
Difficulty of course material	**4**	**3**	**8**
Lack of real-world relevance of coursework	**7**	**2**	**6**
Lack of opportunity to participate in class	**5**	**5**	**5**
Time spent on coursework	**3**	**7**	**5**

Initial adjustment to school culture	**6**	**8**	**1**
Competitiveness	**6**	**7**	**2**
Other (please specify):			

3. How important was each of the following, if at all, in overcoming discouraging experiences in your studies?

	Not a factor	*A minor factor*	*An important factor*
Help from faculty		**1**	**14**
Help from male students	**3**	**6**	**6**
Help from female students	**6**	**6**	**3**
Support from friends or family	**3**	**1**	**11**
Knowing how to learn independently		**2**	**13**
Sense of pride or accomplishment		**3**	**12**
Focus on future goals		**2**	**13**
Diligence and persistence		**1**	**14**
Class discussions	**1**	**8**	**6**
Other (please specify):			

We wish to acknowledge the adaptation of questions on this questionnaire from the work: Gendered Attrition in I. T. (J. McGrath Cohoon, J. Cohoon, and S. Turner, University of Virginia).

Questionnaire - Views on your Program, Discipline and Future Career

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1. Check the column that best describes how you feel about each of the following statements:

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
1. I enjoy figuring out how IT can make someone's life easier.				5	9
2. The design of IT systems should be considered separately from political or workplace issues.		4	6	3	1
3. In evaluating what someone says, I focus on the quality of their argument, not on the person presenting it.				2	12
4. Working with others on coursework is encouraged in this program.		1		7	6
5. I like to experiment with each new programming language that comes along.	1		2	9	2
6. Users need to adapt to systems built for them because reprogramming parts of a system is difficult.	2	4	5	2	1
7. I would like to take more courses from outside of computer studies.	1	2	3	4	4
8. Expectations of students in this program are generally clear and explicit.	1			6	7
9. I enjoy competing with others to try to develop the best possible software.	1	1	4	6	2
10. Software developers often prefer to work on their own.		2		8	4
11. I value the use of logic and reason over the incorporation of my own concerns when solving problems.			1	6	7
12. An important part of my education has been learning to understand people who are very different from me.		2	2	6	4
13. It is not enough for a program to meet program specifications. It must also work the way different users want to use it.				6	8

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
14. The things that are important to me in my everyday life often come up and are discussed in class.	3	4	4	2	1
15. At first it was difficult to adjust to the ways things are done in my program.	1	2		6	5
16. I enjoy developing software that meets people's needs.				3	11
17. I feel that I fit well in this program.	1	1		4	8
18. Software developers generally have few friends.	5	2	1	5	1
19. Cultural differences are valued in this program.	3	2	6	2	1
20. Software development is an iterative process of development and use with each impacting the other.			1	7	6
21. Faculty are aware of how IT is used in different industries.		2	3	3	6
22. I like to understand where other people are 'coming from', what experiences have led them to feel the way they do.	1	1	3	5	4
23. I would like more opportunities in this program to specialize within an area of software development.		1		7	6
24. Assignments cover a wide range of applications of IT in society.		1		8	6
25. I wish to have a job that does not require me to work many overtime hours.	1	1	5	4	3
26. Computer studies seems like a foreign world to me sometimes.	5	4	1	2	2
27. Software developers usually can easily get a date.	1	4	7	2	
28. Descriptive IT language like 'Xtreme programming', 'killer apps' and 'virtual reality' makes programming more fun.	1	3	6	3	1
29. Software is neutral and unbiased.		3	4	5	2

2. Rate your interest in a job in the IT industry that focuses on the following:

	Low Interest	*Medium Interest*	*High Interest*
Building a compiler for a new language	8	6	
Working on educational software (such as Blackboard)		4	10
Working on virtual reality software	2	6	6
Working on animation software	4	2	8
Hacking security systems to find holes	7	3	4
Contributing to an open source software project	6	5	3
Designing software for people with disabilities	1	7	6
Working on e-commerce systems for a major bank	2	5	7
Designing software with which people communicate and collaborate		6	8
Designing gaming software	5	3	6

Demographic Information

In this section we would like to know a bit about yourself so that we can better understand the interests and needs of different students.

1. What is your age? Average Age = 26

2. Do you identify as a visible minority?
(often defined to include: Aboriginals, Chinese, South Asians, Blacks, Arabs, West Asians, Filipinos, Southeast Asians, Latin Americans, Japanese, Koreans)

Yes 8 ***No*** 6

3. In the event that the researcher is unsure of an interpretation of your responses in this interview, are you willing to be contacted by email at a later date for clarification?

Yes _____ ***No*** _____

Thank you for your time, thoughts and consideration in this research. A report of the research findings will be emailed to you upon completion of the study.

Appendix M: Questionnaire Responses
(ii) By Age

Questionnaire **- Your Computing Background**

Legend : **Older (28-39 yrs) / Younger (18-23 yrs)**

Please check the appropriate answer or fill in the blank for each question.

1. **Do you have access to a computer at home?** *Yes* **5 / 10** *No* _____

2. **If you have access to a computer at home, do you share it with anyone else?**
   Yes **2 / 2** *No* **3 / 8**

3. **If you share access to a home computer, how often are you able to use it?**
   None _____ *Some* _____ *All* **3 / 5** *of the time that I need it*

4. **Do you have access to the Internet at home?** *Yes* **5 / 10** *No* _____

5. **On average, how many hours do you spend at a computer each day?** **7.5 / 7.5** *hrs*

6. **Would you prefer to spend more or less time at the computer if you could?**
   Less **2 / 1** *Same* **2 / 7** *More* **1 / 2**

7. Outside of your coursework, in which of the following ways do you use a computer: *(check the most appropriate column for each type of activity)*

	Never	*Occasionally*	*Often*
Single player games	2 1	2 5	0 4
Multi player games	4 4	0 4	0 2
Chat (or IRC)	1 0	3 2	1 8
Email		0 4	5 6
Surf the web		1 3	4 7
Build websites	1 1	1 7	3 2
Programming for fun	0 3	4 4	0 2
Use office software		1 6	4 4
Set up networks	2 5	2 3	0 1
Other (please specify): graphics		1 1	

8a. Check the highest level of post-secondary education you attained prior to entering your program:

University degree(s): 2 0

One or more years of university experience: 2 2

College diploma(s) or certificate(s): _____

One or more years of college experience: 0 3

Other (specify): _____

8b. If you have previous post-secondary experience, what program(s) of post-secondary study were you enrolled in?

4
3

8c. If you have previous post-secondary experience, what was the last academic year in which you were enrolled before entering your program? _____

9. List the computer studies classes, if any, you have taken in high school or during or after high school prior to entering this program.

1
5

10. How would you describe your skill level in the following areas?
(check the most appropriate column for each area of skills)

	Beginner	*Intermediate*	*Expert*
Programming	1 3	4 5	0 2
Business skills	1 5	3 4	1 1
Teamwork	0 2	2 5	3 3
Writing	1 4	2 7	1 1
Social skills	0 2	3 4	2 4
Organizational skills	0 1	2 6	3 3

Questionnaire: **Your Experience in a Computer Studies Program**

Legend :

Older (28-39 yrs)
Younger (18-23yrs)

1. How importance was each of the following factors, if at all, in encouraging you to continue in your program?

	Not a factor	*A minor factor*	*An important factor*
Supportive school environment			**5** **10**
Encouraging helpful faculty		**0** **1**	**5** **9**
Knowledgeable faculty			**5** **10**
Helpful advisors		**1** **3**	**4** **7**
Academic success		**1** **3**	**4** **7**
Challenging coursework		**1** **4**	**4** **6**
Learning applicable skills		**0** **2**	**5** **8**
Breadth of curriculum		**1** **4**	**4** **6**
Interesting, enjoyable classes		**1** **1**	**4** **9**
Coursework that uses real-world relevant problems	**0** **1**		**5** **14**
Ability to use and build on own experience		**0** **2**	**5** **13**
Helpfulness and attitudes of other students	**1** **2**	**2** **3**	**2** **5**
Ability to experiment or tinker with software		**1** **4**	**4** **6**
Diversity of students in classes	**3** **4**	**1** **5**	**0** **1**
Flexible scheduling		**3** **2**	**2** **8**
Good choices of optional courses	**1** **0**		**4** **15**
Opportunity to be creative	**1** **1**	**0** **2**	**4** **12**
Other (please specify):			

2. How important was each of the following factors, if at all, in contributing to a discouraging experience for you in your program?

	Not a factor	*A minor factor*	*An important factor*
Inflexible scheduling of classes	1 2	3 4	1 4
Faculty's lack of knowledge	1 2	2 2	2 6
Poor faculty communication	1 3	3 3	1 4
Inaccessible or unapproachable faculty	1 4	1 2	3 4
Disorganized or unprepared faculty	0 2	2 2	3 6
Discouraging experiences with faculty	0 4	1 2	4 4
Poor quality of academic advisement	2 5	3 2	0 3
Poor quality of student services	2 6	3 3	0 1
Attitudes of other students	2 4	1 4	2 2
Diversity of students in classes	3 6	2 3	0 1
Grading or academic regulations	1 2	2 5	2 3
Unclear expectations	2 2	1 4	2 4
Negative images of software developers	3 3	1 5	1 2
Having to learn by oneself	2 3	0 2	3 5
Difficulty of course material	1 3	2 1	2 6
Lack of real-world relevance of coursework	3 4	0 2	2 4
Lack of opportunity to participate in class	2 3	1 4	2 3
Time spent on coursework	1 2	2 5	2 3
Initial adjustment to school culture	1 5	3 5	1 0
Competitiveness	3 3	1 6	1 1
Other (please specify):			

3. How important was each of the following, if at all, in overcoming discouraging experiences in your studies?

	Not a factor	*A minor factor*	*An important factor*
Help from faculty		**0** **1**	**5** **9**
Help from male students	**1** **2**	**2** **4**	**2** **4**
Help from female students	**1** **5**	**3** **3**	**1** **2**
Support from friends or family	**1** **2**	**0** **1**	**4** **7**
Knowing how to learn independently		**1** **1**	**4** **9**
Sense of pride or accomplishment		**0** **3**	**5** **7**
Focus on future goals		**0** **2**	**5** **8**
Diligence and persistence		**0** **1**	**5** **9**
Class discussions	**1** **0**	**2** **8**	**2** **4**
Other (please specify):			

We wish to acknowledge the adaptation of questions on this questionnaire from the work: Gendered Attrition in I. T. (J. McGrath Cohoon, J. Cohoon, and S. Turner, University of Virginia).

Questionnaire - Views on your Program, Discipline and Future Career

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Legend :

Older (28-39 yrs)
Younger (18-23yrs)

1. Check the column that best describes how you feel about each of the following statements:

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
1. I enjoy figuring out how IT can make someone's life easier.				**1** **4**	**4** **5**
2. The design of IT systems should be considered separately from political or workplace issues.		**2** **2**	**2** **4**	**0** **3**	**1** **0**
3. In evaluating what someone says, I focus on the quality of their argument, not on the person presenting it.				**1** **1**	**4** **8**
4. Working with others on coursework is encouraged in this program.		**1** **0**		**2** **5**	**2** **4**
5. I like to experiment with each new programming language that comes along.	**0** **1**		**0** **2**	**5** **4**	**0** **2**
6. Users need to adapt to systems built for them because reprogramming parts of a system is difficult.	**1** **1**	**2** **2**	**1** **4**	**0** **2**	**1** **0**
7. I would like to take more courses from outside of computer studies.	**0** **1**	**1** **1**	**0** **3**	**2** **2**	**2** **2**
8. Expectations of students in this program are generally clear and explicit.	**0** **1**			**2** **4**	**3** **4**
9. I enjoy competing with others to try to develop the best possible software.	**0** **1**	**0** **1**		**4** **2**	**1** **1**
10. Software developers often prefer to work on their own.		**1** **1**		**3** **5**	**1** **3**
11. I value the use of logic and reason over the incorporation of my own concerns when solving problems.			**0** **1**	**1** **5**	**4** **3**
12. An important part of my education has been learning to understand people who are very different from me.		**0** **2**	**1** **1**	**3** **3**	**1** **3**
13. It is not enough for a program to meet program specifications. It must also work the way different users want to use it.				**1** **5**	**4** **4**

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
14. The things that are important to me in my everyday life often come up and are discussed in class.	0 3	1 3	3 1	1 1	0 1
15. At first it was difficult to adjust to the ways things are done in my program.	0 1	0 2		2 4	3 2
16. I enjoy developing software that meets people's needs.				0 3	5 6
17. I feel that I fit well in this program.	0 1	0 1		3 1	2 6
18. Software developers generally have few friends.	2 3	0 2	1 0	1 4	1 0
19. Cultural differences are valued in this program.	1 2	1 1	2 4	1 1	0 1
20. Software development is an iterative process of development and use with each impacting the other.			1 0	1 6	3 3
21. Faculty are aware of how IT is used in different industries.		0 2	2 1	1 2	2 4
22. I like to understand where other people are 'coming from', what experiences have led them to feel the way they do.	0 1	1 0	0 3	2 3	2 2
23. I would like more opportunities in this program to specialize within an area of software development.		1 0		1 6	3 3
24. Assignments cover a wide range of applications of IT in society.		0 1		3 5	2 3
25. I wish to have a job that does not require me to work many overtime hours.	1 0	0 1	0 5	3 1	1 2
26. Computer studies seems like a foreign world to me sometimes.	2 3	2 2	0 1	1 1	0 2
27. Software developers usually can easily get a date.	0 1	0 4	3 4	2 0	
28. Descriptive IT language like 'Xtreme programming', 'killer apps' and 'virtual reality' makes programming more fun.	0 1	1 2	2 4	2 1	0 1
29. Software is neutral and unbiased.		2 1	1 3	1 4	1 1

2. Rate your interest in a job in the IT industry that focuses on the following:

	Low Interest	*Medium Interest*	*High Interest*
Building a compiler for a new language	2 6	3 3	
Working on educational software (such as Blackboard)		0 5	5 4
Working on virtual reality software	0 2	4 2	1 5
Working on animation software	0 4	1 1	4 4
Hacking security systems to find holes	2 5	1 2	2 2
Contributing to an open source software project	1 5	2 3	2 1
Designing software for people with disabilities	0 1	0 7	5 1
Working on e-commerce systems for a major bank	0 2	2 3	3 4
Designing software with which people communicate and collaborate		0 6	5 3
Designing gaming software	2 3	0 3	3 3

Demographic Information

In this section we would like to know a bit about yourself so that we can better understand the interests and needs of different students.

2. Do you identify as a visible minority?
(often defined to include: Aboriginals, Chinese, South Asians, Blacks, Arabs, West Asians, Filipinos, Southeast Asians, Latin Americans, Japanese, Koreans)

Yes	3 5	*No*	2 4

Appendix M: Questionnaire Responses
(iii) By Race

Questionnaire **- Your Computing Background**

Legend : **White** / **Visible Minority**

Please check the appropriate answer or fill in the blank for each question.

1. **Do you have access to a computer at home?** *Yes* **6** / **9** *No* _____

2. **If you have access to a computer at home, do you share it with anyone else?**
   Yes **0** / **4** *No* **6** / **5**

3. **If you share access to a home computer, how often are you able to use it?**
   None _____ *Some* _____ *All* **2** / **6** *of the time that I need it*

4. **Do you have access to the Internet at home?** *Yes* **6** / **9** *No* _____

5. **On average, how many hours do you spend at a computer each day?** **7.5** / **7.5** *hrs*

6. **Would you prefer to spend more or less time at the computer if you could?**
   Less **1** / **2** *Same* **5** / **4** *More* **0** / **3**

7. Outside of your coursework, in which of the following ways do you use a computer: *(check the most appropriate column for each type of activity)*

	Never	*Occasionally*	*Often*
Single player games	1 2	2 5	3 1
Multi player games	3 5	1 3	2 0
Chat (or IRC)	1 0	1 4	4 5
Email		2 2	4 7
Surf the web		1 3	5 6
Build websites	0 2	5 3	1 4
Programming for fun	1 2	4 4	0 2
Use office software		3 4	3 5
Set up networks	3 4	2 3	0 1
Other (please specify): graphics		1 1	

8a. Check the highest level of post-secondary education you attained prior to entering your program:

University degree(s): 1 1

One or more years of university experience: 2 2

College diploma(s) or certificate(s): _____

One or more years of college experience: 0 3

Other (specify): _____

8b. If you have previous post-secondary experience, what program(s) of post-secondary study were you enrolled in?

3 4

8c. If you have previous post-secondary experience, what was the last academic year in which you were enrolled before entering your program? _____

9. List the computer studies classes, if any, you have taken in high school or during or after high school prior to entering this program.

3 5

10. How would you describe your skill level in the following areas?
(check the most appropriate column for each area of skills)

	Beginner	*Intermediate*	*Expert*
Programming	1 3	4 5	1 1
Business skills	2 4	3 4	1 1
Teamwork	0 2	4 3	2 4
Writing	0 4	5 4	1 1
Social skills	0 2	3 4	3 3
Organizational skills	0 1	4 4	2 4

Questionnaire: **Your Experience in a Computer Studies Program**

Legend :

White
Visible Minority

1. How importance was each of the following factors, if at all, in encouraging you to continue in your program?

	Not a factor	*A minor factor*	*An important factor*
Supportive school environment			**6** **9**
Encouraging helpful faculty		**0** **1**	**6** **8**
Knowledgeable faculty			**6** **9**
Helpful advisors		**0** **4**	**6** **5**
Academic success		**1** **3**	**5** **6**
Challenging coursework		**2** **3**	**4** **6**
Learning applicable skills		**0** **2**	**6** **7**
Breadth of curriculum		**1** **4**	**5** **5**
Interesting, enjoyable classes		**0** **2**	**6** **7**
Coursework that uses real-world relevant problems	**0** **1**		**6** **8**
Ability to use and build on own experience		**1** **1**	**5** **8**
Helpfulness and attitudes of other students	**1** **2**	**3** **2**	**2** **5**
Ability to experiment or tinker with software		**2** **3**	**4** **6**
Diversity of students in classes	**3** **4**	**3** **3**	**0** **1**
Flexible scheduling		**3** **2**	**3** **7**
Good choices of optional courses	**0** **1**		**6** **8**
Opportunity to be creative	**0** **2**	**1** **1**	**5** **6**
Other (please specify):			

2. How important was each of the following factors, if at all, in contributing to a discouraging experience for you in your program?

	Not a factor	*A minor factor*	*An important factor*
Inflexible scheduling of classes	2 1	4 3	0 5
Faculty's lack of knowledge	2 1	3 1	1 7
Poor faculty communication	3 1	2 4	1 4
Inaccessible or unapproachable faculty	3 2	2 1	1 6
Disorganized or unprepared faculty	1 1	4 0	1 8
Discouraging experiences with faculty	3 1	1 2	2 6
Poor quality of academic advisement	4 3	1 4	1 2
Poor quality of student services	4 4	2 4	0 1
Attitudes of other students	3 3	3 2	0 4
Diversity of students in classes	6 3	0 5	0 1
Grading or academic regulations	2 1	3 4	1 4
Unclear expectations	3 1	0 2	2 6
Negative images of software developers	5 1	0 6	1 2
Having to learn by oneself	4 1	0 2	2 6
Difficulty of course material	3 1	0 2	2 6
Lack of real-world relevance of coursework	5 2	1 1	0 6
Lack of opportunity to participate in class	3 2	3 2	0 5
Time spent on coursework	0 3	4 3	1 4
Initial adjustment to school culture	3 3	2 6	1 0
Competitiveness	5 1	1 6	0 2
Other (please specify):			

Note that just about all areas in this question were found to be more discouraging by visible minority students. This may be due to possible misinterpretation of the question or may reflect genuine discouragement.

3. How important was each of the following, if at all, in overcoming discouraging experiences in your studies?

	Not a factor	*A minor factor*	*An important factor*
Help from faculty		1 0	5 9
Help from male students	1 2	2 4	2 4
Help from female students	1 5	3 3	1 2
Support from friends or family	1 2	0 1	4 7
Knowing how to learn independently		1 1	4 9
Sense of pride or accomplishment		0 3	5 7
Focus on future goals		0 2	5 8
Diligence and persistence		0 1	5 9
Class discussions	1 0	2 8	2 4
Other (please specify):			

We wish to acknowledge the adaptation of questions on this questionnaire from the work: Gendered Attrition in I. T. (J. McGrath Cohoon, J. Cohoon, and S. Turner, University of Virginia).

Questionnaire - Views on your Program, Discipline and Future Career

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Legend : **White** / **Visible Minority**

1. Check the column that best describes how you feel about each of the following statements:

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
1. I enjoy figuring out how IT can make someone's life easier.				**1** **4**	**5** **4**
2. The design of IT systems should be considered separately from political or workplace issues.		**0** **4**	**3** **3**	**2** **1**	**1** **0**
3. In evaluating what someone says, I focus on the quality of their argument, not on the person presenting it.				**1** **1**	**1** **7**
4. Working with others on coursework is encouraged in this program.		**0** **1**		**3** **4**	**3** **3**
5. I like to experiment with each new programming language that comes along.	**0** **1**		**2** **0**	**3** **6**	**1** **1**
6. Users need to adapt to systems built for them because reprogramming parts of a system is difficult.	**1** **1**	**2** **2**	**3** **2**	**0** **2**	**0** **1**
7. I would like to take more courses from outside of computer studies.	**1** **0**	**0** **2**	**2** **1**	**1** **3**	**2** **2**
8. Expectations of students in this program are generally clear and explicit.	**1** **0**			**2** **4**	**3** **4**
9. I enjoy competing with others to try to develop the best possible software.	**0** **1**	**1** **0**	**2** **2**	**3** **3**	**0** **2**
10. Software developers often prefer to work on their own.		**1** **1**		**3** **5**	**2** **2**
11. I value the use of logic and reason over the incorporation of my own concerns when solving problems.			**1** **0**	**3** **3**	**2** **5**
12. An important part of my education has been learning to understand people who are very different from me.		**1** **1**	**1** **1**	**2** **4**	**2** **2**
13. It is not enough for a program to meet program specifications. It must also work the way different users want to use it.				**2** **4**	**4** **4**

	Strongly Disagree	*Somewhat Disagree*	*Neither Agree nor Disagree*	*Somewhat Agree*	*Strongly Agree*
14. The things that are important to me in my everyday life often come up and are discussed in class.	0 3	4 0	2 2	0 2	0 1
15. At first it was difficult to adjust to the ways things are done in my program.	1 0	2 0		2 4	1 4
16. I enjoy developing software that meets people's needs.				3 0	3 8
17. I feel that I fit well in this program.	0 1	0 1		2 2	4 4
18. Software developers generally have few friends.	3 2	1 1	1 0	1 4	0 1
19. Cultural differences are valued in this program.	0 3	0 2	4 2	1 1	1 0
20. Software development is an iterative process of development and use with each impacting the other.			0 1	3 4	3 3
21. Faculty are aware of how IT is used in different industries.		0 2	1 2	1 2	4 2
22. I like to understand where other people are 'coming from', what experiences have led them to feel the way they do.	0 1	0 1	1 2	2 3	3 1
23. I would like more opportunities in this program to specialize within an area of software development.		1 0		3 4	2 4
24. Assignments cover a wide range of applications of IT in society.		0 1		2 6	4 1
25. I wish to have a job that does not require me to work many overtime hours.	0 1	0 1	4 1	2 2	0 3
26. Computer studies seems like a foreign world to me sometimes.	3 2	3 1	0 1	1 2	0 2
27. Software developers usually can easily get a date.	0 1	1 3	4 3	1 1	
28. Descriptive IT language like 'Xtreme programming', 'killer apps' and 'virtual reality' makes programming more fun.	0 1	1 2	2 4	2 1	1 0
29. Software is neutral and unbiased.		2 1	1 3	2 3	1 1

2. Rate your interest in a job in the IT industry that focuses on the following:

	Low Interest	*Medium Interest*	*High Interest*
Building a compiler for a new language	4 4	2 4	
Working on educational software (such as Blackboard)		2 2	4 6
Working on virtual reality software	0 2	2 4	4 2
Working on animation software	1 3	0 2	5 3
Hacking security systems to find holes	1 6	2 1	3 1
Contributing to an open source software project	3 3	2 3	1 2
Designing software for people with disabilities	1 0	3 4	2 4
Working on e-commerce systems for a major bank	2 0	3 2	1 6
Designing software with which people communicate and collaborate		3 3	3 5
Designing gaming software	2 3	1 2	3 3

Demographic Information

In this section we would like to know a bit about yourself so that we can better understand the interests and needs of different students.

1. What is your age? Average Age = 26

Appendix N: (i) Enrollment Trends 1995-2006

Enrollment by Semester in Computer Studies Programs

Fall Semester Enrollment by Gender

Year	Semester in Program	Females	Males	% Female
1995	1	129	324	28.5%
	2	40	79	33.6%
	3	46	90	33.8%
	4	52	99	34.4%
	5	22	53	29.3%
	6	26	50	34.2%
1995 Total		**315**	**695**	**31.2%**
1996	1	158	376	29.6%
	2	29	87	25.0%
	3	55	130	29.7%
	4	31	59	34.4%
	5	24	43	35.8%
	6	33	66	33.3%
1996 Total		**330**	**761**	**30.2%**
1997	1	180	400	31.0%
	2	74	127	36.8%
	3	69	129	34.8%
	4	39	97	28.7%
	5	25	51	32.9%
	6	31	54	36.5%
1997 Total		**418**	**858**	**32.8%**
1998	1	203	443	31.4%
	2	80	162	33.1%
	3	88	131	40.2%
	4	73	89	45.1%
	5	28	61	31.5%
	6	42	64	39.6%
1998 Total		**514**	**950**	**35.1%**
1999	1	201	539	27.2%
	2	93	118	44.1%
	3	138	241	36.4%
	4	109	164	39.9%
	5	41	65	38.7%
	6	50	64	43.9%
1999 Total		**632**	**1191**	**34.7%**
2000	1	234	570	29.1%
	2	67	131	33.8%
	3	109	226	32.5%
	4	128	175	42.2%
	5	51	93	35.4%
	6	55	112	32.9%
2000 Total		**644**	**1307**	**33.0%**
2001	1	190	534	26.2%
	2	69	167	29.2%

	3	111	238	31.8%
	4	105	181	36.7%
	5	47	112	29.6%
	6	74	154	32.5%
2001 Total		**596**	**1386**	**30.1%**
2002	1	94	482	16.3%
	2	31	107	22.5%
	3	58	187	23.7%
	4	94	146	39.2%
	5	59	148	28.5%
	6	90	157	36.4%
2002 Total		**426**	**1227**	**25.8%**
2003	1	73	268	21.4%
	2	10	91	9.9%
	3	34	195	14.8%
	4	42	162	20.6%
	5	28	96	22.6%
	6	79	203	28.0%
2003 Total		**266**	**1015**	**20.8%**
2004	1	39	177	18.1%
	2	7	28	20.0%
	3	26	138	15.9%
	4	27	141	16.1%
	5	20	96	17.2%
	6	30	155	16.2%
2004 Total		**149**	**735**	**16.9%**
2005	1	36	152	19.1%
	2	2	31	6.1%
	3	12	91	11.7%
	4	18	71	20.2%
	5	10	80	11.1%
	6	17	126	11.9%
2005 Total		**95**	**551**	**14.7%**
2006	1	40	155	20.5%
	2	7	31	18.4%
	3	7	83	7.8%
	4	10	65	13.3%
	5	6	39	13.3%
	6	11	108	9.2%
2006 Total		**81**	**481**	**14.4%**
1995- 2006 Totals		**4466**	**11157**	**28.6%**

Appendix N: (ii) Success in Computer Studies Programs 2003-2006

Retention of First Year Students

Fall 1st Semester Students moving to 2nd Semester in Winter

Academic Year	Semester in Program	Total Enrollment Females	Total Enrollment Males	1st to 2nd Semester Females	1st to 2nd Semester Males
Fall 2003	1	73	268	**43.8%**	**63.4%**
	2	10	91		
	3	34	195		
	4	42	162		
	5	28	96		
	6	79	203		
		266	1015		
Winter 2004	1	41	143		
	2	32	170		
	3	11	79		
	4	43	227		
	5	13	100		
	6	63	178		
		203	897		
Summer 2004	1	20	60		
	2	13	49		
	3	10	64		
	4	28	84		
	5	9	63		
	6	27	124		
		107	444		
Fall 2004	1	39	177	**46.2%**	**66.1%**
	2	7	28		
	3	26	138		
	4	27	141		
	5	20	96		
	6	30	155		
		149	735		
Winter 2005	1	20	95		
	2	18	117		
	3	10	34		
	4	33	154		
	5	6	63		
	6	31	164		
		118	627		

Summer 2005	1		24	42			
	2		4	39			
	3		7	41			
	4		23	46			
	5		8	40			
	6		15	88			
			81	296			
Fall 2005	1		36	152		**33.3%**	**67.1%**
	2		2	31			
	3		12	91			
	4		18	71			
	5		10	80			
	6		17	126			
			95	551			
Winter 2006	1		22	90			
	2		12	102			
	3		2	26			
	4		20	105			
	5		8	36			
	6		16	131			
			80	490			
Summer 2006	1		7	26			
	2		7	41			
	3		6	25			
	4		12	36			
	5		3	30			
	6		11	71			
			46	229			
Fall 2006	1		40	155			
	2		7	31			
	3		7	83			
	4		10	65			
	5		6	39			
	6		11	108			
			81	481			
Totals			1226	5765			

Appendix N: (ii) Success in Computer Studies Programs 2003-2006

Students placed on Probation

Academic Semester	Semester in Program	On Probation		Total Enrolled		% on probation	
		Females	Males	Females	Males	Females	Males
Fall 2003	1	5	19	73	268	6.8%	7.1%
	2	1	12	10	91	10.0%	13.2%
	3	0	17	34	195	0.0%	8.7%
	4	1	11	42	162	2.4%	6.8%
	5	0	6	28	96	0.0%	6.3%
	6	1	1	79	203	1.3%	0.5%
Total		**8**	**66**	**266**	**1015**	**3.0%**	**6.5%**
Winter 2004	1	9	58	41	143	22.0%	40.6%
	2	10	57	32	170	31.3%	33.5%
	3	2	9	11	79	18.2%	11.4%
	4	5	36	43	227	11.6%	15.9%
	5	2	16	13	100	15.4%	16.0%
	6	3	9	63	178	4.8%	5.1%
Total		**31**	**185**	**203**	**897**	**15.3%**	**20.6%**
Summer 2004	1	0	24	20	60	0.0%	40.0%
	2	4	22	13	49	30.8%	44.9%
	3	2	16	10	64	20.0%	25.0%
	4	0	4	28	84	0.0%	4.8%
	5	1	9	9	63	11.1%	14.3%
	6	0	2	27	124	0.0%	1.6%
Total		**7**	**77**	**107**	**444**	**6.5%**	**17.3%**
Fall 2004	1	8	45	39	177	20.5%	25.4%
	2	2	10	7	28	28.6%	35.7%
	3	3	32	26	138	11.5%	23.2%
	4	2	18	27	141	7.4%	12.8%
	5	2	14	20	96	10.0%	14.6%
	6	1	15	30	155	3.3%	9.7%
Total		**18**	**134**	**149**	**735**	**12.1%**	**18.2%**
Winter 2005	1	4	28	20	95	20.0%	29.5%
	2	3	30	18	117	16.7%	25.6%
	3	3	11	10	34	30.0%	32.4%
	4	2	28	33	154	6.1%	18.2%
	5	0	8	6	63	0.0%	12.7%
	6	0	18	31	164	0.0%	11.0%
Total		**12**	**123**	**118**	**627**	**10.2%**	**19.6%**

Summer 2005	1		2	4	24	42	8.3%	9.5%
	2		2	13	4	39	50.0%	33.3%
	3		2	9	7	41	28.6%	22.0%
	4		2	3	23	46	8.7%	6.5%
	5		1	3	8	40	12.5%	7.5%
	6		0	4	15	88	0.0%	4.5%
Total			**9**	**36**	**81**	**296**	**11.1%**	**12.2%**
Fall 2005	1		3	29	36	152	8.3%	19.1%
	2		0	11	2	31	0.0%	35.5%
	3		2	12	12	91	16.7%	13.2%
	4		1	10	18	71	5.6%	14.1%
	5		2	8	10	80	20.0%	10.0%
	6		1	28	17	126	5.9%	22.2%
Total			**9**	**98**	**95**	**551**	**9.5%**	**17.8%**
Winter 2006	1		1	19	22	90	4.5%	21.1%
	2		5	42	12	102	41.7%	41.2%
	3		0	6	2	26	0.0%	23.1%
	4		1	18	20	105	5.0%	17.1%
	5		3	10	8	36	37.5%	27.8%
	6		1	13	16	131	6.3%	9.9%
Total			**11**	**108**	**80**	**490**	**13.8%**	**22.0%**
Summer 2006	1		0	5	7	26	0.0%	19.2%
	2		1	16	7	41	14.3%	39.0%
	3		2	7	6	25	33.3%	28.0%
	4		0	3	12	36	0.0%	8.3%
	5		0	1	3	30	0.0%	3.3%
	6		2	9	11	71	18.2%	12.7%
Total			**5**	**41**	**46**	**229**	**10.9%**	**17.9%**
Fall 2006	1		1	12	40	155	2.5%	7.7%
	2		2	9	7	31	28.6%	29.0%
	3		3	36	7	83	42.9%	43.4%
	4		1	9	10	65	10.0%	13.8%
	5		1	12	6	39	16.7%	30.8%
	6		1	15	11	108	9.1%	13.9%
Total			**9**	**93**	**81**	**481**	**11.1%**	**19.3%**
Totals			**119**	**961**	**1226**	**5765**	**9.7%**	**16.7%**

Appendix N: (ii) Success in Computer Studies Programs 2003-2006

College Initiated Withdrawal from Program

Academic Semester	Semester in Program	Enrollment		Withdrawn		% Withdrawn	
		Females	Males	Females	Males	Females	Males
Fall 2003	1	73	268		3		
	2	10	91		1		
	3	34	195		2		
	4	42	162		1		
	5	28	96				
	6	79	203				
Total		**266**	**1015**	**0**	**7**	**0.0%**	**0.7%**
Winter 2004	1	41	143				
	2	32	170	1	1		
	3	11	79	1	5		
	4	43	227	1	2		
	5	13	100		3		
	6	63	178				
Total		**203**	**897**	**3**	**11**	**1.5%**	**1.2%**
Summer 2004	1	20	60				
	2	13	49		1		
	3	10	64				
	4	28	84				
	5	9	63				
	6	27	124				
Total		**107**	**444**	**0**	**1**	**0.0%**	**0.2%**
Fall 2004	1	39	177	1	4	1	4
	2	7	28		1		1
	3	26	138				
	4	27	141		6		6
	5	20	96		8		8
	6	30	155	1	1	1	1
Total		**149**	**735**	**2**	**20**	**1.3%**	**2.7%**
Winter 2005	1	20	95	1	1		
	2	18	117		4		
	3	10	34	1	2		
	4	33	154	1			
	5	6	63		3		
	6	31	164	1	6		
Total		**118**	**627**	**4**	**16**	**3.4%**	**2.6%**

Summer 2005	1	24	42				
	2	4	39				
	3	7	41		1		1
	4	23	46	1	1	1	1
	5	8	40				
	6	15	88				
Total		**81**	**296**	**1**	**2**	**1.2%**	**0.7%**
Fall 2005	1	36	152				
	2	2	31		1		1
	3	12	91		5		5
	4	18	71		6		6
	5	10	80		4		4
	6	17	126		4		4
Total		**95**	**551**	**0**	**20**	**0.0%**	**3.6%**
Winter 2006	1	22	90		1		1
	2	12	102				
	3	2	26		4		4
	4	20	105	1	5	1	5
	5	8	36		1		1
	6	16	131		5		5
Total		**80**	**490**	**1**	**16**	**1.3%**	**3.3%**
Summer 2006	1	7	26				
	2	7	41				
	3	6	25				
	4	12	36				
	5	3	30		1		1
	6	11	71	2	2	2	2
Total		**46**	**229**	**2**	**3**	**4.3%**	**1.3%**
Fall 2006	1	40	155	1		1	
	2	7	31		1		1
	3	7	83		5		5
	4	10	65	1	2	1	2
	5	6	39				
	6	11	108	1	5	1	5
Total		**81**	**481**	**3**	**13**	**3.7%**	**2.7%**
Totals		**1226**	**5765**	**16**	**109**	**1.3%**	**1.9%**

Appendix N: (ii) Success in Computer Studies Programs 2003-2006

Success in First Semester Programming Course: IPC144

Academic Semester	Females	Fail	Pass	% Females Pass	Males	Fail	Pass	% Males Pass
Fall 2003	73	49	24	**32.9%**	346	173	173	**50.0%**
Winter 2004	47	31	16	**34.0%**	209	122	87	**41.6%**
Summer 2004	21	10	11	**52.4%**	86	52	34	**39.5%**
Fall 2004	39	15	24	**61.5%**	210	76	134	**63.8%**
Winter 2005	17	13	4	**23.5%**	122	74	48	**39.3%**
Summer 2005	17	8	9	**52.9%**	44	18	26	**59.1%**
Fall 2005	29	12	17	**58.6%**	167	67	100	**59.9%**
Winter 2006	12	2	10	**83.3%**	134	51	83	**61.9%**
Summer 2006	8	2	6	**75.0%**	40	18	22	**55.0%**
Totals	**263**	**142**	**121**	**46.0%**	**1358**	**651**	**707**	**52.1%**

Appendix N: (ii) Success in Computer Studies Programs 2003-2006

Success in Second Semester Programming Course: OOP244

Academic Semester	Females	Fail	Pass	% Females Pass	Males	Fail	Pass	% Males Pass
Fall 2003	46	25	21	**45.7%**	218	111	107	**49.1%**
Winter 2004	55	24	31	**56.4%**	236	103	133	**56.4%**
Summer 2004	24	10	14	**58.3%**	94	55	39	**41.5%**
Fall 2004	28	12	16	**57.1%**	133	71	62	**46.6%**
Winter 2005	29	14	15	**51.7%**	164	104	60	**36.6%**
Summer 2005	9	4	5	**55.6%**	65	34	31	**47.7%**
Fall 2005	15	10	5	**33.3%**	83	46	37	**44.6%**
Winter 2006	22	15	7	**31.8%**	139	76	63	**45.3%**
Summer 2006	16	11	5	**31.3%**	53	30	23	**43.4%**
Totals	**244**	**125**	**119**	**48.8%**	**1185**	**630**	**555**	**46.8%**

Appendix N: (iii) Choices of Specialist Designations 2003-2006

Database Developer Specialization

Academic Semester	Graduates with Specialization Females	Graduates with Specialization Males	Total Graduates Females	Total Graduates Males	% Graduates with Specialization Females	% Graduates with Specialization Males
Fall 2003	18	17	79	203	**22.8%**	**8.4%**
Winter 2004	17	17	63	178	**27.0%**	**9.6%**
Summer 2004	7	15	27	124	**25.9%**	**12.1%**
Fall 2004	6	16	30	155	**20.0%**	**10.3%**
Winter 2005	4	5	31	164	**12.9%**	**3.0%**
Summer 2005	5	14	15	88	**33.3%**	**15.9%**
Fall 2005	6	8	17	126	**35.3%**	**6.3%**
Winter 2006	0	12	16	131	**0.0%**	**9.2%**
Summer 2006	2	5	11	71	**18.2%**	**7.0%**
Fall 2006	2	12	11	108	**18.2%**	**11.1%**
Total	**67**	**121**	**300**	**1348**	**22.3%**	**9.0%**

Appendix N: (iii) Choices of Specialist Designations 2003-2006

Java Internet Developer Specialization

Academic Semester	Graduates with Specialization Females	Graduates with Specialization Males	Total Graduates Females	Total Graduates Males	% Graduates with Specialization Females	% Graduates with Specialization Males
Summer 2004	4	13	27	124	**14.8%**	**10.5%**
Fall 2004	0	7	31	164	**0.0%**	**4.3%**
Winter 2005	4	23	30	155	**13.3%**	**14.8%**
Summer 2005	1	11	15	88	**6.7%**	**12.5%**
Fall 2005	1	8	17	126	**5.9%**	**6.3%**
Winter 2006	1	4	16	131	**6.3%**	**3.1%**
Summer 2006	1	3	11	71	**9.1%**	**4.2%**
Fall 2006	1	3	11	108	**9.1%**	**2.8%**
Total	**13**	**72**	**158**	**967**	**8.2%**	**7.4%**

Appendix N: (iii) Choices of Specialist Designations 2003-2006

Software Developer Specialization

Academic Semester	Graduates with Specialization Females	Graduates with Specialization Males	Total Graduates Females	Total Graduates Males	% Graduates with Specialization Females	% Graduates with Specialization Males
Fall 2003	5	27	79	203	**6.3%**	**13.3%**
Winter 2004	5	20	63	178	**7.9%**	**11.2%**
Summer 2004	2	14	27	124	**7.4%**	**11.3%**
Fall 2004	0	16	31	164	**0.0%**	**9.8%**
Winter 2005	1	22	30	155	**3.3%**	**14.2%**
Summer 2005	2	13	15	88	**13.3%**	**14.8%**
Fall 2005	0	10	17	126	**0.0%**	**7.9%**
Winter 2006	1	11	16	131	**6.3%**	**8.4%**
Summer 2006	1	3	11	71	**9.1%**	**4.2%**
Fall 2006	1	6	11	108	**9.1%**	**5.6%**
Total	**18**	**142**	**300**	**1348**	**6.0%**	**10.5%**