WOMEN AND COMPUTERS:
THE FEMININE MYSTAQUE

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To Gary

whose gift of love

helps me live my dreams

Abstract

Recent Canadian statistics have shown a dramatic decrease in women enrolling in computer science courses at the university level. This study presents quantitative and qualitative research that forms a profile of the family background, schooling experiences and personal characteristics of women who are successful computer science students at this level. Forty-five male and female technology students were surveyed to determine emerging gender differences and 4 females were interviewed. Contrary to previous studies, the lack of early and extensive computer experience did not limit these women. Recommendations for increasing female participation in computer culture include providing parents, teachers, and students with career information and improving critical problem solving skills in math instruction.

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Chapter One: Introduction

We live in a technological era. The rapidly expanding use of computer technology is changing the way we work, the way we educate, and the way we think. Technological developments have increased our opportunity to participate in a global market and competition in this global market has become a priority for the Canadian government. Many provincial governments across the country have responded to business pressure by restructuring education. This is particularly evident in Alberta, which has led the country in introducing educational reforms and has used the business community to help restructure public schooling.

The current trends of educational reform in Alberta are based on the economic assumption that countries with the best-educated workforce maintain a competitive advantage for business in a global economy (Kachur & Harrison, 1999). Increasing levels of technical and intellectual skills are seen as crucial for corporate success. In order to prevent businesses from leaving our province, a labour force ready to fill job requirements is necessary. Preparing students for future jobs becomes the primary mandate for education.

The type of education women typically receive is strongly connected to employment opportunities. Existing hierarchies tend to be reproduced, however, as women choose or are steered towards traditional "female" occupations. Studies of women's experience of schooling indicate that education has not been successful in overcoming the gendered polarization of the job market and has not concerned itself with

developing other aspects of the female potential. Computer education for women is no exception. Recent Canadian statistics have shown a dramatic decrease in women enrolling in computer science courses at the university level. Since there has been a rapid growth in industry needs for technologically skilled workers, this trend is alarming. A low female participation rate in technological fields of study threatens earning potential and employment opportunities for at least half of the population.

Researchers (Fennema, 1990; Gornick, 1983; Klein, 1990) have devoted much time and effort to the study of gender issues in education. During the past 20 years, studies have been designed to explore the reasons for an under-representation of women in the fields of mathematics and science and many recommendations for encouraging female participation in these disciplines have been made. Yet recommendations emanating from gender research in mathematics and science have not influenced the trend of low female participation in the male-dominated area of information technology. Definite gaps between male and female enrolment in computer science continue to emerge.

Educational recommendations for closing the gender gap tend to emphasize access and opportunity. However, access to computers appears to have had little impact on women's participation in the computer culture. Neither has equal opportunity influenced their attitudes towards it. To understand, accordingly, how females bridge the gender gap and participate in the male-dominated field of information technology, it is necessary to examine women who successfully overcome social barriers and become computer scientists. Although studies to date have documented the difficulties faced by women

pursuing a computer science degree, little has been written that examines reasons for success. That is the purpose of my study. I identify themes within three categories thought to contribute to the gender gap. Specifically, my study provides a profile of the family background, schooling experiences and personal characteristics of women who are successful in computer science. Focussing on such positive influences informs new recommendations for social and pedagogical change.

In light of the educational reforms in Alberta, this study is both timely and practical. Businesses can no longer ignore the vast population of women who are rejecting the technological field. Critical shortages in skilled labour threaten economic growth and since previous recommendations have not been effective or successfully implemented, new research is required.

Chapter Two: Review of Related Literature

Education and the Economy

The link between education and the economy has long influenced the selection of curriculum and the implementation of new technology. Schools are perceived as agencies of socialization where individuals are trained for the performance of adult roles and taught what is necessary to succeed in society. This functional perspective suggests that the main purposes for schools are to develop students' skills to enable them to participate productively in the economy and to assign students to occupations based on their capacity to perform job related skills well.

As our society moves from an industrial economy to one requiring technological skills, the relationship between school and work is reinforced. Decisions about the use of computers in the schools continue to be influenced by a functional perspective. Currently, provincial ministries of education are developing strategies that encourage all students to become computer literate. New programs specify that computer technology must be integrated into all curricular areas.

In Alberta, restructuring and educational reform has been influenced by pressure from the business community. Despite massive cuts to educational funding, $105,000,000 has been budgeted for technology integration from 1996 to 2002 for students in Alberta. Easton (1999) argues that a corporate agenda has promoted a new type of student who is a perpetual, flexible learner able to work in the new economy. Education is matching the requirements of a digital workforce. The connection of education to business interests is

evident.

> In a May, 1999 announcement, the Alberta Minister of Learning stated that:
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> In this information age, a good education must be more than a start on life, it must be an on-going commitment for life. The new Department of Learning signals the Alberta government's commitment to life-long learning throughout all stages of life. We want to see every student, regardless of age, acquire, and continue to develop, the knowledge and skills they will need for a trade or profession, to meet their social and cultural needs, and to fulfil their personal goals as they contribute to our shared prosperity and quality of life (Alberta Learning, 1999a, p. 1).

This suggests that education should be able to provide individual development, social equality, and integration into society. It is interesting to note that although the Alberta government supports the development of skills to meet social and cultural needs and to fulfil personal goals, this development is placed in the context of prosperity and quality of life. In the 1999 Annual Report (Alberta Learning, 1999b), eight goals of education in Alberta are described. These goals focus on student achievement, parent, business and school partnerships, student access to support services, teacher quality, integrated information technology, equitable funding, accountability, and effective management. Of the eight goals, five are directly related to career training and the implementation of computer technology. The current trend in education in Alberta supports a functional view of education. Clearly, preparing students for the workforce is a priority.

Social theorists Bowles and Gintis (1976) argue, however, that focussing education on job preparation tends to reproduce social inequalities. They present the goals of schooling as ideally providing an egalitarian, a developmental, and an integrative

education. Egalitarian goals address the need to equalize the natural, social, and historical disparities in society. Developmental goals speak to the need to develop human potential. Integrative goals seek to produce functioning members of a democracy. While agreeing that schooling excels at meeting its integrative function, Bowles and Gintis argue that education in a capitalistic culture reproduces social inequality and represses personal development. This is because education cannot effectively overcome inequities in society and contribute to the personal development of the individual while integrating these individuals as fully functioning members of society. Where the priority of education is preparing workers for a capitalist economic system, students are inevitably assigned to unequal positions in the social hierarchy.

Bowles and Gintis (1976) also point out that factors such as gender, race, and class influence educational attainment, thereby assigning students to unequal positions in society. Women represent just one of these categories of unequals. Understanding how they overcome barriers to change their position in the technological culture will lead to effective educational recommendations that will benefit not only women but potentially all students in our complex society.

The Gender Gap

Gender equity is described in a variety of ways by researchers. Baringa (1993) differentiates between sex and gender by defining sex as biologically determined labels of male and female and gender as a socially constructed set of assumptions and stereotypes based on sex. Fennema (1990) defines equity as involving equal educational opportunities,

equal educational treatment, and equal educational outcomes. She suggests that gender equity is achieved when educational outcomes are emphasized. Similarly, Gaskell and McLaren (1987) argue that equal opportunity involves more than equal access. They suggest that social and educational changes need to occur to allow participation by women on equal terms with men. Producing equal results may mean that educators need to be sensitive to student differences and may need to apply different treatments.

This is borne out in computer science fields where patterns of participation by women indicate a gendered division of education. Equal opportunity here does not result in equity. Even though women have access to the same educational opportunities and programs, identical educational treatments do not allow for individual differences and consequently do not result in women equipping themselves for the changing work force.

This is disquieting since computer technology was not always associated with men. Because computers were initially introduced into business programs, it is reasonable to conclude that women had the ability to access this new technology at the beginning of its inclusion in the school curriculum. In other words, they were not excluded from full participation because of a lack of opportunity. Unlike disciplines of science and mathematics where women were traditionally denied access, the field of computer science offered an opportunity for both access and equity. Becker (1985), in fact, found that women were the majority of adult computer users in elementary schools in 1985. They were innovative, creative, and highly visible as this technology emerged in the school setting. This developing field offered the promise of equity to women as they shared in

the computer revolution.

In other areas, the gender gap is closing. Women are increasing their presence in the work force and as of 1994, made up slightly more than half of the Canadian population and 45% of employed workers (Statistics Canada, 1995, p. 64).

They are also taking advantage of educational opportunities and the gap between men and women with university degrees is closing. In 1991, 10% of women and 13% of men aged fifteen or over held university degrees (Statistics Canada, 1995, p. 54). This trend is expected to continue since women currently make up the majority of full-time students in Canadian universities. Although the gap between male and female enrolment in graduate studies is still evident, figures from 1972-73 indicate that the percentage of women participating in graduate studies has almost doubled in recent years (Statistics Canada, 1995, p. 54). Again, the gap is narrowing.

A similar trend is evident when we look at Canadian women who are employed in some occupations previously dominated by men. The number of female managers, administrators, doctors, and dentists has increased. However, women continue to account for a small portion of the occupational work in engineering, natural sciences, and mathematics. In 1994, 19% of professionals in these occupations were women. Changes since 1982, when the figure was 15%, have been small but as enrolment of women in university programs increases, changes in female participation in related occupations is expected to increase as well (Statistics Canada, 1995).

Statistics gathered at the high school level suggest that the girls are increasing their

participation in math and science courses. A report commissioned by the American Association of University Women (1999) found that comparable numbers of males and females are enrolling in math courses, with a larger proportion of males taking the lowest-level math courses. Similar findings are evident in science courses, with the exception of physics where girls still lag behind boys. In Alberta, female students in grade 12 consistently demonstrate higher academic achievement than male students (Lowe, Krahn, & Bowlby, 1997).

These numbers paint an optimistic picture for women. However, recent studies find that the early momentum of female involvement in computer culture has stalled. It is evident that equal access to computers and opportunity for computer instruction has not been enough. Women are not participating in technological fields of study and this threatens earning potential and employment opportunities.

In 1992-93, women accounted for 28% of all Canadian university students enrolled in mathematics and physical sciences and 18% of students in engineering and applied sciences. These numbers represent some growth since the early 1970s when the figures were 19% and 3% respectively (Statistics Canada, 1995). However, it is difficult to determine how many of these women were participating in computer science programs since some universities placed this field of study into the mathematics department and others designated it as an engineering discipline. Regardless, it is clear that women's participation in each of these fields is unacceptably low and that a gender gap exists.

Many researchers thought that the gender gap would be reduced by increased

participation by women in cyber technology. The Internet provided the ability to communicate with others and the opportunity to access information from home. This new technology could potentially enable women to form support groups without encountering the barrier of a physical environment dominated by men. However, surveys show that 94% of Internet users are men (Spender, 1996). Since the Internet was developed in academic and military settings, perhaps this high representation of men is not surprising. However, as the Internet has become publicly available, women report that on-line hostility by males has discouraged them from using this medium. Women risk becoming excluded from information and power in the electronic era.

The development of an information-based economy requires computer efficacy. An education must help girls realize their potential, develop new skills, and prepare for the workforce. The failure of girls to participate in post-secondary computer science programs limits women's participation in high-salaried, intellectually challenging careers. A critical labor shortage in computer science fields is likely, especially since most of the female population are excluding themselves. Women risk losing a voice in forming the new computer culture and deciding how computers should affect society.

Reasons for the Gender Gap

Socialization

The Computer Geek. Interviewing "hackers", Turkle (1984) discovered that mastery over the computer through programming indicated a culture devoted to overcoming complex systems. Hackers described themselves in self-loathing terms as

socially severed from people and as ostracized computer freaks. They were intensely involved with the machine; they loved the machine and substituted a relationship with it for a relationship with other people. As well, features stereotypically connected with male culture were emphasized. There was a preoccupation with winning and a continual testing of programming ability. It is interesting that many boys become involved in the hacker culture in their adolescent years. Turkle suggests that this is a result of forming a personal identity at a time of development when feelings and relationships to other people seem particularly frightening. Thus, hacking becomes a refuge from social expectations.

This self-characterization of hackers contributes to the socialized view of computer enthusiasts as "computer geeks". Collis (1991) found that female high school students believed that computer users were bright males who enjoyed mathematics but were not socially attractive. In the same study, Collis discovered that males did not endorse this stereotype as strongly as the females. This suggests that girls have a firmly entrenched concept of the typical computer user.

The Male Culture. Computer culture today is produced and controlled by men. There is a strong sex-role identification. Men tend to think of the computer as power and are challenged by glitches in the software and hardware. Men try to dominate and learn how to fix the system.

When personal computers became popular, most systems required users that had an extensive programming background. Women resented the time it took to learn how to

use the machine. Men, in contrast, spent the time learning because they were directly challenged and engaged in mastering the machine. Moreover, they recognized that computers provided excellent opportunities for self-advancement and organizational success.

Extracurricular Computer Use. Extracurricular computer use is predominantly a male activity. This is particularly evident in videogames, which became popular as boys became proficient in using computer technology. The games were primarily designed by men and "GameBoy" became a best seller. Video arcades became places where boys congregated with their male friends and where girls were excluded. Kiesler, Sproull, and Eccles (1985) studied male computing culture and suggest that students who play games are more likely to take computer courses in high school. Also, Spender (1996) found that playing computer games increases intellectual ability by making the user think, assess, react, decide, and act. Whereas boys become very confident in playing these games, Turkle's studies (1988) show that girls are hesitant to play computer games because the rules are not clear and risks are hard to take. Perhaps this would be of little concern if games did not act as a gatekeeper to the computer culture. It seems that experience with playing computer games initiates the player into the computer culture, and familiarity contributes to a computer's holding power (Turkle, 1984).

In addition, boys use home computers more than girls do. Sanders (1985) surveyed 459 seventh and eighth grade students and found that boys report a heavier computer use and that girls are significantly less likely than the boys to identify

themselves as the primary user. Boys use computers more often and for longer periods of time. All of this gives them an advantage when participating in high school computer science courses.

Parents. Parental behavior tends to reinforce social patterns entrenched in computer culture. Parents are more willing to purchase computers for their sons than for their daughters (Lockheed & Frakt, 1984). Also, they encourage their sons more than their daughters to register in computer classes and to pursue further training in this field.

Software. Software packaging also promotes the socialized view of men and computers. Covers show significantly more men than women and when women are portrayed, they are in stereotypical female roles. Games tend to be oriented around war, crimes, destruction, male sports, and hobbies (Kiesler, Sproull, & Eccles, 1985). In short, games and educational software targeted at the adolescent market tend to be designed for the male market. Such choices do not encourage girls to participate in computer culture.

Media. Media portrayals of computer users further substantiate the link between computers and male culture. Sanders (1985) analyzed four issues of computer magazines commonly read by parents and teachers interested in computer science. Magazine articles were dominated by photographs of males. Of the 172 photographs of people interacting with computers, females were represented as active computer users in 17% of them and as passive users in 36% of them. Only one quarter of the feature articles on prominent people in the industry was about women and these tended to focus on women's participation in male culture, further associating computers with men. It is also interesting

to note that whereas 76% of the articles were written by men, only 12% were written by women (and 12% by authors whose sex could not be identified by their names).

Gendered Attitudes. Gender differences are shown in feminine and masculine attitudes towards computers. In one study, researchers interviewed men and women who were technological experts and identified distinct gender differences. Children were also asked about their expectations and feelings about technology. The responses of women experts were similar to those of the girls as they focussed on the use of the technology to solve social problems. The men and boys tended to focus on the machine as a source of power (Brunner & Bennett, 1997).

Other studies show that attitudes of boys toward computers are consistently more positive than girls in the adolescent years. While both genders show comparable appreciation of computers for future job opportunities, boys are more likely to express interest and pleasure in using computers than girls are (Collis, 1991).

Toy vs. Tool. The way computers are viewed significantly affects women's attitudes. Lockheed (1985) compares a computer to a Rorschach inkblot, seen differently by each viewer. A computer can be viewed as an object of study, as a device that delivers information, as a piece of recreational equipment, as a communication medium, and as a general-purpose tool. Women tend to view the computer as a tool and use the computer as a means to an end. If a computer doesn't cooperate, they will find another way of working. In other words, rather than having technology change the world, a female perspective tends to change how technology will be used.

Typical perceptions of the computer user challenge cultural notions of femininity. A girl's choice to participate in computer culture as a programmer alienates her from her friends. In a society that values women for being intuitive and relational, she experiences conflict when faced with a science that values objective and linear thinking. It forces her to choose between participating in feminine activities and identifying with a male culture. Especially during adolescence when females are struggling with sex-role identification, the choice to belong to a male culture is difficult, if not impossible, to consider. Social and peer pressures are too great.

Women who make the choice to participate in this culture experience a great deal of loneliness. Frenkel (1990) suggests that female computer scientists working in the field feel isolated and need a community. A support system is developing as all-women's forums and electronic mailing lists have become popular. Although female computer scientists are able to create a small community, the choice to participate in this field of study remains socially unacceptable to most women. For the majority of women, changing the computer culture by adding a female perspective is not an option.

Computers represent an emotionless world. Women are uncomfortable with a developing field of study that promotes highly concentrated, independent behavior. Men focus on the machine as a toy; women focus on the computer as a tool with a social function. Women hesitate to embrace computers as objects because this threatens to substitute relationships with machines for relationships with people (Turkle, 1988). Women intentionally remove themselves from the computer science field of study

because it is incongruent with their view of themselves. By insisting that the computer is just a tool, women establish that they are opposed to having a relationship with a machine. By doing so, they inadvertently reinforce the developing sex roles and contribute to the socialization of girls away from the male computer culture.

Concept of Power. Perhaps the best explanation for why a gender gap exists involves the concept of power. Cultural values emphasize that technology could dominate the physical world. Men seem comfortable with this technical world view. Conversely, women have been socialized to relate to the world. Controlling nature and the physical world is not seen as desirable. Rather than seeking to change technology to meet social goals, women avoid leadership roles in the computer culture altogether.

Schooling

Math Links to Computer Science. Decisions made at the school level limit the involvement of girls. Initially computers were used in business courses. However, as the nature of computer use changed to include programming, more males became involved with the study of computers. When computer science courses were introduced into the school curriculum, they usually required mathematics courses as prerequisites and were taught within the mathematics department. Additional computer resources were used to enhance existing math programs. Because new resources were allocated to these specific courses and not integrated into a variety of school subjects, girls were not given an opportunity to use the computer as a tool in relevant applications (Collis, 1991). Mathematics became a gatekeeper for computer science enrolment. Once the connection

between math and computer science was made, girls avoided computer classes.

Teachers. Some teachers believe that girls are innately limited in their ability to learn mathematical concepts. Such notions are accepted by the public and reinforced by published results of lower achievement by females on standardized aptitude tests. Although such prejudicial attitudes have been discredited by research showing comparable levels of mathematical achievement by both genders, cultural notions persist. The resulting behavior of some mathematics teachers contributes to a girl's loss of self-confidence. Researchers found that math and science teachers made eye contact more often with boys, paid more attention to their questions in class, challenged their wrong answers, and provided opportunities for them to operate the machines when solving problems. Girls were ignored, given sympathy when they could not respond to a question, and assigned duties of recording and reporting data rather than experimenting with the machines (Alper, 1993). The unequal treatment of girls in math classes further limits learning opportunities. The female tendency to stay away from computers is reinforced and their options to participate in the computer culture become prematurely limited.

Treatment and experience in a mathematics classroom significantly affect attitudes of girls toward computer science. In a study of 89 high school students in Quebec, researchers found that students who chose to enroll in science courses had more positive attitudes toward math than students not enrolled in science programs. They also found that there were no gender differences in viewing math as useful and enjoyable for students

enrolled in science courses. What the study did show were gender differences related to confidence. Girls attributed their success in math to effort rather than ability (Mura, Kimball, & Cloutier, 1987). It seems that social perceptions even affect the self-confidence of very successful girls.

School Scheduling. Course streaming and using computer applications exclusively in scientific disciplines prevents increased opportunity for girls. Schedules for courses also inhibit a majority of girls from taking computer classes as many mathematics and business courses are taught concurrently. A majority of girls enroll in business programs, making it impossible to enroll in the prerequisite mathematics courses. Because most girls do not participate in computer science classes, they identify computer education as a male discipline.

Gaskell (1992) was intrigued with the question of why young women chose business courses rather than more non-traditional programs. In her study of working-class girls, she found that sex-stereotyped socialization, perception of employment opportunities, and the assumption of family responsibilities led to the reproduction of gender divisions. Better opportunities were avoided by these girls because change was perceived to involve unacceptable levels of risk and unhappiness. Clerical work was appealing because it offered a safety net. Even when it was seen as boring and unsatisfying, girls still chose to enroll in business courses.

Guidance Counseling. The schools perpetuate social reproduction. Guidance counselors and teachers limit student choice and shape the way they view the future.

More boys than girls are encouraged to enroll in computer classes and to excel in this field (Kirkpatrick & Cuban, 1998). The question of choice is raised when students are faced with the reality of course streaming. Many girls think that they make choices when, in fact, they are reproducing social expectations. Choosing business courses means excluding academic paths. Opting out of academic courses limits educational and occupational opportunities (Sanders & Stone, 1986).

The Physical Setting. In addition to curriculum and scheduling problems, the physical setting provides obstacles for girls learning about the new technology. Computers in schools are grouped together in one room and are typically dominated by men. Locating computers within a mathematics curriculum and constructing environments catering to a male culture limit female participation in computer science courses. The learning environment in computer education involves independent work with a machine. It encourages a technical relationship with a machine. This is not an environment that attracts females. In addition, it is an environment that tends to limit extracurricular use of computers by girls.

Extracurricular Computer Use. Becker (1987) found that three times as many boys as girls used the computer before or after school. In a study of several schools in Ontario, 10 times as many males as females used computers during extracurricular time at school. Other research indicates that only 15% of extracurricular users are girls (Collis, 1991). Computer clubs and courses are attended by more boys than girls (Hess & Miura, 1985). This is a concern because research shows that when male and female experience of

computer use is the same in terms of quality and quantity, achievement scores and attitudes of girls are similar to those of boys in computer classes (Kirkpatrick & Cuban, 1998).

Software. Klein (1990) found that masculine software encourages competitiveness and gives girls a low sense of ownership. Girls tend to enjoy games that allowed more than one solution (Kantrowitz, 1994). Elementary school software tends to represent female characters in only 12% of the cases, and these characters confirm passive, stereotypical views of women (Weinman & Haag, 1999). Programs are designed primarily for boys. Experiences with software are exciting for boys but produce anxiety for girls (Frenkel, 1990). This greatly influences the attitudes of girls toward video and computer games.

Joiner, Messer, Littleton, and Light (1996) studied ten- and eleven-year-old children. They presented boys and girls with stereotyped versions of the same software and found that boys performed better than girls did on both versions. Although girls preferred the female version only marginally more than the male version, there was a significant link between preferences and performance. In other words, girls who liked the female version did better using that software; girls who preferred the male version performed better using that one. The same correlation did not exist for the boys. The researchers suggest that programs should be made more interesting for girls and that software should be designed for girls as well as boys.

Learning Styles. Typical computer education places a heavy emphasis on

programming. Turkle (1995) describes her first experience with computer programming as negative. She was forced to work in a linear manner, to follow a prescribed canon, and to arrange lines of text in a correct way.

Learning styles like these may be connected to the absence of girls in computer science classes. Turkle (1984) documents different styles of mastery in her work with child programmers. She identifies a hard style where will is imposed over the machine by applying a plan. Soft mastery is when a user tinkers interactively with the medium. She describes hard mastery as abstract and the soft style as concrete. Each programming style is an expression of the personality of the user. Hard masters approach the world through control; soft masters tend to accommodate the world. In Turkle's experience, girls tend to be soft masters, an approach reinforced by society.

Turkle (1984) suggests that girls treat a computer as a person, referring to it as he/she. Girls assign personalities to the machines and interact relationally. They tend to view computers in subjective terms rather than in objective terms. By focussing on formal programming, educators present learning in only one prescribed way and foster a climate of individualism, not connection. This contributes to a mismatch between learner and subject for many students. Turkle believes that the use of computers can draw out learning styles and accommodate them. Allowing for a flexible programming style encourages the diversity of learning approaches. Applying educational theories of learning style seems to be missing from the approach taken by computer science teachers in the schools.

The distinction between viewing the computer as an object and using the computer as a tool causes women to participate more readily in business programs where the gradual introduction of new technologies occurs in application contexts. The learning environment in these classes more closely matches the learning style of females. Relevancy is provided as girls learn skills that directly relate to the changing work force. This gender typing creates a barrier for participation in computer programs. Women again choose to limit their involvement in mathematical programming classes.

Personal factors

Sex-role Identity. The extent to which girls embrace the computer culture is dependent upon the degree to which they personalize social expectations. The experiences of girls during their adolescent years are crucial to their educational and job-related choices. At this age, girls and boys start to examine gender roles. They begin to accept or reject behaviors according to how they match social expectations. Peer pressure becomes very strong. The computer gender gap emerges at this age. Girls who successfully pursue studies in the computer science field face great pressures at a time of development when their identity is being formed.

Gilligan (1982) identifies that girls base decisions on relationships rather than on personal goals and that girls experience a decline in confidence and self-esteem between the ages of eleven and seventeen. Choices made in these years clearly limit the opportunities that are available to them as adults.

Turkle (1988) suggests that for adolescent students, working with formal systems

of programming offers protective worlds from relationships with people. Although she observes that men are more likely than women to escape the anxiety of relationships by turning to the machine, the possibility exists that women who love computers are antisocial. If this were the case, then these women would be viewed as unfeminine.

In studying the lives of eminent women, Kerr (1994) found that women discuss the importance of time alone, the effect of being different, and the value of individualized instruction, childhood mentoring, and same-sex schooling. Guidance and encouragement during adolescence are critical. Many gifted girls struggle with a lack of confidence in their ability and experience conflict between social definitions of femininity and their own intellectual goals. Ultimately each girl must analyze the gender appropriateness of pursuing computer education and reject social norms.

Taking this risk prepares them for learning in an environment where risk is a powerful learning strategy. Turkle (1988) proposes that risk taking is necessary in programming courses where failures can not be taken personally and understanding of outcomes are unpredictable. A trial-and-error approach is rewarded by a later understanding. Women interested in continuing with further computer studies require confidence, risk taking, and a strong sense of identity.

Educational Background. A strong educational background influences the degree to which women are encouraged to move into non-traditional studies. The research suggests that success in computer science programs is linked to participation in mathematics classes. Also, gender research in mathematics indicates that confidence and the perception

of usefulness are important in determining success for females. Fennema (1990) argues that sex-role identity and external influences such as teachers, peers, and parents have an impact on confidence and achievement. Girls who are successful in math have a greater opportunity to consider studies in computer science. Singer and Stake (1986) found that scholastic ability and math background influence women's choices for math-related careers. Mura, Kimball, and Cloutier (1987) suggest that a girl's perception of the value of the task and her expectancy of success contributes to her choice to enroll in math classes. Task value is affected by intrinsic, utility, cost, and attainment attitudes. If a girl likes math, perceives it to be useful, feels that it benefits her in some way, and is successful in it, she is likely to enroll in math classes. For successful women in computer science, math is not a critical filter.

Parents also strongly influence female choice to enroll in post-secondary education. Women attending university are profiled as having parents who hold bachelors degrees and as being from high-income families. Sixty-four percent of such women have fathers with professional, managerial, or entrepreneurial occupations (Bellamy & Guppy, 1991).

Educational Links to Employment. In further studies of women who enroll in post-secondary programs. Bellamy and Guppy (1991) found that there was a significant understanding of the relationship of schooling to the work force. Women want to gain employment in areas that are personally rewarding and interesting and job-market awareness contributes to choices that women make. In an era where computer literacy is

becoming essential, women recognize that jobs in these fields will require more than just user skills. Of the top 10 occupations with the fastest employment growth projected between 1996 and 2006, computer-related jobs account for four (Stover, 1999). All of these areas of growth involve programming skills as database administrators, computer support specialists, computer scientists, computer engineers, systems analysts, and desktop publishing specialists. These occupations promise high wages and high employment.

Occupations with shortages in Alberta include radio frequency engineers, process control specialists, electronic engineers, database designers and administrators, network specialists and designers, software developers, systems designers, computer engineers, project managers, and web designers (Kernow Enterprises Inc., 1998). These occupations require university degrees in computer science or information technology. All of these occupations require programming knowledge.

For many girls becoming a computer programmer is not perceived as relevant since they expect to be the primary caregivers in the home. Researchers found that only 23% of high school girls expected to work full-time when their children were young while 88% expected their husbands to work full-time (Mura, Kimball, & Cloutier, 1987). Many expect to drop out of the workforce or work part-time when they have children. In contrast, women who enter the computer science discipline must be committed to many years of schooling prior to employment and continual upgrading once they are in the field. Moreover, to participate in a changing technology, they are unable to leave the workforce

without jeopardizing their accumulated knowledge and skill base.

Work and Family. Kerr (1994) found that the women she studied refused to be limited by their gender. They were able to combine roles of mother and wife with that of worker. They were able to take responsibility for their lives and based decisions on a strong sense of mission and personal identity. Because early marriage and childbirth limited the achievement of goals, many women delayed having a family. However, high demands for computer technologists offer women the opportunity to work from home or contract jobs and thus provide the flexibility necessary for combining family and career.

Gornick (1983) explored the experiences of women in science and found that these women were extremely curious about the world around them, they found pleasure in mental exercise, and were completely dedicated to their work. Most of these women balanced family and career, but stated that if forced to choose between science and family life, they would choose science. Many of them married men who worked in similar professions. When characterizing successful, scientific women, she describes them as truth-seekers, problem-solvers, and competitors that are free to be themselves with full humanity and individuality as women.

Consequences

Expansions in technological fields require more than word-processing and data-entry skills. High paying positions and high employability will be available to those who have programming knowledge. Learning to use the computer as a tool is not enough to ensure an equitable position in the developing computer culture. Those who do so risk

becoming passive consumers who do not experience computer efficacy. They will be in lower paying jobs, controlled by the technology that requires skills for performing monotonous tasks. These people are mostly women.

Schools can provide the vehicle for social change, however, if the disparities are recognized and addressed. Informed educators can become agents of change. As reasons for the gender gap are explored, researchers make corresponding recommendations for change. These recommendations closely match the social and educational reasons for the disparity.

Recommendations

Socialization

Role Models. Social perceptions of using computers need to change. Spender (1996) suggests that women do not identify with the type of person drawn to computers. The image of the technologist does not fit with the idea of themselves as women. Providing role models of women who are successful in technological fields and arranging mentoring programs are recommended.

The majority of the recommendations suggested in the literature emphasize that same-sex role models are essential in order to bring about desired change. Becker (1985) surveyed 2,265 American schools and found that 67% of the elementary schools and 44% of secondary schools identified females as the primary computer-using teachers in the school. In secondary schools where the faculty was over-represented by males, females still retained a high representation. Therefore, female role models dominated computer

education in the schools.

Women teaching in the elementary grades tended to use the computer more for programming activities and less for drill-and-practice, spent more time in class utilizing the machine, and had more positive attitudes about computers than the men did. At the secondary level, discrepancies arose because of course streaming. Computers tended to be used more by male teachers in math-related subjects and more by female teachers in business education. Men tended to be personally enthusiastic about computers, usually describing themselves as hobbyists. However, since girls represented the majority of students enrolled in business programs, they received instruction from a female computer user and encountered women who were computer literate. In other words, same-sex role models do not seem to have made an impact on girls' participation in computer courses. The presence of large numbers of female teachers who use computers has not resulted in a view of the computer as a gender-neutral technology.

Stasz, Shavelson, and Stasz (1985) found that male and female teachers did not differ in their training, experience, use of computers, and teaching strategies. They sampled teachers who were not primary instructors of programming or computer literacy classes in order to assess whether females and males differed in their capacity to be viable role models. They found that both men and women provided leadership in computer culture and that there were no significant gender differences between their pedagogical practices. These role models did not make a difference in preventing a gender gap from developing.

However, a distinction between role models as computer users and computer scientists must be made. The female teachers were models of the stereotype "women as users". Perhaps girls are effectively influenced by these role models and are choosing similar computer-use patterns. This would help explain why girls are primarily choosing to view the computer as a tool. Teachers who merely "use" computers do not serve as effective role models of computer programmers.

Mentors. Mentoring is a key strategy for encouraging girls to pursue scientific fields. However research shows that the influence on women is dependent on the character, not the gender, of the mentor. Many women had fathers, male teachers, and male classmates who became mentors (Gibbons, 1992). By specifying that same-sex mentoring is the key to increasing female participation in the computer science field, many girls are faced with experiences that reflect gender stereotypes. Female mentors who approach technology in male-oriented manners can completely discourage girls who are struggling with issues of sex-role identity.

Schooling

Integrating Computer Technology. Promoting computer efficacy for all students should be a priority. Gender attitudes emerge in secondary education primarily because of business and academic course streaming. Recommendations for integrating computer technology across many subjects have been made. Every student should have repeated opportunities to apply a computer as a tool in a variety of contexts. It is hoped that this will dissolve gender attitudes with respect to computer use.

Teacher Attitudes. The attitudes of teachers greatly affect students' attainment of computer efficacy. Research findings showing that girls learn as efficiently and effectively as boys when given the same prior experience should be used to destroy the myth that girls are not successful in computer activities. Teachers need to become aware of gender issues in computer education and provide equality of access, opportunity, and outcome when using technology in their classrooms.

Guidance Counseling. Girls need to increase their awareness of the job market and be presented with statistics relating computer fields to salary scales and employment opportunities. An understanding of the importance of work in their lives will encourage girls to see the necessity of being self-confident and productive members in a technological society.

Mowat, the president of Impact Communications Limited, believes that technology equalizes business opportunities for women because the importance of size is replaced by the value of competency (Maxwell, 1999). Technology allows business owners to compete in the global market with the flexibility of work hours, location, and capital investment. Conflicting roles of worker and mother can be resolved when technology is used to create flexibility. Social change can occur when women recognize the benefits associated with this occupation.

Access and Opportunity. Results of a study completed in 1982-1983 reveal that boys in grades 6 and 12 display higher achievement in tests of performance, attitudes, and experience in computer science than girls. The results are attributed to lower participation

by girls to interact with computers at school and at home. The suggestion is made that increased access and opportunity to learn about computer technology will result in higher levels of computer literacy. The justification for increasing girls' experience is that society's needs and individuals' needs will be met (Fetler, 1985). Researchers concerned with the lack of access to computers recommend that computers be utilized in spaces other than a computer laboratory. Collis (1991) recommends that teachers monitor computer laboratories to ensure that girls have equitable access.

Theoretically, if girls become computer literate, they will take advantage of occupational and educational opportunities. Although this seems like a logical conclusion, recent Canadian findings suggest that there are relatively small differences between girls and boys in computer usage. In 1993, 56% of women and 58% of men aged 15 or over used a computer. Women and men, who were 15 to 19 years old, had similar experiences in computer use, computer courses taken, and home ownership of computers (Statistics Canada, 1995). These statistics cannot explain the fact that even though the gender gap in computer experience is closing, women are not increasing their involvement in computer-related occupations. Computer literacy does not appear to result in increased employment in computer fields. Computer use and experience do not seem to be affecting women's choices to enroll in computer science programs. Increasing computer use does not necessarily lead to an increased interest in computer disciplines. Instead, this emphasizes the need to distinguish between computer users and computer scientists.

Software. Researchers propose that educational software appealing to girls should

be developed (Pearl, Pollack, Riskin, Thomas, Wolf, & Wu, 1990). The study by Joiner, Sproull, and Eccles (1996) found that using software with female characters did not significantly appeal to girls. In fact, they found that comparable numbers of girls preferred the male version to the female version. Changing the gender of the characters did not reduce or reverse gender differences in performance. Catering to a socialized view of girls when designing software does not seem to encourage greater participation by females.

Learning Styles. Turkle and Papert (1992) suggest that gender differences occur because of styles, not stages, of learning. They describe a "soft" approach to programming as one that involves tinkering and indicate that this connects women to objects of work in interactive and relational ways. Linear programming is viewed as only one approach, not the approach. Teaching strategies that encourage multiple ways of knowing and thinking may promote equal technological outcomes for women.

Ironically it is the computer industry that is contributing to this new way of thinking. In order to reach new markets, companies are designing interfaces that allow the average user to be successful. The introduction of icons and object-oriented programming allows nonprogrammers to use the machine with ease. The popularity of the Macintosh computer has influenced the PC world to become more user-friendly. A mechanical understanding of the computer is being replaced by an acceptance of the consumer object as an opaque tool.

Sanders (1985) proposes that allowing girls to use a computer in a practical setting

encourages greater computer use. Student use of word-processing, database, and graphics programs appeal to students who view the computer as a tool. While skills like these are necessary for all learners, higher-level skills are required for computer-based occupations. Women's leadership in computer culture depends on programming skills. Greater computer use does not imply greater computer interest.

Another recommended teaching strategy involves group work. Computer activities should include having girls work cooperatively in teams rather than participating in individual competitions. However, Fennema and Peterson (1985) link high cognitive thinking to autonomous learning behaviors where learners can experience success when choosing, working independently, and persisting with difficult tasks. Perhaps when teachers concentrate on cooperative learning strategies, girls are more likely to attribute success to a group effort rather than to ability. Experience with computers in group settings does not necessarily lead to individual expertise in computer science.

Alarming Outcomes

Many of the recommendations are a result of common sense reasoning, but are not substantiated by research. Moreover, many of them are based on research done in the field of mathematics. Collis (1991), however, suggests that intervention programs do not have any sustained impact on females' use of school technology. In spite of positive results in narrowing the disparity in mathematics enrolments between the genders, changes as a result of these recommendations seem to have little effect on participation by females in technology courses. In fact, not only do they have little effect, negative results

are evident.

A statistical look at math participation indicates that males and females are taking a comparable number of high school math courses (The American Association of University Women, 1999). The number of university degrees granted to women in mathematics and physics are increasing (Statistics Canada, 1995). The opposite is true of women enrolled in computer science courses. The report commissioned by the AAUW finds that high school girls are taking few computer science and computer design courses and that girls tend to enroll in lower-end data entry and word processing classes. Current trends in computer science areas are totally unique and puzzling.

From 1992-1998, girls' involvement in computer science courses has dropped. The AAUW report finds that only 17% of high school students writing advanced placement computer science tests in 1997 were females. This was the lowest of all placement tests given, including physics. In 1985, women were awarded 36% of computer science university degrees; by 1995 women received only 28%.

Similar trends are evident in Canada. Recent Canadian statistics have shown a dramatic decrease in women enrolling in computer science courses at the university level (Martin & Murchie-Beyma, 1990). Tahany Gadalla (1998), from the Ontario Institute for Studies in Education, University of Toronto, found that from 1972-1983, male and female enrolment in computer science undergraduate programs steadily increased, although a gender gap was evident. After 1983, both gender enrolments dropped. Whereas male enrolment has bounced back, female participation has continued to decline. The Canadian

Engineering Human Resources Board in Ottawa documents that in 1996 females comprised only 10% of the students in Canadian undergraduate programs in computer science (TMP Worldwide, 1998b). In a recent interview, Maria Klawe, head of UBC computer science department, estimated the number of women in computer science programs in North America to be around 15% and has noticed that the situation has worsened in the past 15 to 20 years. Jane Fritz, a professor of computer science at the University of New Brunswick, suggests that there is a disturbing trend in female enrolment in computer science and electrical engineering in the past 15 years. Enrolment figures have dropped from 40% to 20% (TMP Worldwide, 1998a).

At a time when Canada is investing money and resources to make computer technology available to students and to promote the use of technology in the classroom, the lower participation rates by women in computer science are difficult to understand. Since there has been a rapid growth in industry needs for technologically skilled workers, the trend is puzzling.

I shall be exploring the reasons for this trend in the following parts of my thesis. I believe that descriptive inquiry into the childhood background, schooling experiences, and personal characteristics of these women will create a profile that informs recommendations for educational change. The choices that girls make in limiting their leadership in the technological era could have devastating consequences for them and for society. Further research is needed to correct this feminine mystaque.

Chapter Three: Methodology

Introduction

My study employs both quantitative and qualitative research methodologies. Much debate surrounds the research traditions of both these approaches. Gay (1996) compares the two types by describing quantitative approaches as focussing on numbers, explaining and predicting, controlling variables, involving deduction, attempting to "prove" hypotheses, and producing generalizable results. Qualitative research emphasizes using words as data, gaining insight into a phenomena, involving many variables, using induction, generating hypotheses, and producing in-depth and specific understandings. Gay suggests that the type of research procedure chosen is dependent on the nature of the problem or question to be investigated. He does not find these two types of research to be in opposition.

Many qualitative researchers, however, disagree with this reasoning. Maykut and Morehouse (1994) argue that philosophical differences distinguish qualitative methods from quantitative approaches and that each approach represents competing views of the world. The use of numbers or words, the role of the observer as objective or perspectival, and the outcome of proof or discovery contrast the two types of research. Heshusius and Ballard (1996) describe the radical shift in paradigms that is necessary in embracing qualitative research methodologies. It is their view that embodied, participatory ways of knowing are results of fundamental shifts in assumptions about the world and that quantitative research based on positivism is merely an intellectual exercise that does not represent reality.

Current trends in research show that the two approaches are not necessarily mutually exclusive. Reichardt and Rallis (1994) recognize the strengths and weaknesses of both types of research and suggest that the combination of both methods results in a better understanding of the human condition. House (1994) explains that insider and outsider perspectives can better express the complexity of the real world and indicates that facts and values can be established in similar ways. He believes that qualitative and quantitative interpretations are composites of each other. Choosing between a mechanistic science and participatory interpretation limits the ability to focus on content as researchers emphasize methodology. The key consideration should be whether data exists in a qualitative or quantitative form.

The data gathered for my study existed in both forms. Combining quantitative and qualitative items in a questionnaire, I used quantitative methodology to identify patterns and themes that described successful computer scientists. Qualitative follow-up interviews complimented this information by further exploring these themes, thus providing insightful and in-depth understandings of why a particular group of women was successful in computer science.

Participants

Participants included a total of 31 male and 14 female students enrolled in a 3000-level computer science course or a 3000-level management of information technology course in the Spring 2000 semester at a primarily undergraduate Canadian university. The participants for this study were selected because they were accessible and representative of the larger population of students who were successful in technological fields of study.

The literature suggests that computer science is perceived as a masculine field of study. Gender stereotypes portray females successful in this area as masculine. In order to determine whether gender differences emerged in the reasons stated for success in computer-related programs, male and female responses were required. These gendered responses were compared.

Previous research emphasized the role of stereotyped views of computer culture in limiting girls' participation. Therefore, I chose to work with undergraduate computer science students in order to understand their process of overcoming these high school prejudices. This group of women represented those in the process of forming new social identities. Some research suggested that women working in the computer field had already adjusted their perception of computer scientists to match their experience. These professional women found fulfillment in the variety, the challenge, the cooperative work environment, and the opportunity to help people provided by this career choice (Clark & Teague, 1996). Studying the women who were near the completion of their degree provided me with a sample who were successful technologists not yet influenced by long-term employment in computer-related occupations.

I was careful to choose my sample from a population that would be prepared to meet current job shortages requiring highly skilled technological workers. I considered all technical programs being offered at post-secondary levels and chose university degree programs because they provided graduates with more than entry-level computer skills. These degrees met industry needs for programmers. Three relevant degree programs were offered by the university: Bachelor of Science with a computer science major, Bachelor of

Management with a computer science major, and Bachelor of Management with a major in management of information systems.

I chose students enrolled in a required computer science course in order to maximize the number of female computer science majors for either degree program. By sampling students enrolled in a required management of information course, I matched levels of experience, progress, and success in a program to students enrolled in the computer science course.

Although the study included male and female responses, the focus of this study was on women. Male responses were required only as a way of determining if differences existed between the male and female sample. Women were central to my research.

Instrument

A questionnaire was developed to measure participants' reasons for choosing the field of computer science (Appendix A). I chose this instrument because the participants' beliefs about what made them successful in computer science were central to the research problem. Self-reported responses were desirable and a questionnaire best matched the purpose of the study.

Items were based on the survey of the literature and current research, as well as suggestions from professors in the Faculty of Education and the Computer Science Department. Open-ended questions were used in order to learn about the respondents' beliefs. The questionnaire contained four categories of items: personal characteristics, family and childhood background, schooling experiences, and motivation. Participants were also asked to respond to items requesting demographic data.

In order to understand the gender differences emerging in the questionnaire data, I conducted in-depth interviews. I wanted to encourage open and honest conversation and, therefore, decided to interview those women who had volunteered to participate. Unfortunately, because of the small percentage of women in these classes, only two women from the computer science class indicated their willingness to participate in additional interviews and this limited my research. It was important to me to have a variety of perspectives, so I included two women from the pilot test who had also volunteered.

This enabled me to included women of different ages, degree programs, majors, and experience in my sample. Since this was a purposive sample and results were not intended for generalization, I felt this would add depth and breadth to my understanding of their success in computer science.

General categories of questions that reflected research reviewed in the literature and outcomes of the questionnaire were used. Specific questions were formed as the study progressed. An interview blueprint (Appendix B) was designed according to examples given by Maykut and Morehouse (1994). Each participant signed a consent letter (Appendix C).

Procedure

Pilot Test

I tested the questionnaire by asking for the responses of people who had recently taken the 3000-level computer science course. Eight names were obtained from the lab instructor in the computer science department. These students were contacted by

electronic mail in order to explain the study and request their help. Electronic mail distribution of the survey was used since members of this population were extremely familiar with the technology and time was a limiting factor. The questionnaire was forwarded to them. All eight students responded and revisions were made to two of the demographic items. During the initial contact, confidentiality was assured, privacy was maintained, and the respondent was not pressured to participate. Participants were thanked.

Questionnaire

Professors of the computer science course and the management course were contacted personally. The study was explained and each professor was asked for his cooperation in administering the questionnaire. Permission was given to introduce the questionnaire during the last fifteen minutes of the class. Questionnaires were distributed and students were encouraged to complete them. Seven females and 23 males were enrolled in the management course and 7 females and 27 males in the computer science course. The questionnaire was completed by 7 females and 12 males from the management class and 7 females and 19 males from the computer science class. This represented an overall response rate of 69%. However, it is important to note that all students present for class on the day that I administered the questionnaire participated in the survey. Confidentiality and anonymity were ensured and names of contact people outside the research group were made available on the questionnaire. Students were not pressured to participate.

In-depth Interviews

Follow-up interviews were conducted but were limited in number by available time. Four women were contacted by electronic mail and meeting dates and places were arranged. All ethical considerations of the questionnaire were followed. Each woman signed a consent letter and interviews were recorded using audio equipment to increase accuracy of the collection of data. Interviews were completed before students wrote final exams in order to encourage their participation. Transcripts were electronically mailed to each participant for review in order to check the validity of the interpretation.

Limitations

Regional responses and sample size limited this study. Results of the follow-up interview could not be generalized because of the sample size and purposive sampling method. The study did not include the views of students who were not successful in computer science. Basing questionnaire items on current research minimized researcher bias as much as possible. I was deeply committed to investigating the complexity of encouraging increased participation in computer science fields by all students.

Data Analysis

Results from the demographic information were tabulated. These were analyzed using frequency distributions generated by a computer software statistical program. The data was entered twice and checked by hand in order to increase reliability. The open-ended statements (Appendix D) were coded and analyzed by frequency of responses. Two of my colleagues recoded the data in order to ensure reliability. Categories and themes were identified and gendered responses were compared.

Follow-up interviews were transcribed and coded. Transcript conventions were recorded (Appendix E). Analysis procedures outlined by Miles and Huberman (1984) were used. Direct quotations and summaries formed the data for interpretation in order to preserve the thoughts, experiences, feelings, and perceptions of the participant.

Chapter Four: Results

Demographic Data

Thirty-one male students and 14 female students were surveyed. Since the sample size was small, the results could not be generalized. However, they did provide us with a picture of the population of people who were successful in computer studies at this university.

Enrolment patterns in age categories were similar for both genders. Almost three-quarters of the students surveyed were between the ages of 21-25.

Gender differences emerged in the choice of programs and majors. Sixty-two percent of the males were enrolled in a Bachelor of Science program, compared to only 29% of the females. Females tended to enroll in a Bachelor of Management program (50% as compared to 35% of males) or a combined Bachelor or Science/Bachelor of Management (7% vs. 0%). A related gender difference was in the choice of major. Sixty-one percent of the males chose computer science, 26% chose management of information systems, and 13% chose a dual major involving computer science or management of information systems. Statistics for the females were 29% for each of the categories listed above, with an additional 13% choosing majors not related to computer science or management of information systems.

Foreign students made up 10% of the males and 29% of the females. An additional 17% of the students were schooled in a Canadian province other than Alberta, bringing the total of males and females graduating from high schools in Alberta to 74% and 50% respectively.

Published literature suggested that females were more affected by the level of education of their parents than males were. When levels of education were compared, a higher percentage of women had mothers who had completed post-secondary education than men (see Figures 1 and 2). Again, this statement is tentative because of the small sample size.

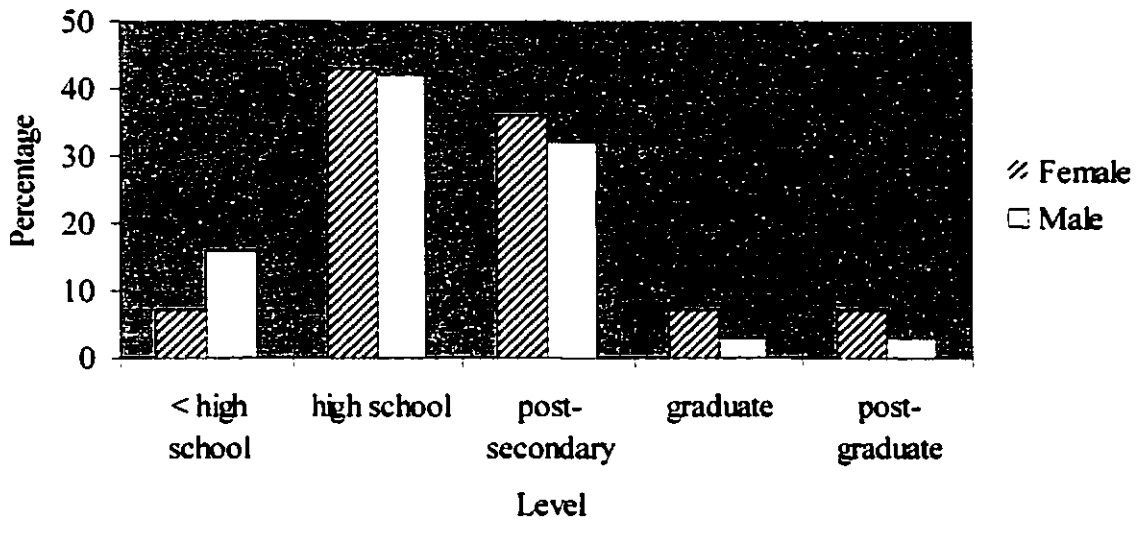

Figure 1. Highest level of education attained by participants' mothers.

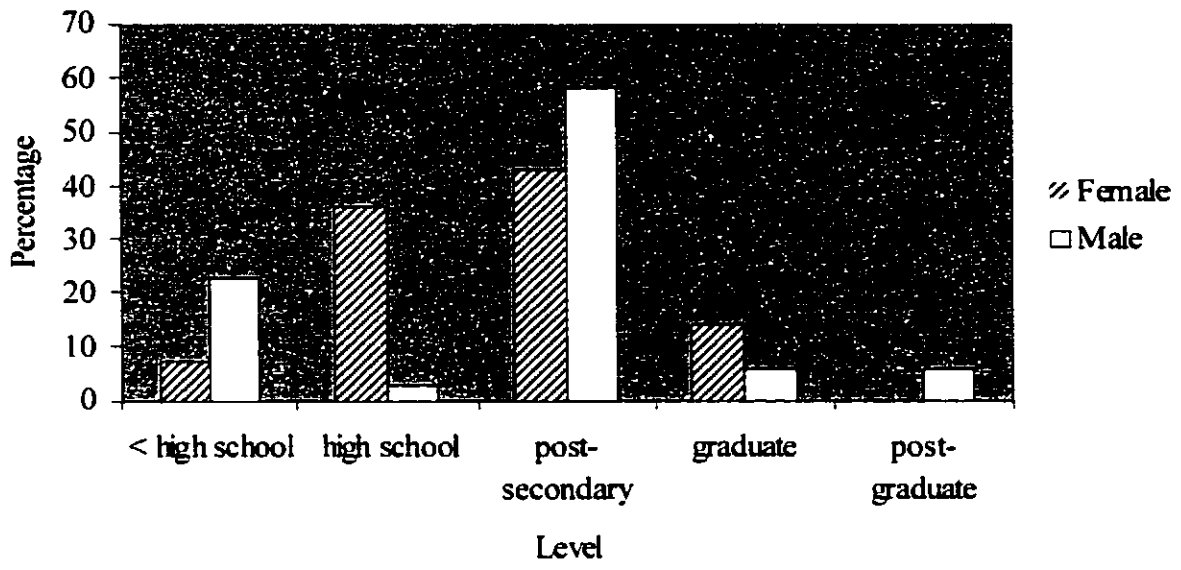

Figure 2. Highest level of education attained by participants' fathers.

In previous research, access to computers seemed to play an important role in the success of computer technologists. The data collected showed that females tended use computers for the first time later in life than males did (see Figure 3).

I had thought that the grade point average of women in this field would be higher than the men because of the self-confidence required to work against social stereotypes. I was surprised to find that this was not the case (see Figure 4).

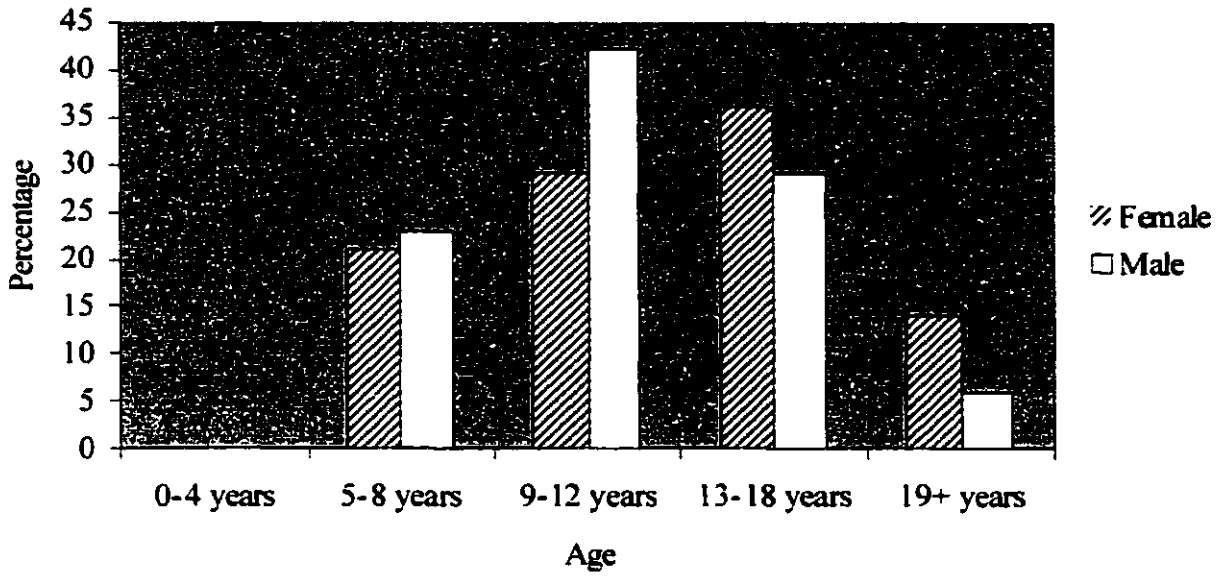

Figure 3. Age of participants when they first used computers.

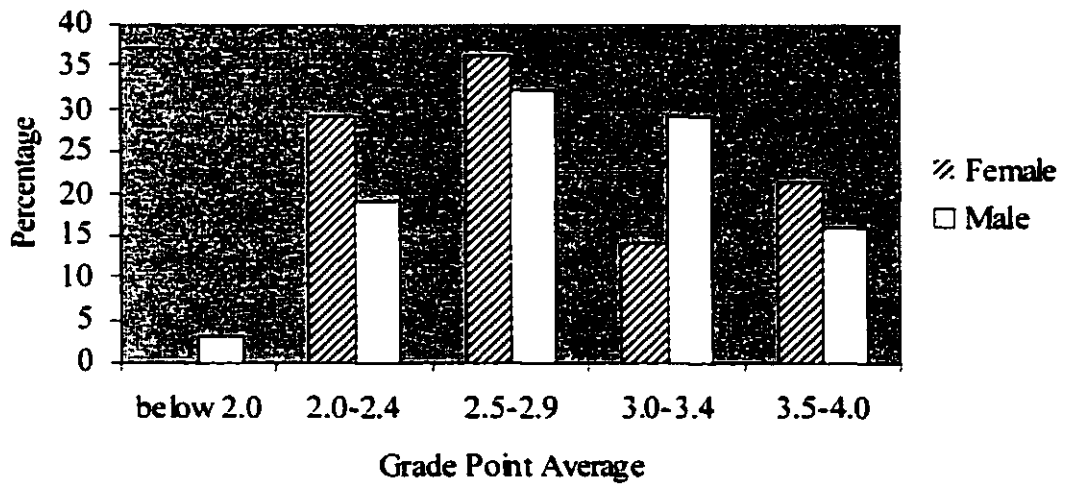

Figure 4. Current grade point average of participants by gender.

Descriptive Data

Four questions that required written responses were asked. Many students supplied more than one idea in their answers, therefore the response total for each gender exceeds the number of students. A comparison of the male and female responses was made using a ratio of 31 males to 14 females and converting to percentages.

1. *To be in this course, you have successfully passed a number of computer science classes. In your opinion, what personal qualities and/or abilities enabled you to reach this level of success?*

Table 1

Personal Qualities Enabling Success in University Computer Science Classes

	Male	Female	M%:F%	Comparison
Hard Worker	20	8	65:57	Males higher
Problem-solver	7	3	23:21	Similar
Good math skills	4	4	13:29	Females higher
Love of learning	5	4	16:29	Females higher
High interest	8	0	26:0	Males higher
Experience	3	0	10:0	Males higher

Females and males similarly and predominantly identified hard work as the most important personal characteristic leading to success in computer science. Females were more likely than males to identify math skills and a love of learning as helpful. Interest

and experience with computers were exclusively male responses, with interest in computers being more important.

2. *Were there any family and/or childhood experiences that influenced you to pursue university studies in computer science? Please specify.*

Table 2

Family and/or Childhood Experiences Influencing Computer Science Studies in University

	Male	Female	M%:F%	Comparison
No Influence	11	9	35:64	Females higher
Role Models	5	1	16:7	Males higher
Home Computer	9	2	29:14	Males higher
Experience with games/software	5	0	16:0	Males higher
Parent Support for Career	4	1	13:7	Males higher

An overwhelming number of females felt family had no influence. Nine of the 14 females responded this way, while only 11 of the 31 males felt this way. For males, having a computer at home and playing computer games on it were important. Males identified role models as influential and experienced more parental support and encouragement for choosing this career.

3. *To what extent do you think that your high school education has prepared you to undertake university courses in computer science? Please explain.*

Table 3

High School Experiences Influencing Computer Science Studies in University

	Male	Female	M%:F%	Comparison
Minimal/None	23	9	74:64	Males higher
Hindered	2	0	6:0	Males higher
Computer courses	2	2	6:14	Females higher
Math courses	6	4	19:29	Females higher
Other courses	5	1	16:7	Males higher

The majority of students felt strongly that educational experiences in high school had minimal or no impact on them. In fact, several male students commented emphatically that high school hindered them. Responses of "none" on this item were capitalized, underlined, printed largely to fill up the space, and followed by exclamation marks. Females were more affected by their experiences in math than with computers in schools. Most of the students found that computer classes were useless and irrelevant.

4. *What is your motivation for taking courses in computer science?*

Table 4

Motivation for Taking Computer Science Courses in University

	Male	Female	M%:F%	Comparison
Personal interest	16	6	52:43	Males higher
Money	8	2	26:14	Males higher
Job Future	9	5	29:36	Females higher
Required Course	4	4	13:29	Females higher

Women tended to be pragmatic in terms of choosing to study computer science. They were concerned with program requirements and future employability. Many females expressed an interest in the field, but males described their interest in terms of love, enjoyment, fun, and excitement. Most men chose this field because of personal interest and financial rewards. Women were less likely to connect personal interest in computers to monetary rewards.

Socialization was presented in the literature as the primary reason for women opting out of computer studies. One common theory suggested that women who were successful in computer science were androgynous. Another theory claimed that these women were just like the men, socialized as computer misfits and comfortable with this masculine label. Based on the questionnaire responses, we could not assume that successful female computer scientists had adapted to a male-dominated culture by acting

like a man. It appeared that the women in this study had much different experiences than the men and made very different choices based on their background.

Interview Data

Several responses to the questionnaire items puzzled me. I wondered how women, who had very little prior experience with computers, made the decision to undertake computer courses. Despite having few role models, a minimal amount of home computer use, little experience playing computer games, and a limited amount of related high school experience, these women seemed to have found success in technological studies. What made them successful? How could we as teachers encourage more women to consider this area of study? What could be done to present all students with opportunities in this field and prepare them for success?

In my search to understand these issues, I asked four women for the opportunity to interview them. I chose these women because they had computer science or management of information systems majors and they were graduates of high schools in Alberta. They graciously shared their perspectives with me.

On Socialization

Kathryn*. Kathryn, a woman in her late teens, was enrolled in a Bachelor of Arts and Science Degree program. She was majoring in history and computer science. As a student in her second year, she had completed seven computer science courses.

She was hesitant when explaining how she first got interested in computers: "I

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* All names have been changed

can't really remember what exactly made me decide to go into computers. I think I was interested in graphics, drawing things on the computer. When I was trying to decide what to go into in university, I was really sort of confused because I really didn't know what anything was. So I decided I'd try computer science. During high school, I liked the computer courses we had taken, but I was never really interested in them. Not extremely. I didn't have a computer at home. I really didn't get too much into it until I started university."

The choice Kathryn made to have two majors was described in pragmatic terms: "As far as I consider it, computer science is the major that will get me a job later and that will make me successful. Even though, I don't mind computer science. It is interesting. It's a lot of work. Whereas history is something I'm taking not because it will have any financial benefit, but because I really enjoy it and I think it would better myself to have that. That's basically why I'm taking the two majors. I do hope to combine them someday. I don't really have any plans for that soon, but I'm thinking after I graduate finally from school I will probably work in the normal computer science field for quite a few years. As I get more of an idea of what I'm doing and more stable and independent, I might try to do more independent things combining history and computer science, like making computer science programs that would help out history."

While Kathryn was clear in describing her passion as something other than computers, she suggested that the typical view of a computer scientist was totally wrong. When asked to describe one, she stated that "that's really hard to say because there's your general stereotype of computer scientist, but especially after being in computer

science, I realize that that's really quite false. Even looking at myself. I'm going to be a computer scientist and I don't think I fit the stereotype. Everyone pictures a geek, a male geek. Not all the males in here are geeks and not all of them are males. It's really hard to say. It could be anyone."

Kathryn's view of the work process differed a great deal from the antisocial picture of the loner: "Even though we're working individually and working on our own work, we're always discussing things with each other about the assignment. Do you do this? Do you do that? We're always bouncing ideas off each other, just talking to each other. I don't find it lonely at all. Even though you're working on your own thing, you're working beside other people. It's good that way."

When we met for the interview, Kathryn was wearing jeans and a T-shirt. She was also wearing a lot of jewelry and had long, blonde hair. She had difficulty maintaining eye contact with me, especially when I asked her about being a woman in a male-dominated work environment: "I don't ever really think of it too much. That's not really my goal. I'm not sitting there in computer science thinking how can I make them think I'm a girl. My goal is to learn and to do well and as far as me being a girl, if anyone cares, they should realize it without me having to tell them. I don't really worry too much about thinking, 'Oh, are they going to be thinking of me being a tomboy or not being feminine.' Even though you're surrounded by guys, I don't really care that much. That's not what I'm here to do. I don't really worry about trying to be feminine because the only way I can think of to do that is ...I'm going into the stereotypes. There's a sort of a stereotype of girls being maybe not as smart, maybe ditsy and happy. I'm not going to try and do

that to make people think of me as being a girl. Besides that being really silly, it's going to hinder my school. I'm just going to do as best as I can."

She seemed focussed on doing well as a student and did not see her role as changing socialized perceptions of women. She stated that she had not faced any obstacles in computer science courses that were not evident in other courses as well. Her biggest obstacle was that computer science was a difficult major that required a lot of work. To her, her role as a woman was irrelevant.

Her dad did not seem to play a role in her decision to go into this field as he was not computer literate. Her mom had completed a college computer course and was interested in computer hardware. However, Kathryn seemed unwilling to attribute her interest in computers to her mother's interest and suggested that she "wasn't sure" and that "it was hard to say if that influenced her."

Kathryn mentioned that some of her family members were end-users but this was not the same as being a programmer: "As an end-user, you basically just use the programs that people have created for you to use. I think programming is really interesting. It's like math, but different. It's like a puzzle. You have to arrange things and move things around so they work like it's supposed to. It's like theoretical math, not dealing with numbers and dealing with more structures. It's really interesting." Her expertise as a programmer is "probably just because I can envision it in my head. If you're dealing with objects which don't really exist but in a computer sense they do, like a linked list or something, it's pretty easy to envision that and I think that really helps. If you can't really see that, than you'd be in trouble."

Julie. Julie was an extremely articulate and expressive woman. She was 23-years-old and was completing her final year of a Bachelor of Science Degree with dual majors in math and computer science.

Of the four women interviewed, she needed the fewest prompts and questions. She spoke freely of her experiences and had very strong opinions. She seemed to appreciate the opportunity to express her views and was very willing to spend extra time talking to me. The university experience had not been kind to her, but she was excited as she prepared to start a new job in California.

When I asked her how she became interested in computer science and why she enjoyed it, she was emphatic in her answer: "It's not that I enjoy computer science. It's a means to an end. I enjoy horseback riding. I could not make a living doing horseback riding. There are a lot of upstart costs that I just can't cover. However, in computer science, the way the market is right now, you get your job, you can go down to the states, you can make piles of money, you can dabble in stocks and then retire when you're young and then I can do horses. I couldn't do anything in math. I don't think I could handle the research pressures of being a professor in mathematics."

She continued by explaining that computer science was a requirement of a math major and she did very well in the computer courses: "I got an A in [the first computer science course]. He should have given me an A+, I had 94% and then I got an A+ in [the second course] and thought, 'This stuff is easy. Why not? Why not? Why not just do it and then get your good job.' I like being good at things and I can be good at that. It's not that I love computers, but it's something that I can be good at. And I like being good at

things. I can't do what I love because it doesn't cater to the lifestyle that I want to have. So I'll work hard at being good at doing computers. And then I can like it for a little while without driving myself crazy, and then quit when I'm ready."

Julie was very aware of the socialized view of a computer scientist, but had developed her own distinction in order to find a place for herself: "There's a difference between geeks and "nerds". Nerds are people that work on computers. Geeks are people who work on computers and enjoy it. There are definitely more geeks in computer science than nerds given that definition. I'm more of a nerd type. I'm taking it because I don't think I can get a good job with math. I don't want to go on and get a master's in math so it's a means to an end. I can go down and get a good job, make some money and retire early." Julie was quick to point out that she found more geeks in school than on her cooperative work terms.

Work in university was a lonely process for Julie because she was a woman. She was the only person I interviewed who talked in great detail about problems she had encountered: "There were of course no obstacles getting into classes and no obstacles with professors. But definitely obstacles with students. I don't know if it's the type of student that computer science attracts, but in my first year, we were coding late at night (I think it was 2:00 in the morning) and there were three of us in the lab: two girls, including myself, and this guy. I finished my stuff and printed it out and was packing up to go home and he ripped my assignment right out of my hand. When I tried to grab it out, he grabbed me and another guy there said, 'Hey, knock it off' and [he] did. He failed the class and he hasn't been back since. So that might deter the faint of heart. But I'm not

the faint of heart."

She went on to describe an incident in her second year: "This obviously wasn't directed at me but there was one guy in particular who was surfing pornography right in the lab which I find kind of disgusting. I mean, there is a time and a place for that. So I told the lab Prof. and it never happened again. It's just an attitude that these guys have."

Julie described other events where she was grabbed, hugged, and hassled by men. She dealt with these experiences by becoming protective and defensive: "It took me awhile. Now I'm not nice to them. I have two guys that I respect and I like doing the work with and it's changed me that way from being a friendly person to really selective about who I'm friendly to. You don't say 'Hi' to everybody. You don't talk to everybody. You don't invite people to your study groups because you never know. You just never know. With these kinds of people, they stare at you and you have to pretend that they don't exist. You're an anomaly, you're a woman in their class and they stare."

In order to cope with the unwanted male attention, she bought her own computer and worked from home after her second year. I wondered if she had experienced any problems with men in other courses: "I haven't had those kinds of problems with any of the guys in math. Although I would say that it's interesting that in my fourth year computer science. I'm the only woman, but in my fourth year math, there's only one guy. So I never had a problem with the fellows that take math. It's been so long ago since I've taken anything else, but I never had a problem with them. I never had a problem."

Since she had experienced so much trouble with the men in her computer classes, I was interested to know how she viewed her role as a woman. She had dressed for our

interview in a navy T-shirt and jeans. She was petite, her hair was cut short and she wore no makeup. She was wearing a necklace. Her view of her role as a woman was consistent with her appearance: "Well, one thing's for sure. When you're doing computer science you don't dress very much like a girl. You don't wear tight shirts, you don't wear tight pants, you don't wear a lot of dresses. On purpose. That's just attracting attention. And the wrong kind. You don't want to be a sex symbol in these classes, so you don't exude femininity. You don't paint your fingernails and your toenails and wear red lipstick and stuff. You look like you're working, like you've got more important things to do than your hair and your makeup. There are some people, I think, that succeed in doing both, but I haven't seen any of it."

Her parents were well educated. Her father was a philosophy professor and her mother was a lawyer. She grew up on a farm and described the experience as isolated from other kids: "When I was first born, my mother was in law school, and of course she finished law school when I was two. She was busy so I was very much my father's daughter. When daycare wasn't available, what did I do? I went to philosophy lectures, and logic lectures and I could do Venn diagrams by the time I was four, which most people don't learn until second or third year. And I spent my youth with adults. But it's also the case that I know I wasn't a normal kid."

Her childhood experiences seemed to contribute to her view of working in computer science: "I grew up finding things like horses more reliable as friends and entertainment than other people who were often mean, especially when you're kids (and kids are evil). My father says I was born 35. And it is true that I have never liked kids,

even when I was a kid. I grew up being able to entertain myself. I don't need other people. Doing computer science by myself is just like not having to deal with other people. It's not a problem." This seemed to match the stereotyped view of the antisocial computer scientist.

Shannon. Shannon was a woman in her early thirties. She was in her second year of a Bachelor of Science program with a computer science major. She was the only woman I interviewed who did not have a dual major.

Shannon became interested in computers as a child. After high school, she did some upgrading and worked on computers in office environments. She married, got divorced, and then went back to college: "I graduated with honors but was unable to find work so I went into computer science here at the university. When I was at the college, whenever we had computer stuff, I always helped out in class. I seemed to know more than they did. When I couldn't find work, I thought, why not just go into computer science? It's something I enjoyed. There's a demand out there."

Her main motivation for choosing computer science was "my future as well as that of my daughter's. I'm a single mother and I'm thinking of both of our futures."

Later, she remarked that "if I'm working at home, then I have my daughter with me which is ideal. That's my dream job. To be able to work from home so I can be there with her."

When asked to describe a computer scientist, she seemed unable to present the stereotype: "A computer scientist? A programmer? An average person who likes, doing good problem solving, likes to work away on the computer, just like any other

occupation. How does someone describe a banker, how does someone describe a veterinarian? Someone who enjoys their work." I found this response interesting because she graduated from high school in the 1980's at a time when hackers and computer geeks were prominent. When I asked if she considered herself a computer geek, she was reluctant to answer the question. She responded that she did not consider herself that way because "there are some people in my class that are more into it than I am. Big time. For instance, they go on the Internet a lot more than I do. Some of them contract work out right now."

Then she wanted my thoughts on describing the typical computer geek because "what you may see as a geek, maybe I am or maybe I'm not." I tried to rephrase the question, but she was silent until I responded by describing a guy that worked at his computer all day and had minimal social skills: "No. No. If you know the people in my class, you would not agree with that. They are very sociable. You're thinking about the one with the pocket protector and the 'nerdy' glasses. I've never experienced that. In fact, the people that I've worked with and I have in my classes, they go out, they have fun. We kid around and joke around in the lab. I don't see myself as the computer geek. And I don't see any others as the computer geek, either. Unless there are some and I haven't met them yet."

She seemed to be very comfortable in the man's world: "Most of my friends are men because my classes are mainly men. I have no problem with it at the moment." She didn't feel that she had lost her femininity at all and described her interaction with the men in her class as "getting better. So I think I'm influencing them as well as them

influencing me. It's like a symbiotic relationship. It goes hand in hand. I help them out, they help me out. Co-existence."

Obstacles faced by Shannon as a woman occurred in the office environment where the pay scale was different and her family responsibilities were viewed as a liability: "I believe the reason why I couldn't get work after graduating with honors from the college – there were men in my class who were just barely passing, they got jobs right away – I couldn't even get an interview. And if I did, the first question was, 'Do you have kids?' The second question was, 'Are you married?', which is illegal for them to ask but they still ask it."

Her experience was different in the computer field and she was hopeful about her future in the industry: "One thing I do notice about this industry, I don't know if it's a different mentality, but the interviews I've been on, I haven't been asked that. After I have the job offers, and I've talked it over with my daughter and I found out that it was better for me not to take the job because of the separation, and I told them, they were completely understandable. In fact, one job said, 'If your situation changes and you're able to come, just give us a call. You have a job.' I greatly encourage women to seek out this type of field because the maturity level is a lot higher. The mentality is a lot better. I think the men see the women more as an equal, so it's a great advantage."

When I asked her what contributed to the difference in mentality, she suggested that the greater numbers of women and the newness of the industry were influential: "With a fresh industry, comes fresh ideas and fresh ways of looking at things. In this industry, with the problem solving you have to find new ways of approaching tasks and

problem solving. I think by training the mind with this problem solving. I think it's more of an equal basis because the mind's been trained with problem solving and different ways of approaching ideas, different perspectives."

Shannon's parents were very influential in helping Shannon be successful in computer science. When she was a child, "they bought us that little Commodore 64. As far as computers [go], my dad is self-taught. He taught himself when he opened up his business and that was about six years ago. My mom, I taught her, because she had her own business and that was about 10 years ago. My mom has worked on computers in an office environment as well and she is right now. I come from a family where they do encourage you. For instance, after my divorce and I decided I wanted to go back to school, my dad was trying to convince me to go into computer science because he knew I liked it. As it turns out, my dad was right. I wish I had of listened to him before because then I would be finished now. My parents have always encouraged me in whatever I did and that's important. Without that encouragement, I don't know if I would be here."

She was concerned with her own parental role in encouraging her daughter to be successful in computer science: "I feel that it doesn't matter what industry they're going into, without computers – you have to know computers. It's just out there everywhere. It's more efficient for your job. I think that for our children to succeed in life, they need to have the hands-on as soon as they can. My daughter has been on the computer at home since she was literally a baby."

Shannon seemed to be providing a rich computer environment for her daughter: "I'm encouraging her right now because I have all sorts of computer games and learning

programs for her at home. Plus sometimes she'll help me out if I'm working over the modem through telnet on a computer program. You can find that her name comes up quite often in my variable names because she'll be sitting in my lap and she'll be typing her name whenever that variable comes up. Also, I bought her an electronic digital keyboard for piano lessons. The reason why I wanted the digital is because you can integrate it into the computer. Later on she can have the experience of that aspect as well."

Her own view of the importance of computing impacted the decisions she made regarding her daughter. She believed that programmers and end-users were integrated and that "a good programmer needs the experience on the users' end in order to understand what they need and be able to proceed from that." She believed that computer experience would lead to greater success in life. She was committed to providing that experience for her daughter.

Jaclyn. Jaclyn, 23 years old, was in her fourth year of a five-year Bachelor of Science/Bachelor of Management degree. She was majoring in management of information systems and computer science.

Having started out in an accounting program, Jaclyn found that she did not like the job prospects associated with it. Since she was meeting the requirements of a liberal program, she was enrolled in computer science courses. She enjoyed them and was doing well in them. She did not want to lose the management courses she had completed, so she decided to do a combined degree.

She was able to describe the stereotype of a computer geek, but was quick to assure me that she did not fit that picture. She had changed her mind about what a

computer scientist was based on her experience at the university: "Since I've entered the program, I've met a few like-minded people that are the same as me. They have outside interests besides computer science, other extra-curricular activities outside of the university. They're not solely focussed on solving algorithms or playing around with computers 24 hours a day. They care about their appearance, they have communication skills." It was important for her to mention that geeks still existed, but other types of people were also in the field.

When Jaclyn switched from accounting into computer science, she found it lonely. This past year she was able to connect with another woman who shared similar interests. This made learning wonderful.

It was important to Jaclyn to challenge stereotypical roles: "I guess I feel that I'm defying the norm because I am one of the few female students. I think it's important for the professors in the class to see that and recognize that a female student can do well in the program. And I also think it's important for other students to see that there's computer science students that are female and that are different from the typical stereotype of the computer science person."

One way that Jaclyn challenged established stereotypes was "by dressing up, wearing makeup, almost going to the extreme of looking like a woman as opposed to wearing jeans and a T-shirt and a sweatshirt. I tend to feel better about myself when I look more feminine. I tend to want to look more professional. I like wearing dress shirts and dress pants and tend to do that even on a daily basis. I like to be considered a professional, classy type of person, someone with intelligence and that cares about their

appearance." For this interview, Jaclyn was dressed very professionally in a blazer and skirt. She was wearing makeup, stylish glasses and had long hair.

Jaclyn's parents did not encourage her to enter feminized programs and "because they didn't force those upon me or make me feel like that was what I should be aiming for, I aimed above it. It's actually to my advantage that they didn't pressure me or persuade me to enter any specific discipline." Education was very important in her family. Her father was a farmer and insisted that his children, especially his sons, pursue a university degree. Two brothers had or were working on doctoral degrees. Two older sisters enrolled in university but got married before finishing degrees.

Jaclyn did have experience with a home computer, but felt intimidated by math and computer science: "I've always been very frightened of them because it's almost like you need to speak a separate language to feel that you're comfortable with them and with people that know anything about them. Even still, I still feel intimidated because I don't know everything there is to know and I don't think anyone does. But certainly, lots of people know more than others do, especially in different areas. I think it's a continual learning process with computers and you just have to not be afraid. Once you learn the basics of the language, I've found this both in math and computer science, you're more comfortable with it. It's not as frightening. Knowledge is power."

Computer knowledge and user skills were seen as necessary. The combination of management courses and computer science courses provided strengths in learning how to effectively use a computer and how to design a software program that worked on the computer. Jaclyn preferred the design of things: "I find it more interesting. It's really

rewarding to work on a project and know that you've created something and that it works."

On Schooling

Kathryn. Kathryn's first experience with computers was in elementary school where "they let you play games all the time." She valued this activity more than the junior high experiences of typing and using the mouse: "I think that to promote interest, it's a good idea to let students just basically play around. I know people think playing computer games is not really a good idea, it's not really practical, but doing stuff like that probably helped develop my interest in computers because you play the games, but then you think 'How does it work?' It seems impractical, but it really is."

She elaborated on the importance of games by linking them to her choice of career: "Because I didn't have a computer at home, I never really played computer games that much besides a little bit in elementary school. I played Nintendo and even though it's separate from computers, I think that actually helped probably influence me going towards computer science because it's kind of the same thing. Especially because originally when I went into computer science, I was interested in graphics and creating games like that. I think playing those games influenced my decision to go into computer science." She became interested in games "because all my friends were doing it. I was 10 or 11 when Nintendo came out and everyone was excited. All my friends were playing games. I liked doing it because it was a challenge and it was interesting."

The experiences she had with computers in high school seemed to influence her choice to study computers in university: "Most of the courses, or all of them, I took in

high school were end-user. So it would be how to use the word-processing program or spreadsheet program or the graphics program. Just using the mouse. I did think those were interesting. It wasn't incredibly fascinating. As far as influencing me to go into computer science, the only one that really did would be probably the graphics one. And it wasn't even really graphics. It was just draw[ing] a picture with the mouse. And I thought that was interesting and I liked to do that so I thought computer science would be something good to go into. But again, another major factor for me choosing computer science was just the fact that I thought it's an industry where you could really be successful. There's lots of jobs available and the pay when you get out is pretty good." She was very clear on emphasizing the importance of the job market in her decision-making process.

She viewed learning as an active process, made easier in computer classes when all students had computers to work on: "In computers you can be hands-on and have your own computer while the professor is speaking or the teacher, and you can do actually what they tell you to do. You can use the program or do programming or you can have your own computer and take it apart a little bit. I don't know if they want to encourage that in high school. It's easy to get student participation if they have their own thing to do. You do what you see being done and it's easier to pay attention that way."

Kathryn also acknowledged the importance of independent learning: "Most of my learning takes place more at home when I sit down and try and study it and when I sit down and try and do the programs. That's when you really learn is when you sit down and try and do it. You have to go over and make sure you know what's going on. It's

really important to be able to do that because if you can't, you're in trouble. You can go and ask for help, but they can only help you so much. A lot of times being university, as opposed to high school, there isn't quite as much help available. Not so much babysitting. You really have to be able to do it yourself."

Kathryn was the valedictorian for her graduating class and experienced much success as a student. She had consistent marks in every course, which increased her options when deciding on further study in university. She completed Math 10, 20, 30, and 31 and felt that computer science and math were connected: "It was definitely a help to have a math background. And even in university the more math courses you take, the easier computer science can get. There is definitely a difference between computer science and math. It is possible to be good at computer science without being very good at math. But it helps. Having math background in high school did help and it helps having more math in university."

I asked Kathryn to consider what prevented girls from pursuing careers in computer science: "I really don't see anything preventing me so it's kind of hard for me to imagine for the girls that are prevented what exactly is going on in their heads. I think, again, it might just be the stereotype. The general stereotype that girls don't like science, or girls don't like technical math or computers and stuff. I guess they're raised to think that it's boring and that it's something you don't want to go into. Really, I think it's not boring at all. Well, some of it is. With computer science, compared to history, I think it is a little bit dull. But there's a lot of interesting things you can do. You just have to get over the stereotype of it being boring and not interesting. The only way that I've done that is

just to go and learn it. In high school, I was never really discouraged by sciences and math as opposed to other courses. I don't really know why. Maybe it's my natural tendencies. I thought some of them were maybe more boring than English or social, but I still did fairly well in them. Going into computer science, the more I learn about it, the more I realize that a lot of it is really fascinating. It's a lot of tedious details, but when it comes together as a whole and you find that you know enough to do something practical with it, it's really nice. It's empowering."

Her recommendation to high school educators involved reducing the attention given to gender differences: "I personally don't understand why women don't go into computer science. I know that there's a stereotype, again, of computer science: you have to be a geek. But [the way] I see it: geeks make money. I really don't care. I don't think you'd encourage women any differently than you would encourage men. Just by providing them with more computer science education: An introduction into computers in all sort of areas, hardware, using computers, maybe programming computers. Just making sure, like you do in math, that you're trying to make it so everyone's involved. Not be more focussing on the males and the females, just make sure that you put across the point that there's nothing wrong with being a girl and interested in computers."

Kathryn added that "in high school, the idea of being a computer scientist, I don't think I even realized that until I started to go into computer science. I think that's kind of a big deal. When they suggest things for you to be when you grow up, you can be a math teacher or a biologist, never did I even hear anyone mention computer science. It's silly, especially considering the great demand for it now." Her first understanding of this career

was from university professors. She felt that she still didn't really know too much about computer scientists. This formed another recommendation to high school educators.

Julie. Julie told a story of adolescent isolation. Her years in junior high were characterized by loneliness at school and escape at home: "I really never liked my peers. If you want to go into junior high, especially by then, the love of my life was horseback riding. And there was no one in school I could share that with. There's never been anyone except for my father that I could share that with to the extent that it is my calling. It is my thing. I love just playing mind games with the ponies and trying to get them to enjoy what you're asking them to do. And there was no one at school I could share that with. In junior high I had friends that I would eat lunch with. I would never do anything with them after school."

Perhaps her experiences in school helped her thrive in the isolated environment in computer science education. When asked if she found the work lonely, she responded, "That's not a problem for me. I don't know why. I mean, I work hard. I've always been that way. It's a character trait. I don't find it lonely."

Her interest in computer science was not a direct result of any school or childhood experiences: "I thought I was destined to be an art student. So I started in arts, took calculus in my first year and loved it. So I started in math, and then said, 'What the hell am I going to do with math?' and so did computer science. And here I am. It's nothing really in my childhood that made me pick computer science. It was all in university."

Julie suggested that nothing in high school influenced her decision to go into computer science. However, she implied that computer science became a natural choice

after she determined that a math degree was impractical. She had the option of studying computers because of her experience with success in math. She mentioned that her confidence in math came from her interactions with a grade 12 math teacher. From him she learned study skills that influenced her attitude towards learning: "That taught me that with hard work I can exceed whatever natural ability I happen to have. I didn't have any natural ability in math. But with hard work, I could. And that teachers are approachable and teachers will help you if you ask them nicely. So I came here with the same attitude and I took calculus. No it wasn't easy for me. I went and talked to my prof often. I'd ask him questions for every assignment. And when I'd get an assignment back and I wasn't satisfied with the mark I'd go talk to him again and get marks back. And that was another good experience. [He] didn't mind that at all. And so it just reinforced it. That's the way you get through. That's the way someone like me who's not gifted gets through. You do it by working hard and you go and you talk to your profs often and you ask questions." It was this attitude that encouraged her to attempt computer science courses.

Since she had been deeply impacted by a teacher, I asked her to explain what made him effective: "He had us working in our groups so that it was comfortable. Our desks were together. If one of the kids in the group had a question, they could answer it. Why doesn't everybody do that? I don't know. He told corny jokes, which livens it up a bit. Yes, they're stupid. And everyone thinks they're stupid jokes, but it gives a certain amount of levity to a serious subject. It makes it more accessible to students who are having the trouble rather than just bogging them down in constant surge of information. He was approachable. As I said, I could go talk to him anytime. Anytime." She added

that the same teaching strategy of working in groups should be encouraged at the university level.

She identified math teachers as detrimental to the computer science field: "Some of these people that graduate with math education shouldn't be. Shouldn't be. If you don't like math, if you don't understand math, or if you have to take calculus three times to be able to get your D and get out, what are you doing teaching other kids? You obviously find math hard. And it's those people that tell kids that math is hard and that it needs lots of work. Don't tell them it's hard. Teach them how to work at it. I don't understand why these people pick math. I guess it's easy to get a job in math maybe, I don't know. But there are an awful lot of women doing math ed. who are not helping the kids of tomorrow, the university students of tomorrow, do any better. The ones that make good math teachers are the ones who are good at math and like math and like working in math."

She connected success in math to success in computer science: "There's nothing that the high school can teach that prepares any kid for computer science classes. I don't think there's anything that a high school can do other than keep trying to teach kids basic skills. You need math skills, you need study skills, you need work skills. And if there are people that can learn work skills, then they're good people for computer science."

Even though Julie believed that school contributed to her learning, she understood that personality and family background had more impact on her choice of career. She was hesitant to make recommendations in order to encourage more women to go into computer science studies: "I think it has to be a decision that people make based on their personality and their personal preference. A lot of women in high school know they just

want a desk job. They know they just want to be secretaries. This is not a job for people who don't want to work. And a lot of people in high school don't want to work. They get through with C's. You can't encourage those people into this industry. You're not doing them a favour. The learning doesn't stop after university. As a matter of fact, you have to learn faster when you get out because the industry is accelerating faster than an educational institution can keep up. Not everybody is suited to the job. Your parents have to raise you that way. I don't know if the school system can raise kids that way."

Shannon. Shannon's high school experience minimally impacted her decision to pursue studies in technology. However, she identified her experience with problem solving as the basis for success in computer science. This ability to problem solve was connected to math: "I've always had a natural aptitude for math. I think that's where you have problem solving. The English courses I was good at and I enjoyed reading that, but the math courses is where you have problem solving."

As a parent, she was trying to encourage her daughter to problem solve: "Let's face it. If we're just starting something for the first time, we're scared. But if it's something that we have been doing for years, from the very beginning, it's more natural. It's like when you're first learning to walk. It's kind of scary at first. But now you're running around and everything. It's the same thing with problem solving. I believe that if a child is in an environment where they're able to experience the problem solving, as they get older, it's more natural and they're able to pick up more, more, more." She suggested that schools could provide more of an environment for problem solving: "I wish there were more courses that were more like the math courses where there were problem

solving. I'm glad that they will be putting computer science in the high schools. It's a big advantage." When I explained to her that most computer classes in high school were end-user oriented, she felt that that would be "a definite advantage for anybody. But as far as the computer science field, there is talk that they're going to have programming, C++ [a computer programming language] and those languages, high level languages which I think will be even better."

She established that independent learning was essential in this industry: "This is an industry where you're constantly learning. If you don't have that ability to teach yourself, then when you have your degree and you go off into the job force, and there's new languages out there and you don't know how to teach yourself, you won't survive."

Although she did not mention any high school teachers who had been influential, she identified computer professors who had impacted her learning. They were described as good professors because of their teaching skills: "There're profs up there that are excellent in research, but they lack in teaching skills. For instance, there's this one. I was looking forward to having him again this year, and in the summer he was snatched up by a university down in the States, down in Texas. He had the teaching skills. He had the knowledge. You could talk to him freely. You could joke around with him. You felt at ease with him, which is very important. If you feel uncomfortable about talking to your prof about a particular assignment or a problem you might have, then you're not going to talk to him and you won't find out what's wrong, what obstacle, how to overcome it."

When asked to consider what prevented girls from pursuing careers in computer science, Shannon was perplexed: "Maybe they don't know what it is. Maybe they

haven't had the experience. Maybe they're scared. Maybe they don't have the self-esteem. Maybe they think that it's just a man's world. It's funny, because when I'm in classes, there's only a handful of us that are women. The rest are men." She noted that she was in a male-dominated environment but did not see that as an obstacle.

Jaclyn. Jaclyn suggested that her friends in school were instrumental in helping her develop as an individual: "I had a really solid group of friends in high school. I wasn't afraid of what people thought of me. I wasn't very outgoing. I tend to be a more quiet person. I keep to myself. I don't make a lot of friendship or acquaintance type contacts, but the friendships that I do make are more deep and lasting. With the really solid group of friends that I had, it made it really easy for me to focus on any type of career path that I wanted to. I wasn't that concerned with it. I knew that I would do something that was best for me and that I wouldn't be following them to specific colleges or universities because I didn't know what I wanted to do. I was never really like that. I didn't have anything really set in my mind about what I wanted to do as a career, but I knew that I did want to go to university."

Because she felt that computer knowledge was very important, Jaclyn took two computer courses in high school. In order to schedule these extra classes, she arranged with a teacher to work independently during noon hour or after classes. Her motivation for taking these courses was pragmatic.

Her connection of math to computer science was not evident: "I've always really enjoyed solving puzzles and problems but I didn't view math as being really that way until I got into university. The math departmental in my grade 12 year was the worst

[exam]. I performed more badly on that than I did on any of the others. It brought my mark down to a low A for that class." Obviously she classified herself as a gifted student: "I was constantly on the honor roll. I graduated second in my class."

A math teacher was briefly mentioned as influential because of his teaching style: "My teacher was not discriminating towards females at all. He was always very open-minded and he was a very logical thinker, a very logical man. Not everyone liked his style of teaching, but I really did. So I think that my math courses were better because of that. I've never considered dropping down to the lower level math courses."

Jaclyn's experiences in the faculty of management were different from those in the department of computer science: "The math and computer science department tends to take a different approach to the way that they teach courses. In management, it's a lot like high school or college type courses where you're spoon-fed the information. They hold your hand through the process and make sure that you understand at every stage of the way. It's an easier learning process. In the math and computer science courses I've taken, you're left on your own; you're left to your own devices to figure out things. The textbooks are not as easy to read. They're at a higher level. There's not as many examples which makes it very difficult to do assignments. Typically you have to tend to work in groups because there's no other way to get the assignment done. They're not as concerned with holding your hand but they're more likely to force you to figure things out on your own. It's almost as if they're trying to weed out the people that aren't sure about whether or not they want to enter that faculty or courses from that department."

Her recommendations to high school educators were based on social roles and

career counseling: "I don't know what educators could do. It almost goes back to the mindset of females or even just personality types. We tend to like things like home economics and things and tend to sign up for those classes more readily than we would computer classes especially in high school when you're not really thinking about the future. I've always been more practically minded though, sometimes to my disadvantage. I'm constantly thinking about the future and how that will affect me. That's why in addition to the electives that I took such as band and things that I really enjoyed, I made sure that I had a few more practical courses in there as well. It goes back to changing the mindset of people as to what they want to pursue in the future and what will help them to get there. So maybe, just helping students to view high school in a different light. As opposed to a time for fun and games, it is that, making social connections and friendships, but also to prepare them for the future and any jobs that they might like to get after high school or any career they might want to pursue after high school."

Her high school did not provide any information to Jaclyn about careers in computer science. She found out about career prospects through a friend in university: "I had a friend that was doing the same program as me, Management and computer science combined degree, and he did a work term up in Calgary and told me about some of the amazing opportunities up there. People were getting hired on before even finishing their degrees, they had unlimited expense accounts, the companies were paying for their living expenses and their apartments, they could basically state the hours they were going to work. It was very open because computer science students were in such high demand. I'd kind of known that before, but I'd never really considered it as a career option. Once I

started considering it, those were just added benefits to what I had already decided that I liked."

Support from friends had been evident throughout Jaclyn's schooling. Her main strategy for overcoming obstacles was "having friends in the same discipline that reassure you lots of times because it's scary. It's not an easy degree but by building those friendships and realizing there's other people that are in the same boat as you and if you can stick it out, then everything will be okay." When she became discouraged, she concentrated on "keeping the long range goals in mind as opposed to focussing on individual grades for classes but making sure that you understand what's going on to the best of your ability and focussing on what you want to accomplish in the future."

On Personal Characteristics

Kathryn. Kathryn was extremely career oriented. She had an extensive long-range plan that included a 16-month cooperative work experience placement, and then returning to finish her undergraduate degree. She envisioned working to save up money for graduate school and then proceeding to complete her master and doctorate degrees. After this, she planned to work in the industry for five to ten years. When asked why she was so career oriented, she explained her life goals: "I think I see that as the way to accomplish things in life and the way to get things you want in life. One of the things that I'd really like to do that's not too much related to my career is I'd like to see the world. I'd like to travel to different places and experience different cultures. Like live on the other side of Canada, live in the states, live in Europe. To be able to do that you need to have obviously money, but also the kind of job where there's enough demand that you could work wherever you

want. That's one of the things I really like about computer science is that there's freedom. The only limit is like in a place like Lethbridge. You can't find too much jobs. You have to stick to major centers. Besides that, you can go anywhere. That's really nice."

A conscious decision had been made by Kathryn about motherhood: "I don't envision it soon, that's for sure. If I were going to do it, it would probably be after I get my Ph. D. and after I've been working for a while. Of course, assuming I find a father, that would be nice too. I can't ever see myself giving up my career no matter (I can't see myself having that many kids) but even if I have one or two, I probably will take a year or two off and then go back to work. As far as I'm concerned, if I've spent 10 years trying to get my Ph. D. in computer science, I'm not going to quit five years later and have children and just not do computer science for the rest of my life. It's still certainly possible to, especially with computer science, because you can work at home so much and you don't really even have to go to the office. Just send all your stuff through email. It is possible to be a mother, I guess, but it's not at the top of my list as far as goals is. It might happen, but I'm not really in any hurry."

Kathryn described her success in computer science in terms of personal ability: "Probably, just having a general ability to grasp the concepts, that's definitely important. I think one of the major things that's important is having a lot of dedication. The assignments that I have assigned every week take 10, 12, 15 hours to do. It really takes a lot of patience, too, because they're the kind of assignments where it's sort of like math in a way. Either it works or it doesn't. But you can have it working but yet one little thing won't work and then you have to spend hours and hours trying to find this one

little tiny error. It can be something as simple as you forgot an equal sign or a semicolon or something like that. It can be really frustrating. It takes a lot of patience to be able to sit and go through it and do all that. Again, it takes dedication. It's just sort of an aspect of my personality. I guess a bit of perfectionism. If I don't have it done, I'm not happy with myself. So I sit and work at it until I have it done. That really makes you successful."

Time was the only factor that kept her from reaching her full potential: "One of the things that I found that makes university so difficult, especially in computer science, is not so much that you can't get the things done, you're not smart enough or it's too difficult to figure out. It is difficult. You really do have to think about it. But a lot of times, if you have enough time to sit and figure it out, you can get it done. It's just the problem of it takes so much time. On top of that, you have your classes and you have five different classes. Right now I'm taking three computer science classes and you just don't have time to do it. It's not so much that you can't, just no time."

Was she passionate about computers? "It's hard to say. When I compare myself to a lot of the people I go to school with, they're hobbyist computers. They get home at night and they play with their computer and they do things with their computer. I do a little bit, but not nearly to an extent that they do. So when I'm doing my assignments and things, I am fairly passionate because I think they're interesting and I want to get them done. I can see as I get more into computer science and get better at what I do, wanting to maybe to work at it at home. I don't know. It's hard to say. In some ways I am and in other ways I'm not. I'd still probably rather read a book than do a computer program. I

guess, moderately."

Julie. Julie saw her success as a computer scientist as a product of her determination: "It takes sheer determination and will power to do computer science. It's a lot of work. It's not hard work compared to math. I mean, I could spend ten hours of really intense labour and have to go talk to my prof and it's just hard, a really hard assignment. But in computer science, it's nothing for them to give you an assignment that takes 40 hours of just sitting there, typing it in. Concepts are easy to understand, but it still just takes work to get it in and get the compiler working properly, finding little bugs and little typos that you made. It takes time and so you have to spend the time.

She was engaged to a student in computer engineering at the time of our interview. When I asked her about her thoughts on balancing a career and motherhood, she spoke with some hesitation: "I guess you have to be career oriented. Why do computer science and be a stay-at-home mom? I've never wanted children. Never. So a career is what's left. I've never wanted children, so I don't see myself ever wanting children. So that's fine for him too. And so we're just going to go and be career people. Just because I'm attracted to intelligence doesn't mean that all women in computer science are attracted to intelligence. I mean, that's just what I go for. I'm going to be working all day and I want to be able to come home and talk about what I was working on and have the person understand without me having to give him a Bachelor of Science in computer science. So that's just what I look for in life. I don't think that's a generality at all." Although she had chosen a non-traditional path, she was somewhat hesitant to share that with me. After our interview, I mentioned to her that I also had chosen not to have children. She seemed

grateful to be able to share more of her thoughts on this with me.

Was she happy with her career choice? "Yeah. Or put it this way, I can't see myself doing anything else. I have an excellent job. As soon as I write my last final exam, I'm going down to California. I've got a good job down there. It's exciting. I was born [here], raised [here], so going to California is an exciting thing. I'll be doing something new. My boss, so far, seems like a really great guy, and I'm really looking forward to a change and the parts of my world that doing this job can open up for me. I don't think it's something that I'll do forever. I know I won't. But, yeah, I'm happy with it."

Shannon. Shannon had deliberately chosen this field in order to reach her life goals: "I want to work as a programmer and I would like to have the type of job where I have the option where I can work from home as well as in the office. You can't do all the work from home. You have to go into the office for meetings. That is my dream. This way I can work and be there for my daughter. Being a single parent, it's very important for me to be there for her. How many jobs allow me to do that? Not very many. I believe that this is one field that does."

Her success in computer science was based on natural aptitude and interest: "Well, I enjoy being on the computer. If you're the type of person that cannot stand sitting in front of a terminal, in front of a monitor, typing away for literally eight hours straight, then it's not the occupation for you. But if you're the type that enjoys problem solving, because there's a lot of problem solving in programming. For instance, just the other day we finally completed our assignment. I had this great feeling inside of me and I'm so excited and so proud because yes I accomplished this, yes I solved this."

The limitations faced by Shannon included the location of jobs; she was restricted by family obligations. She also expressed a tendency to have self-doubt at times and felt that this limited her from reaching her full potential.

Blending a career with family was not a choice for Shannon: "I'm in the situation where I have to have a career that would pay enough money so that I can raise my daughter and this is one of those. Either I go into a field where I'm working all the time in an office or somewhere else, or I go into a field where I can do that plus be at home for her. After researching and talking to a bunch of people, I found out that yes, I've made a good decision going into computer science. One of our academic assistants just came out of the job force. He's been telling me that depending on what team you're on, quite often they will let you work from home and go into the office on set days so that everyone's there and they can have their meetings. I just hope I'm lucky enough when I'm finished to find a job like that."

Did she consider herself passionate about computers? "Yes. I enjoy it. I find that if I go a week without going onto the computer, I'm antsy. I can't wait to go on... It's something that's inside of me. It's something that's been taught in a sense. Well, I don't know. I don't think you can teach it. There are quite a few people who don't even do their assignments, which I don't understand. Ever since I've been at the university and I've taken my first computer course, I liked it so much that I just wanted to keep going. For instance, this summer I'm going to learn more languages on my own, which I think will be beneficial. I think the more experience that you have, the more of the desire builds inside of you to learn more. It's like an addiction, almost. In a good sense." She saw

herself doing this for the rest of her life: "I wouldn't mind doing some work on my own. On the side. With some programming. Come up with something that maybe I could market. I don't know if that's possible, but it's a dream. It never hurts to have dreams. We all have dreams. I think it's healthy."

Jaclyn. Similar to the other women, Jaclyn had established long-term goals: "I plan on getting an entry-level position in some organization working as a coder or programmer or in some type of entry-level position type like that. I feel that with my management background and education and training, I'll be able to quickly rise and gain some sort of management level type position and possibly work my way up through the company." She had already developed a marketable database system with her team in university and hoped someday to own her own company.

A career was important because "I never really saw myself getting married I guess. A lot of my friends were solely focussed on that. They felt that they wanted to graduate high school, get married, and start a family. And that's all right. I just always felt that that wasn't for me. I wouldn't mind that in the future and I wouldn't have minded if that happened in the past, but I wanted a backup plan. For instance, even if I did get married and start a family, I want to know that I have a career that I can fall back on in case one or both of us needs to work or if I decide to pursue my career and my husband decides to stay home. If you want to work at home, you have to be able to have computer skills to be able to stay at home and work in an office. It's a career that I could pursue even if I was staying at home with the children. I could telnet into the office and work from home. It's very flexible that way. Not that I would have thought that a few years ago. When you

think of career options that females typically pursue so that they can stay at home with their families, things like travel agent or other jobs like that where you're doing a lot of phone work, but I think computer skills are also necessary if you're planning on staying home or even working in an office."

Jaclyn brought another dimension to her ability to be career oriented. She was very aware of her own role as a woman and how she could influence the industry: "I like being one of the few female members of a faculty or department or even just one of the few female members of the class. I like feeling that I'm helping to change a set pattern or stereotype in people's minds. I don't like gender and role definitions. I'm not a feminist per se. I don't actively pursue the rights of women as a whole, but I enjoy feeling that I'm making a difference somewhat in the way that society and our culture develops. Even though it doesn't make that big a difference statistics wise, if you think about one person, that one person may motivate other people to make the same change or to enter the same field. I don't think it's an immediate change, but I think that it's a gradual change and every single person helps to make up a huge body of people."

Would she classify herself as being passionate about computers? "No, I don't think that I am. I really enjoy programming. I think computers are very important but I also think that there's tons of other things in life that are important. I'm passionate about a lot of things: writing, music, creative type things. I love music and I love the arts. I'm passionate about a lot of those things. I wouldn't say that I am passionate about computers but I am passionate about logic and puzzle solving and math. I really love math. Now, I never used to but I do now. And so I think those things enter into the

equation. But I'm not passionate about computers per se."

Chapter Five: Discussion

Introduction

It was clear from the results of the questionnaire and interview that the women in this study successfully coped with varying degrees of societal pressure, schooling limitations, and personal inadequacies when pursuing computer education. Societal expectations were not reproduced by the parents and the male computer culture did not limit their involvement. Although school experiences did not directly influence these women in their career choice, teachers were instrumental in equipping them with the skills and abilities necessary to achieve in computer studies in university. Personal characteristics greatly influenced the success of these females in the technological culture.

Connection to the Literature Review

Socialization

The Computer Geek. The societal view of computer experts as antisocial and unfeminine was not apparent in the responses of the women. Turkle (1984) suggested that hackers were predominant in the computer culture. All of the women in this study disagreed with this impression. Kathryn stated that not all of the students in her classes were male and that not all of the males were geeks. Julie distinguished between geeks and nerds, classifying herself as a nerd. She mentioned that although she met more geeks in university classes, her experience in the workforce did not perpetuate this type of computer scientist. Julie described computer science as not having to deal with other people, yet emphasized her social interactions in her work experience and schooling. Shannon believed that computer scientists were average people who enjoyed their work.

Jaclyn suggested that while geeks still existed in university classes, other types of people were also in the courses. All of the women distanced themselves from the stereotyped view of the computer scientist. Contrary to research by Collis (1991), these women were not discouraged because of a firmly entrenched view of the typical computer geek.

The Male Culture. At the university being studied, female computer scientists were rare. A computer science major was introduced in 1991. Enrolment patterns were varied for the Bachelor of Science (B.Sc.) degree with a computer science (CS) major, the Bachelor of Management (B.Mgt.) with a CS major and the B.Mgt. with a management of information systems (MIS) major.

Table 5

University Enrolment Totals in Computer-Related Degree Programs

	1991-1992		1992-1993		1993-1994		1994-1995		1995-1996		1996-1997	
Degree (major)	Male	Female	M	F	M	F	M	F	M	F	M	F
B.Sc. (CS)	16	4	12	1	17	0	13	3	11	4	17	2
B.Mgt. (CS)	0	0	2	0	1	0	1	0	n/a	n/a	0	2
B.Mgt. (MIS)	6	2	6	1	12	5	13	9	11	11	12	4

A gender gap definitely existed. Male domination of the computer presented unique challenges to the females. Shannon was able to fit into the male culture immediately, possibly because of her prior computer-related experiences. However, Kathryn, Julie, and Jaclyn experienced loneliness as computer science majors. Julie

described many instances where the men in her class harassed her. She initially coped by buying her own computer and working from home. This reinforced her loneliness. She was able to persist because she had cooperative work experiences that provided perspective and eventually was able to find two men with whom to work. When faced with the isolation, all three women had coped by forming small study groups with the men in their classes. Jaclyn was one of the few women to have formed a friendship with another woman in her program. She felt that this made learning wonderful. Julie suggested that courage was required for this aspect of learning.

Parents. Parental behavior did not reinforce the predominant social patterns. Kathryn's mother was taking computer courses in college. Shannon's parents encouraged her interest in technology by purchasing a family computer. Jaclyn emphasized that her parents did not push her into a traditional career and shared that education was valued in her family. Education was also valued in Julie's family where her father was a professor and her mother was a lawyer. Although Shannon was the only woman who had a home computer, this lack of experience did not limit the technological success of the other females. Parents strongly influenced these women by not perpetuating stereotyped sex roles for their daughters.

Gendered Attitudes. Although parental support was strong, the women struggled with gendered attitudes. They were unwilling to suggest that they enjoyed relating to a machine. They seemed to resent the time it took to complete assignments. They spent the time learning not because they were directly challenged and engaged in a relationship with a machine, but because of pragmatic reasons. These women tended to view computer

studies as a means to an end. Kathryn wanted to travel. Julie's passion was riding horses. Shannon wanted to be able to work from home in order to spend time with her daughter. Jaclyn wanted a career in management so that someday she could run her own company. Three of them had dual majors that broadened their career options and allowed them to learn more about the subjects they were interested in.

The cultural pressure for women to be intuitive and relational affected how each woman viewed her femininity. Identification with the male computer culture was important as it provided the social support necessary to succeed. Each woman chose to present herself in a unique way in order to find her place in this culture. Kathryn refused to present the socialized image of the intellectually inferior girl. To her, this stereotype would hinder her learning and she would not sacrifice herself for how others might envision her. In this way, she went against her idea of what was feminine and created a new self. Julie insisted that she purposely did not dress like a woman because she did not want to attract attention. She also changed her self. Shannon co-existed with the men in her class. She became one of them. Jaclyn chose the opposite extreme by dressing professionally in a feminine way. She wanted her classmates to notice her as a woman. In all four cases, the women struggled with how they would be socially accepted in the classes and made conscious choices about the image they were projecting to the male students.

Gendered attitudes emerged when each woman was asked if she was passionate about computers. It was evident that the cultural view of the computer programmer was incompatible with the cultural view of being a woman. Julie was adamant she did not

enjoy computers. Jaclyn made a distinction between passion and enjoyment of computing. She admitted that she enjoyed computing, but stressed that she was passionate about a lot of other things. Kathryn was hesitant in admitting that she enjoyed computing. In fact, she explained that she would rather read a book than do a computer program and gave examples of people who were more involved in computers than she was. It seemed important to Julie, Jaclyn, and Kathryn to not be recognized as passionate technologists. Shannon described herself as passionately addicted to computers. However, when I asked her if she was a computer geek, she distanced herself from this label by explaining that other class members were more involved in the Internet and contracting work than she was. All of the women wanted to present themselves in a balanced way and saw their involvement in the computer field as enjoyable but not obsessive.

Toy vs. Tool. All of the women indicated the value of being a proficient end-user and thus viewed the computer as a tool. However, all of them also described programming in terms of creating solutions. Although the concept of power was not raised, the idea of a sense of accomplishment after designing a program was presented. Even Julie, who viewed the computer exclusively as a tool, derived pleasure from being good at programming. Programming provided a mental challenge for these women. They wanted to learn how to fix the system and were challenged by glitches in the software and hardware. In this way, they viewed the computer as a toy. Kathryn, Shannon, and Jaclyn purposefully combined their ability to program with their ability to use software. They seemed to integrate their view of computers as toys and as tools.

Schooling

School experiences provided much of the incentive for these girls to pursue computer studies. They did not encounter an environment that saw computer education as a masculine activity. For the majority of these girls, school was where they were introduced to computers and this encouraged them to become computer users.

Math Links to Computer Science. Kathryn, Julie, and Shannon connected their success in computer science to their high school math background. Solving puzzles and problems gave these women confidence to tackle computer science courses even when they had a limited amount of computer experience. They felt that their math knowledge compensated for their lack of experience in programming.

It should be noted that all computer-related programs at this university list an advanced math course as a high school prerequisite and include at least two university-level math courses. This reinforces the connection of mathematics to computer science programs.

Teachers. Julie, Shannon, and Jaclyn identified male math teachers as influential. Their experience contradicts research that suggested that math teachers discriminated against females. Jaclyn portrayed her math teacher as open-minded and accepting of her as a girl. Julie described her teacher as approachable and available for help. Shannon explained that computer professors had influenced her learning by being approachable, knowledgeable, and helpful. Mathematics teachers contributed to these women's sense of self-confidence and positive attitude.

Scheduling. School scheduling did not limit these women's opportunities to take

computer courses. All girls interviewed were academically strong students. Kathryn was the valedictorian, Jaclyn graduated second in her class, Shannon enjoyed success in language and math, and Julie was able to achieve high marks in every subject because she worked hard. As they were all enrolled in the university-bound stream, it was difficult to know if all girls would have enjoyed the same opportunities. However, when asked to describe high school computer courses, Kathryn and Jaclyn stated that they were end-user type classes, not programming courses. These courses are part of the business stream and a majority of females take them.

Guidance Counseling. Even though most of these women considered themselves gifted high school students, they did not learn about careers in computer science until they reached university. It was accidental that 3 of the 4 women landed up in computer science. It seemed that guidance and counseling in the area of computer science was not provided. Options of being a biologist or a math teacher were presented but none of the women knew too much about the field prior to talking to university professors. In this way schools limited student choice and shaped the future by promoting traditional career paths and perpetuating social reproduction.

Gendered attitudes toward achievement, careers, and confidence were evident. Kathryn thought that girls were raised to avoid technical math and computers because they were boring subjects. Julie suggested that most girls wanted to be secretaries. Shannon indicated that a lack of self-esteem might prevent women from participating in a male-dominated environment. Jaclyn felt that the mindset of females involved seeing high school as a time for fun and social connections. She wanted teachers to help girls view

high school differently in order to prepare them for a career. Scholastic competence seemed to help these women overcome social barriers and gendered attitudes.

Software. Kathryn was the only woman who identified computer games as valuable. Her initial experience with computers involved playing games in elementary school. Playing computer games with her friends impacted her decision to continue studies in computer science. She related the games to a graphics program she used and became interested in their design. She saw computing as solving puzzles about how things worked.

Learning Styles. The university learning environment in computer science involved a combination of social interaction and independent work. Kathryn enjoyed the active participation involved in learning. Julie and Jaclyn emphasized the value of group work while learning. All of the women acknowledged the necessity for independent work habits. These women intentionally adapted the environment to suit their learning styles and combined the use of group and independent approaches to maximize their success. Julie and Shannon recognized the importance of life-long learning as a way of staying current in the changing field of technology.

A recurring style of learning was that of puzzle solving. The women did not find themselves forced to work in a linear manner but appreciated the problem-solving aspects of computing. This was similar to Turkle's (1984) description of soft mastery. Also, their learning became relevant because they viewed a career in computer science as a means to an end. This allowed them to focus on the practical reasons for learning about computers. The schooling experiences gained by these women prepared them to function as leaders in

the computer culture. Rather than viewing the male-created technology as not producing a cooperative society, they challenged the technological environment to meet social goals. This provides a beginning step in changing computer culture.

Personal Characteristics

Sex-role Identity. Each of the women in this study personalized social expectations in a limited way. They were hesitant to identify themselves as passionate computer scientists, yet clearly enjoyed programming. They wanted to be accepted in computer science classes as people, yet made conscious choices about how they projected their images as women because they were aware that they were anomalies. They shunned the label of computer geek, yet understood the necessity of independent work dedicated to relating to a machine. Their life choices represented a shift in sex-role identity and indicated a personal agenda for finding the middle ground between cultural views of computer scientists and cultural views of women.

Adolescent experiences contributed to the development of identities that differed from traditional sex roles. Kathryn played computer games because all her friends were involved in this activity. Jaclyn had a strong group of friends who encouraged her to explore a variety of career options. Peer support gave Kathryn and Jaclyn the confidence to create their own career paths. Julie did not have close friends in junior high. Her father provided her with the encouragement and support needed in order to survive a period of deep loneliness. Peer and family support was crucial during these years.

Shannon made traditional decisions after high school. She married and had a child. She worked as an administrative assistant. Her adolescent experiences seemed to

contribute to a strong sex-role identity. It was Shannon's experiences as an adult that equipped her with the incentive to pursue a non-traditional career. Being a single parent caused her to reassess her career options and she chose to become a computer scientist out of necessity.

Educational Background. Perhaps the strong academic achievement of these women provided them with the confidence and self-esteem needed to challenge social expectations. Certainly success in math was closely connected to success in computer science and was attributed to natural ability and hard work. It was probable that scholastic success set them apart from most of their peers and caused them to consider their future in a deliberate manner.

Educational Links to Employment. In every case, education was linked to employment. Each woman was aware of the opportunities in the computer science field. The choice was made based on money, lifestyle, and employability. Job-market awareness contributed to choices that these women made. Education in computer science was seen as providing excellent opportunities for self-advancement and career success.

Work and Family. These women based decisions on personal goals. They were very career oriented and demonstrated a high degree of commitment to further education. All four women had extensive long-range plans. They refused to accept computer science as a male-dominated field and understood the importance of computer efficacy for their future.

Each of the women, except Shannon, rejected the social norm of having a family. Being a mother was not a priority for Kathryn. Julie didn't want children. Jaclyn didn't

see herself as getting married. In analyzing life choices, these women chose intellectual goals over social definitions of femininity. They demonstrated a strong sense of identity in their ability to choose a non-traditional life path.

Summary

These women refused to be limited by their gender. They had strong identities and were challenging their role in the computer culture. Ambivalence was evident as they tried to integrate who they were as women and who they were as computer scientists. They enjoyed computing but were not geeks. They argued that the men in their classes were not different from them, but many of them had formed study groups to cope with the loneliness of their work. This suggested that they were not entirely comfortable with the general atmosphere. The women treated computers as tools yet were able to find pleasure in creating programs. These women were seeking equitable treatment and acceptance from their male counterparts. To some degree they were successful in finding this.

Although parents strongly encouraged these women to pursue university studies, it was evident that they also strongly supported other daughters in the family for choosing to raise traditional families. In this supportive family environment, it seems likely that these women would choose to balance their career with their future role as a mother. However, even though the women recognized the theoretical possibility of blending family and work in this career choice, to this point in their lives, three of them deliberately chose not to have children. They seemed to react to the demands of computer culture by adopting a career path similar to that of a man. In this way, they had not quite overcome expectations of society.

Perhaps the best way that described the reality for these women was in terms of transition. The computer culture that they had experienced was different from the hacker culture of an earlier era. Small changes in gendered attitudes were evident. However, these women remained a small minority in a male realm.

Chapter Six: Conclusion

Profile

A profile of successful female computer scientists can be formed from the questionnaire and interview data. Because of the small sample size, this profile cannot be generalized. It does, however, provide an initial framework.

Socialization

The home environment was influential in creating the climate needed to challenge the social expectations of feminine roles. These women experienced parental acceptance and encouragement to choose a suitable career that utilized their abilities. While most of the fathers of female students had a post-secondary education, half of the mothers had education at a post-secondary level or higher. The value placed on education in the home was significant. Mothers and fathers played a role in supporting their daughters to take risks and modeled nontraditional career choices. It would appear that these women had strong male and female role models.

In most cases, friends provided additional support. This was especially apparent in the adolescent years. In the instances where peer support was not available, the fathers assisted the girls in forming a strong independent identity. These women found the necessary social endorsement for developing abilities in nontraditional areas.

Schooling

The two most important factors that affected these women in school were teachers and academic ability. In high school and university, these women were encouraged to ask questions and to become assertive in approaching teachers for help.

This proved to be instrumental in developing women who were persistent and hard working. Taking charge of their own learning helped these women overcome the obstacles they faced in computer culture.

Questionnaire responses indicated that high school computer classes were not useful. All of the women recognized the difference between programming and being an end-user. Most of the courses being offered in high school were based on using computer applications and did not involve programming. Computer experience was not an advantage for male or female students.

Most of the women did not have extensive computer experience but they were able to transfer mathematical expertise to programming contexts. Since they had a strong academic background, their options were not limited. Many of them mentioned that they had a natural ability that allowed them to be successful at solving problems. They were able to face the new content in computer science by using their math background and applying consistent work habits. This was more important to their success than previous computer experience.

Learning in a social environment contributed to the success of these women in computer studies at the university level. Most of the women struggled with isolation and loneliness and chose to form study groups. They were able to change the learning environment to suit their learning style. They did not view computing as an antisocial activity.

Personal Characteristics

All of these women understood the importance of having a career that would

provide them with opportunities to pursue their passions. They believed that they would be working for the rest of their lives and wanted to place themselves in a lucrative profession. They planned extensively, set realistic goals, and became focussed in achieving those goals. Societal pressures were inconsequential because these women realized that a career in computer science would provide excellent opportunities in the future. They were ambitious, confident, and willing to take risks. Dedication and hard work were identified as characteristics that led to their success. All of them were successful math students.

Recommendations

Guidance Counseling

Guidance counseling was limited in every school experience. Traditional careers were being presented to the students. Teachers were not aware of the vast opportunities available in computer science. The women interviewed became computer science students purely by chance. This suggests that we are not providing the knowledge required for some students to make informed career choices. It also suggests that women should be exposed to technical work environments. The distinction between programmers and end-users should be communicated. Women need direct encouragement to consider computer fields of study so that this choice does not become a chance occurrence.

Girls need to view themselves as potential designers of software and hardware. To be merely end users promotes the misconception that computer literacy is enough to ensure high-paying jobs in a market of high employability. It does not. Equity in the computer era depends on women participating as developers and decision-makers.

Instead, computer users (at this point mostly women) will likely become part of the low skilled, low paid work force.

Teachers and counselors can play a role in dismantling the stereotype of the computer geek. The assumptions that playing computer games leads to taking computer courses and that this results in careers in computing was not a pattern for these women. Moreover, they did not immerse themselves in computer culture to the exclusion of everything else. The typical view of the sort of person who is successful in computer science can be changed by good counseling, thus increasing the willingness of women to consider these career opportunities.

Career information should be made available to teachers so that they are prepared to describe the work environment and communicate job-market requirements to their students. Partnerships between schools and the business community could provide opportunities for teachers to learn about potential careers in computer science. Students could benefit from these connections by interacting with actual computer scientists. Direct experience can change socialized perceptions and this might encourage girls to pursue computer studies.

Socialization

Parents played a significant role in empowering their daughters to overcome social barriers and pursue post-secondary education. Although in most cases they did not specifically promote computer studies, they valued education and supported these particular women when they chose a career in this non-traditional field.

In cases where parents are not familiar with opportunities connected to post-

secondary education, teachers can be extremely influential in providing information. By working together, educators can encourage parents to consider the viability of careers in computer science for their daughters. This could be done through parent/teacher conferences, parent workshops, or initiatives promoted by school councils. Until parents and teachers understand the opportunities available to their daughters in the field of technology, the socialization of girls to avoid participation in computer culture will most likely continue. A strong partnership between home and school is desirable and leadership by teachers in this area can be effective in changing social patterns.

Problem Solving Expertise

Cultural patterns are difficult to change because of how computer science is socially defined and understood. Historical uses of the computer have divided interested students into technologists and users. Business education and mathematics programs further emphasize the separation. Gender studies and learning theories add to the perception that women use the computer as a tool and men treat the machine as a toy. The focus on computer literacy becomes concerned with the use of computer applications. Media hype contributes to the notion that computer familiarity is necessary. Girls buy into the idea that if they can use a computer, then they are ready for the new century.

Computer science, however, involves more than using the computer as a tool. It entails problem-solving, making hypotheses, testing, exploring, and experimenting. It is the science of computations. Women involved in this work enjoy the mental challenge and creative energy required to solve puzzles.

Early experiences in applying problem solving approaches to thinking are crucial. Mathematics classes should be taught in this context. Natural math ability was identified by these women as a key factor for success. However, they indicated that their ability was based on hard work and perseverance. I believe that "natural" math ability can be taught. As students learn to solve problems, the science of computations can be better understood. With consistent practice and experience, confidence can increase and critical thinking skills can become natural. We need mathematics teachers who love math and are trained to provide puzzle-rich learning environments so that students are equipped to consider all career options.

Teacher Preparation Programs

Universities can play a vital role in providing teachers with the skills and knowledge necessary for change. Offering math courses in numeracy, for example, could improve the attitudes and understandings of teachers who struggle with math concepts. Elementary math teachers, in particular, should be trained in pedagogical practices involving problem solving and critical thinking in order to counter tendencies to encourage rote memorization of mathematical processes. What is needed is a shift in thinking to embrace a more comprehensive problem solving approach to mathematics. Teachers are needed that are enthusiastic, knowledgeable, and skilled in presenting mathematical concepts in relevant and meaningful ways. By providing excellent math instruction, they can increase student success and interest in technological careers.

Further Research

The decreasing participation rate of girls in computer science fields of study

contradicts enrolment trends in mathematics and science. Educational funding initiatives in computer technology at the elementary and secondary school levels have not arrested the decline in female involvement. Employment opportunities available in occupations related to information technology continue to dominate the business market, yet women are not embracing the computer era. In an age where women comprise 45% of the workforce, this choice is puzzling.

Although some research has been conducted on the barriers that technology presents to women, research gaps exist when studying characteristics of women who are successful in computer science studies. Further research is needed to establish population patterns that can be generalized. Reasons for success arising from this research could be tested using a larger sample. Longitudinal studies could be conducted to investigate changes relative to moving into the work force. Follow-up studies could be designed to examine changes in student perceptions over time. Future studies could include the effect of race and class on success in computer science. Recent findings suggest that male success in math is declining. Additional work could examine the implications of poor math skills of male students on computer science enrolment.

One area of particular interest is problem solving in math classes. I am interested in pursuing further research connecting early math experience to computer programming in order to develop critical thinking skills.

Social change is possible because Canada is at an economic turning point. Businesses can no longer ignore the vast population of women who are rejecting involvement in the technological field. Critical shortages in skilled labor threaten economic

growth. Ironically, a functional perspective of education may provide the vehicle for gender equity. As companies actively recruit female workers, changes in the work environment and computer culture will result. A critical mass of women involved in computer-related occupations holds promise for social change.

Schools can provide the vehicle for social change. Through changes in pedagogy, business-school partnerships, and meaningful implementation of technology, students can be encouraged to consider careers in computing. Teachers can play a significant role in combating the current inclination of women to opt out of computer culture, so helping to correct the feminine mystaque.

Personal Reflections

My own practices have been greatly influenced by the process of writing this thesis and the results of my research. One of the difficulties of research is that it is never complete; more questions arise. This can be very discomforting. In reflecting on my methodology, I wonder if a deeper understanding of the women's perspectives could have been gained from a narrative approach. I was interested in pursuing issues of balance but was limited by the single interview. The extent to which they struggled against computer stereotypes and sought to achieve balance in their lives could have been explored in greater depth.

From a pedagogical perspective, as a result of this study, I am much more aware of the importance of problem solving and critical thinking skills in math education. As a teacher, I am excited about the opportunity to introduce math concepts in a puzzle-rich environment. This study has shown me the importance of incorporating a wide range of

projects designed to show mathematical thinking embedded in everyday life, integrating problem solving and technology through creative programming activities, and improving guidance counseling. Above all else, I want to encourage critical thought through exciting and meaningful math instruction. Hopefully, by doing so, I can make a difference as a role model and math teacher in the lives of my students.

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Appendix A: Computer Study

The purpose of this study is to construct a profile of successful computer science students in order to present new program recommendations for technology teachers in public schools. Please note that all information will be handled in a confidential and professional manner. All names, locations and other identifying information will not be reported.

Your participation in completing this questionnaire implies consent.

Thank you for participating in this study of what makes you successful in computer science. Your opinion is important in encouraging others to follow your example.

Part 1: Demographic Data

1. Gender (please check one):
   - ❑ Male
   - ❑ Female

2. Age (please check one):
   - ❑ 16 - 20 years
   - ❑ 21 – 25 years
   - ❑ 26 - 35 years
   - ❑ 36 years or older

3. Degree Program (please check one):
   - ❑ Bachelor of Science
   - ❑ Bachelor of Management
   - ❑ Bachelor of Arts and Science
   - ❑ Bachelor of Science/Bachelor of Management (combined degree)
   - ❑ Bachelor of Science/Bachelor of Education (combined degree)
   - ❑ Bachelor of Management/Bachelor of Education (combined degree)
   - ❑ Other (please specify) _____

4. Major (please check all that apply):
   - ❑ Mathematics
   - ❑ Computer Science
   - ❑ Management of Information Systems
   - ❑ Accounting
   - ❑ Finance
   - ❑ Other (please specify) _____

5. Current G.P.A. (please check one):
   - ❑ below 2.0
   - ❑ 2.0 – 2.4
   - ❑ 2.5 – 2.9
   - ❑ 3.0 – 3.4
   - ❑ 3.5 – 4.0

6. Age when you first used a computer (please check one):
   - ❑ 0 - 4 years
   - ❑ 5 - 8 years
   - ❑ 9 - 12 years
   - ❑ 13 - 18 years
   - ❑ 19 years or older

7. Highest level of education of Father (please check one):
   - ❑ less than high school
   - ❑ high school
   - ❑ post-secondary
   - ❑ graduate (master's degree)
   - ❑ post-graduate (doctoral degree)
   - ❑ unsure

8. Highest level of education of Mother (please check one):
   - ❑ less than high school
   - ❑ high school
   - ❑ post-secondary
   - ❑ graduate (master's degree)
   - ❑ post-graduate (doctoral degree)
   - ❑ unsure

9. Location of High School you graduated from (please check one):
   - ❑ in Alberta
   - ❑ in a Canadian province/territory other than Alberta
   - ❑ in a country other than Canada

Part Two: Descriptive Data

1. To be in this course, you have successfully passed a number of computer science classes. In your opinion, what personal qualities and/or abilities enabled you to reach this level of success?

2. Were there any family and/or childhood experiences that influenced you to pursue university studies in computer science? Please specify.

3. To what extent do you think that your high school education has prepared you to undertake university courses in computer science? Please explain.

4. What is your motivation for taking courses in computer science?

5. Please include any additional comments you think might be helpful.

Part Three: Interview Information

If you are willing to participate in follow-up interviews, please include your name on this questionnaire or e-mail me at gladys.sterenberg@uleth.ca.

_____
(name)

I very much appreciate your assistance in this study. If you have any questions, please call me at 329-2450. Also please feel free to contact the supervisor of my study, Dr. Jane O'Dea at 329-2458 and/or the chair of the Faculty of Education Human Subject Research Committee, Dr. Richard Butt at 329-2434, if you wish additional information.

Thank you for taking the time to help me understand what is important in becoming a computer technologist.

Gladys Sterenberg
gladys.sterenberg@uleth.ca

Appendix B: Interview Blueprint and Guide

Explain topic of study, make personal contact
Explain why she was chosen
Ask permission to tape
Review level of confidentiality
Have her sign consent letter
Explain note-taking process

[Interview [number] by Gladys Sterenberg on [date].

I have prepared some questions, but it they don't seem clear, please feel free to correct me or clarify them.

Guiding Question	Theoretical Issue	Relevance	Interview Question
Introduction		to establish comfort level and trust	Tell me about yourself.

Guiding Question	Theoretical Issue	Relevance	Interview Question
Socialization	Do participants see themselves as computer geeks? How do participants deal with the male-dominated culture (software, extracurricular activities, media, gendered attitude)? What role did parents play? Is the computer viewed as a tool or as a toy?	to determine how participant has overcome prevalent societal stereotypes	Explain how you became interested in computers. How would you describe computer scientists? What obstacles, if any, have you encountered in the computer science classes? What role did your parents play?

Guiding Question	Theoretical Issue	Relevance	Interview Question
Schooling	How important was math? Did teachers as role models influence you? What career counseling did you get? How did your learning style match the instruction? What did you experience in physical settings of computer labs, software?	to establish the degree to which schooling influenced choice of career	Describe your schooling experiences. Describe how you learn best. Would you classify yourself as a gifted high school student? Explain. What would you recommend to high school educators in order to encourage other students to consider computer science as a career? In your opinion, what prevents girls from pursuing careers in technology?

Guiding Question	Theoretical Issue	Relevance	Interview Question
Personal Qualities	How strong is your sex-role identity? How did your educational background contribute to this choice? How important is education to career choice? How does this choice allow you to balance work and family? Are you passionate about computing?	to identify personal characteristics that contributed to success in computer science to describe the process of sex-role identity	Describe your adolescence. How do you maintain your femininity in a male-dominated culture? What makes you successful? What limits you from reaching your full potential in this industry? What are your future career plans? How do you envision motherhood? Are you passionate about computers?
Conclusion			Is there anything else you would like to add?

Is there anything else you would like to add? Anything you think I'm missing? Thank you very much. The preceding interview was with participant [number] for master's thesis, [date] by Gladys Sterenberg.

Appendix C: Consent Letter

[date]

Dear [participant's name]:

Thank you for expressing interest in participating in follow-up interviews to the questionnaire administered in [month].

As a brief reminder, I am a graduate student in the Faculty of Education at the University of Lethbridge. I am conducting a study exploring reasons for success in computer science. The purpose of this study is to construct a profile of successful students in order to present new program recommendations for technology teachers in public schools. In this era of declining enrolments in technological studies, I anticipate that your participation in this study will encourage others to consider becoming involved in computer science.

As part of this research you will be asked to engage in two taped interviews that explore your family background, schooling experiences and personal characteristics connected to your success in computer science. The second interview will present an opportunity for you to review the transcripts and to react to my understanding of the previous interview. Confidentiality will be maintained. Information received during the interviews will be transcribed and coded. Names, locations and other identifying information will not be included in any discussion of the results. The tapes will be erased at the conclusion of the study.

Participation in this study is voluntary. If you are willing to participate in these interviews please sign the consent statement below. You have the right to withdraw from this study at any time without prejudice.

I very much appreciate your assistance in this study. If you have any questions, please call me at 329-2450. Also please feel free to contact the supervisor of my study, Dr. Jane O'Dea at 329-2458 and/or the chair of the Faculty of Education Human Subject Research Committee, Dr. Richard Butt at 329-2434, if you wish additional information.

Sincerely,

Gladys Sterenberg

Date: _____

I, _____, have read and agree to the above information and am willing to participate in two taped interviews.

_____

Appendix D: Computer Study Results - Comments

1. *To be in this course, you have successfully passed a number of computer science classes. In your opinion, what personal qualities and/or abilities enabled you to reach this level of success?*

   - Ability to direct focus towards weekly projects in Comp Sci. Sitting at keyboard for hours at a time and trying everything possible to make the program run. Ability to sustain high levels of frustration w/o giving up. (1)
   - Love of learning and love of technology. Also, a good work ?? and a "go and get it" attitude is definitely an asset. (2)
   - Constant learning -> always staying ahead of material. Classes are useless unless chapters are read ahead of time. (3)
   - Peer programming and using computer since elementary school – always had access to current computer. (4)
   - Lots of time dedication. Willingness to work with others to solve/problem. (5)
   - A willing to put in long hours. Good math skills will aid tremendously in the understanding of programming. Able to teach yourself concepts outside of class. (6)
   - Knowing the right people. CPSC 1620 definitely helps. (7)
   - Focus, focus, focus. Must be interested in logical flow of data. (8)
   - Interest in computers. I learn through trial and error. Motivated. (9)
   - Experience of computers. (10)
   - Determination. (11)
   - An interest in computers. (12)
   - Logical thinking, mathematical knowledge, hard-working (because of too many assignments), interested on computer game. (13)
   - Genuine passion for computer science, you don't choose to major in computer science, you are destined for computer science. You must "play" around with computers, not just what you learn in class. You should have started "playing" with computers as young as possible. You must like learning new things constantly (i.e. new technologies). (14)
   - To me, probably the most important quality for anyone in computers to develop is strong problem-solving skills. (15)
   - Hard work, perseverance, time management. (16)
   - Study hard. (17)
   - Mathematical sensibility; logical analysis ability; abstract imaginations. (18)
   - I am a very hard worker that is motivated to learn on my own. I don't like to be wrong and strive for perfection. The ability of previous professors to teach well and create an interesting and stimulating learning environment also helped. (19)
   - I am very stubborn and persistent. I quit university for one year, but I came back. (20)

- Laziness. (21)
- The ability to learn quickly and work hard allowed me to reach this level. I am determined to work on something until I understand the concepts and get the correct solution. (22)
- Personal interesting in CP. Math background. Logical thinking. (23)
- Love of programming. Sometime the assignments can discourage you, but the personal achievements are what count. When you successfully complete a difficult program, you feel good. (24)
- The most important thing is being able to put up with crap. I first went to UofC where you must first complete tons of useless math courses. The small amount of math needed later is of course forgotten. To do well in Com Sci courses, problem solving skills are needed. But not just math solving skills. (25)
- Interest in the operations and workings of computers. Interest in the advancement of technology. Broad usefulness of computers. (26)
- Work hard. (27)
- Keep with the program, and putting up with all the crap in the junior course. (28)
- Dedication and many late nights programming. I think my personal experience with computers at an early age enabled me to grasp the concepts easily. (29)
- Motivation, desire to learn. Interest in how things work/why. I was always interested in learning. I was always an independent thinker (i.e. loner as most comp sci geeks are). (30)
- Hours spent working on it – 99% perspiration 1% inspiration – if you can stay motivated to do the work, you will be fine. (31)
- Ability to solve program logically. Able to think of the details. (100)
- Patience, requires a lot sometimes for compiling. Determination to learn the material. Refusal to give up. Desire to learn new things. (101)
- Patience. Willingness to spend extra time reading texts and understanding the language. (102)
- Help from a tutor to pass CS1620. (103)
- Hard work, enjoyment of the classes.... (104)
- I think to be successful in CPS you must have a strong math background. (105)
- Stubbornness. Ability not to give up. (106)
- The ability to work long hours in front of a computer. Be ambitious. Be self-assured and not give up. Have the drive to complete what you've started. Don't be too hard on yourself if you don't understand a problem. Don't be afraid to ask for help. (107)
- Persistence and dedication, intelligence. I work very hard. Skills in math and abstract thought helps greatly. (108)
- I am highly motivated to succeed, because I like what I am doing and I like it more and more every day. (109)
- Math is very important. (110)
- Willing to accept challenges. Like problem solving. Open minded. (111)

- Basic logic, math background will help. (112)
- Be patient. (113)

2. *Were there any family and/or childhood experiences that influenced you to pursue university studies in computer science? Please specify.*

- No. Family, yes. Meaning it if weren't for my wife and baby boy, I probably wouldn't be here. (1)
- No! (2)
- No. (3)
- Brother started programming when I was young so I learned from him at first. (4)
- No, perhaps the "family" computer may have had an influence. (5)
- Started using a computer in elementary school and in high school I learned some programming. Loved computer games. (6)
- Mmmmm..... No! (7)
- No, started by taking computer course at LCC. (8)
- No. (9)
- I'm not in computer science. (10)
- Had no response. (11)
- NA (12)
- No, because I think CS can get me a pretty good future. (13)
- My dad had a 286 computer. My junior high had Apple IIGS/IIC/IIE computers, and they taught some BASIC in class. (14)
- The most important factor was having a computer at home that I could play on. Of course, it didn't hurt that my mother is a computer programmer. (15)
- No. (16)
- No. (17)
- First sight of computer-generized architecture model when I was interested in architecture design. (18)
- There has been a computer in my house for a long time. I started programming my commodore 64 when I was about eight, and was fascinated how it would do things I told it to. (19)
- Mom told me to get a job, or go to school. (20)
- Yes. I loved working with computers. (21)
- No. I became interested in computers in grade 12 due to my own curiosity. (22)
- Interesting in playing game and solving problems. (23)
- We did get a computer in the house when I was a teenager, and I loved playing on it. I wanted to explore them further – and get paid for it. (24)
- Had no response. (25)
- Playing video games. Interest in technology advancements. (26)
- Yes, know computer. (27)

- I was encouraged to follow any career I chose, I was fully supported for comp sci. (28)
- We always had a computer in the house (instead of a nintendo). (29)
- Always wanted to be a scientist, like my dad. Was always encouraged to question and be inquisitive. We always spoke our minds at home and were encouraged to do so. Academics was a priority for my family, esp. hard sciences, but creativity was always encouraged and never hampered. I am a creative person and comp sci allows me to be both academic and creative. It is very broad in possibilities. (30)
- Education very important in our house – mother a teacher. In junior high I bought with my own money an 8K commodore pet with a tape drive! Had an uncle into electronics and computers, first exposure in junior high due to him. Video games were brand new and I was an addict! (31)
- No. I just want to learn it by myself. (100)
- No. (101)
- No. My parents still can't use a computer. (102)
- No. (103)
- No, it was after I got my diploma in Tourism that I decided to go into computers. They play a large part in all of our lives, it's good to know everything you can about them. (104)
- No. (105)
- No. (106)
- Worked in an office environment for years. Owned a computer as a child. Took computer courses in school. (107)
- No, in high school I did a module where you had to create sort of an information thing on linked cards (hyper-card?). I also really like drawing on the computer. These things influenced me. (108)
- No, I've never used computer until 3 years ago, but I always wanted to. (109)
- All of my family members' work/study are relative to computer. (110)
- I crashed my computer in the first day of purchased, so at that moment I am looking for way to fix it. I guess that is when I begin to be interested in computer. (111)
- Family encourage me to take CPSC. (112)
- Yes. More logical (realistic) than other same age friends. (113)

3. *To what extent do you think that your high school education has prepared you to undertake university courses in computer science? Please explain.*

- None. High school was for "fooling around". Any real learning I've accomplished in my life has been post high school. If I could do it over, I would have spend more time in H.S. ?? study skills to ease my first year of university. (1)
- I'm a little older 25 turning 26 this year so the extent to which I was exposed to computers in high school was minimal. So, I wasn't really prepared from H.S.

experiences for what I'm taking now. (2)

- By taking extra courses such as computers 10, 20, 30 and extra accounting courses. (3)
- Not at all really. High school computer classes are very slack. (4)
- Very little, (if at all) – computer classes in high school were next to nothing (CCH school). (5)
- Not much because math was not a great focus and computers was only an option class. (6)
- None, computer science is an elective in HS and is often overlooked and not promoted. (7)
- None, took a C.S. course, but nothing like what we do here. (8)
- None. The extent of computers in high school was word processing and typing classes. (9)
- None at all. (10)
- Minimal. Where does Social Studies fit into this picture. (11)
- Minor intro to programming. (12)
- Mathematical calculation. Activities that trained my logical thinking. Not sure, maybe economics helped. (13)
- None, high school doesn't have much to do with university – "textbook" learning/facts/ knowledge based vs. thinking/self-thought. (14)
- Aside from providing me with basic math skills, not at all. In fact, I never took any classes in high school which were even remotely connected to computers. (15)
- Almost no help. Computer classes were no help. Math helped a little. (16)
- In high school computer courses and math courses are easy. So I thought computer science is easy compare to other major. (17)
- Lost of mathematics practices in high school education in China. Especially proof ability fields. (18)
- None. The only benefit of my education before post secondary was that I could read and write. I was not interested in anything in high school. (19)
- Not at all. I was very unimpressed at how little the little I learned in high school helped me here. (20)
- Typing classes were helpful. (21)
- It did not. Though there were computer courses, they had nothing to do with computer science. (22)
- Math. (23)
- It didn't. The level of computer education was very low. (24)
- High school actually hindered me in preparation for university courses as I never had to do any work in high school. (25)
- Nill. The only contact with computers in high school was in a typing course. (26)
- Good because they have good access in computers. (27)
- NONE AT ALL. (28)
- Not at all. I didn't take any computer courses in high school, and computers were

not a required part of high school. (29)

- Math & physics helped. The rest was useless because it was not relevant, in "computer" classes we learned how to type and use windows computers. I was well beyond that already. In fact most of my high school classes probably inhibited me because it held me back. (30)
- Poorly – high school mathematics needs a complete overhaul – I had to almost start over in math when I cam back for my 2nd degree and it is still the most difficult part of the program for me. Math has to be made more interesting, more applied, more engaging some how – one basic problem in my opinion is that generally math/computer people are not great teachers – just because you can do it doesn't mean you can teach it! It is taught far too mechanically in high school. (31)
- I took the computer science course in high school. That was a very good experience in programming using turbo pascal? (100)
- None. I took my courses in high school that dealt with programming. I ended up in MIS by accident after enjoying an intro course in university. (101)
- Very minimal. Some experience with Pascal but very little. (102)
- None! (103)
- I never took any computers in high school, but I feel that now computers should be a required course in school. (104)
- It has not. (105)
- None. (106)
- Very little – I graduated high school in 1987, back then there weren't computer courses available in school. I wish there were. (107)
- High school taught me how to learn, study and work. Besides math skills it taught me very little specific information on computers, on end-user view and very little of that. (108)
- I had a lot of math in high school, probably that helps, I also had logic. (109)
- Some math courses -> base of the computer science course. (110)
- No much. They don't provide much technology course or any technological related courses to students in high school. (111)
- The math course in high school and basic easy software courses. (112)
- Can't explain. I didn't graduate high school here. (113)

4. *What is your motivation for taking courses in computer science?*

- Comp Sci courses are required for my MIS degree, but for tangible reasons. They provide the fundamentals for troubleshooting the flow that companies deal with in unit applications. (1)
- It's exciting to me, it's something I can see myself enjoying as a career. (2)
- To become an expert at programming languages such as Ctt, Java. (3)
- It's my major. (4)

- $, not ergonomics. (5)
- It is a stepping stone to working with computers in another way. i.e. networking. (6)
- Job outlook (number and quality $) (7)
- $$$ (8)
- Graduated in accounting – worked for six months and hated it so I thought I would try this. (9)
- Requirements. (10)
- Had no response. (11)
- None. I don't like cs courses. (12)
- Good future. (13)
- For my degree, I like computer science, and it's way of thinking. (14)
- Frankly, I take classes in computer science because I enjoy them. I started my degree as a psychology major, and ended up switching to computer science because it was just so much fun! (15)
- Not much choice for other majors. Interest in computers. (16)
- Getting a great job after graduate. (17)
- Interesting and good employment market. (18)
- I love computers. (19)
- I want to be a computer programmer for a hiring. (20)
- Getting a job in the computer industry. (21)
- I became interested in computers while in high school, and decided to go into this field. The job prospects are better than most fields, and it is interesting material. (22)
- Interesting. High demanding jobs. (23)
- Learning how to control and develop computers it's a very exciting field. (24)
- I like programming. (25)
- Money. Interest in comps. (26)
- I love what I am doing. (27)
- A fun career is sys/network admin and working with latest technology and a whole lot of money as well. (28)
- I am looking forward to a well paying job in the industry. I also enjoy working with computers, and have felt so for a long time. (29)
- Fun, personal interest, internet/technical community is where I feel the most comfortable. (30)
- 2nd degree – career change – B.A. liberal arts is great for your mind but lousy for your pocket book. (31)
- Learn more new way to solve problems. (100)
- Required for an MIS graduate. Enjoy aspects of MIS. (101)
- Good job with good pay. (102)
- To finish my degree in MIS, it was a require course. (103)
- I like computers, more the analysis end than the programming. (104)

- It will get me a good job. (105)
- Interesting, sense of accomplishment when assign completed. (106)
- My future as well as that of my daughter's. I'm a single mother and I'm thinking of both of our futures. (107)
- Because I like programming and working on computers, I also like the job security, demand and salaries in the field of C.S. Greater opportunity for success. I like abstract and virtual thought. (108)
- That's my major. I love doing it. Sometimes seems impossible to me to learn something then somehow I succeed. It's excellent feeling. (109)
- I don't like all other (major) courses. (110)
- To graduate. To manage any problem in computer course. (111)
- It is interesting and useful. (112)
- Job. (113)

5. *Please indicate any additional comments you think might be helpful.*

- Very little of what I will learn in these comp. sci. courses will relate directly to anything I do when I enter the workforce. (1)
- I struggle with a lot of the classes and coursework. A strong analytical/mathematical background and aptitude is extremely valuable to students. I lack that and I feel it! (2)
- No response for (3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 18, 21, 22, 23, 24, 25, 29, 31, 100, 101, 102, 104, 106, 109, 110, 111, 112, 113)
- Good luck in grad school – hope this helps. (8)
- Can introduce computer course to kids as early as possible, of course, they are able to understand because it can build up their interests. Try computer game to get their attention first!! (13)
- Study hard. (17)
- My GPA sucks because I took management for a year and only passed half my courses. My G.P.A. in computer science classes is near 4.0. (19)
- Interview my if you want. (20)
- Since I had no technology courses in my high school I would advice getting some courses that use computers for things other than typing. (26)
- We need good instructors like our instructors, they are awesome. (27)
- School students need exposure to lots of programming and a variety of operating systems, linking with hardware and software say in the web for all sorts of things and getting used to lost of pizza and long nights. (28)
- Don't try to make geeks, nerds, dorks, oddballs, etc. conform in high school. Doing this would have/has destroyed many brilliant kids. (30)
- I found CS 1620 very difficult. (103)
- I found java, ctt extremely difficult. I believe CPS majors think differently (mathematically). CPS is not for everyone. (105)

- Being a mother, I can't stress strongly enough the importance of education – the more prepared our children are, the more they succeed in life. (107)
- I knew next to nothing about computers before starting the program. (108)

Appendix E: Transcripts

Transcript Conventions

I selected the transcript format because it was easily done this way. We did not tend to interrupt each other and rarely talked at the same time. I removed stutters and repeated phrases from both the respondent's and my own speech because I wanted to preserve the flow of the conversation. I have also removed verbal prompts (Hmm, Yes, Um, Uh huh, etc.) and repetitious speech patterns that might identify the respondent (usually, like, really, sort of, whatnot). Single square brackets indicate omissions and changes that I have made to protect the identity of the respondent as well as editorial comments. They also indicate changes suggested by the respondent in email correspondence after she read the transcripts. All personal pronouns used are feminine since the study included only women. Line numbers, which were included on the original transcripts to make analysis more efficient, have been removed.

Interview #1

This is [date]. It's Gladys Sterenberg doing interview #1 and we'll get started.

I've already had you sign the consent letter and you understand I'm taping this.
Yup.
Good.

What I'll be doing a little bit through here is just making notes to help me remember what to ask. So nothing major [OK] and you can watch as I do this.

I'd like you just to get started. Just tell me a little bit about yourself and your program here and what year you're in

By the time I graduate, I've already completed 41 courses so I'm in fourth year. It's taken me six years to get this far though with co-op. I'm a math and computer science major and I'm working towards a B.Sc. What else do you want to know?

Maybe you could tell me a little about your family background?

My father works here, he's been working here for over 35 years in the [department]. My mother got her law degree in [year] and she's just quit practicing law this year and she's in [place] now and practising law there.

Thank you. We'll start right into it. I've read your responses on some of the questions I asked you earlier so I've made my questions around those specifically.

You spoke in one part about obstacles that you faced studying computer science because you are female. Could you just describe some of those and talk about that?

There were of course no obstacles getting into classes and no obstacles with professors. But definitely obstacles with students. I don't know if it's the type of student that computer science attracts, or what the deal is. In my first year I took [first level computer science course] in [summer] from [name] and there was one particular fellow there who. . We were coding late at night, I think it was 2:00 in the morning and there were three of us in the lab. Two girls, including myself, and this guy. And I finished my stuff and printed it out and was packing up to go home and he ripped my assignment right out of my hand. And when I tried to grab it out, he grabbed me and another guy there said, "Hey, knock it off" and I did and he failed the class and he hasn't been back since. So that might deter the faint of heart, but I'm not the faint of heart.

Then when I was taking the second year computer science course, and this obviously wasn't directed at me but there was one guy in particular who was surfing pornography right in the lab, which I find kind of disgusting. I mean, there is a time and a place for that. So I told the lab prof and it never happened again. It's just an attitude that these guys have.

And then when I was taking [course], I was the youngest in the class and there was one fellow there, he was doing some work for the university while I was taking that class and it was his last semester. I think he actually worked at the university after he graduated for a little while and he took to walking up behind me in the hall or anywhere and just grabbing my shoulders as I couldn't figure out what the . . I don't know...why. I mean it was just frustrating and annoying and really stupid and frustrating and I couldn't, you can't get through to these people that you don't want their attention. They're really clueless that way. And it took me awhile. Now I'm not nice to them. I have two guys that I respect and I like doing the work with and it's changed me that way from being a friendly person to really selective about who I'm friendly to. You don't say Hi to everybody. You don't talk to everybody. You don't invite people to your study groups because you never know. You just never know. With these kinds of people, you just . . I mean, they stare at you. And you have to pretend that they don't exist. I mean, you're an

anomaly, you're a woman in their class and they stare. There's actually one guy, it's another guy who has been staring at me for a good couple of years now. He's married. At least he wears a ring on his ring finger. Yet, when we're in the computer lab, every time I look up . . He always sits so that he can just sit there and stare at me. He's always staring at me . It's just disgusting. You keep your eyes on your work. Well, he's not an intimidating guy, I mean, I'm not big but I could defend myself if he ever did anything. He's just a wimp, but it's just disgusting. You know, come on. Don't be disgusting.

Do you find that type of student different from other classes that you're in?

Like in other disciplines?

Yeah.

Even math I haven't had problems with, I haven't had those kinds of problems with any of the guys in math. Although I would say that it's kind of interesting that in my fourth year computer science I'm the only woman, but in my fourth year math, there's only one guy.

That is interesting.

So I never had a problem with the fellows that take math. It's been so long ago since I've taken anything else, but I never had a problem with them. I never had a problem.

One of my questions was how would you describe computer scientists? Going with the idea that you just said that they are a different type of student.

I mean that's a stereotype. They're not all bad. But let's see. It certainly, in this little climate, being computers, there's a difference between geeks and nerds. And nerds are people that work on computers. And geeks are people who work on computers and enjoy it. And there are definitely more geeks in computer science than nerds given that definition. I'm more of a nerd type. I'm taking it because I don't think I can get a good job with math. I don't want to go on and get a master's in math so it's a means to an end. I can go down and get a good job. Make some money and retire early. But. . . I don't know. I guess the other interesting thing is that there are more of these, I find more of these kind of gucky people in school than I did on my co-op work terms. So I don't really know how to classify them. There are a lot of lonely people out there who take computer science. A lot of normal ones, but there are a few that are just eccentric, really eccentric. And of course, it's lonely work. In math, there's always groups. You get together and do your assignments together and study together and it's always doing group work. In computer science it's always every one for himself.

Do you think loneliness is absent in the workplace? It that what makes the co-ops

different? Do they work differently?

It's different because they're managed and actually, what is different, and this something I notice is a lot of the people who are groddy by my definition, are insecure. And they have, they like [place], they like university and a lot of them graduate and stay in [place] and even stay in the university afterwards. It's only the people who know that there's more to life than school that go out and get jobs and make some money.

How do you become secure as a woman in this environment?

You don't become secure. You're born that way. Or raised that way. Anyone who is ... it takes sheer determination and will power to, I think, to do computer science. It's a lot of work. It's not hard work compared to math. I mean, I could spend ten hours of really intense labour and have to go talk to my prof and it's just hard, a really hard assignment. But in computer science it's nothing for them to give you an assignment that takes 40 hours of just sitting there, typing it in. Concepts are easy to understand, but it still just takes work to get it in and get the compiler working properly, finding little bugs and little typos that you made. It takes time and so you have to spend the time. And soon, almost right away, after I took [course names], where I had those really gross experiences, I bought my own computer and I do it all at home

I was going to ask you how you managed to deal with all that.

Yup, I bought my own computer and I do it all at home.

How do you deal with the loneliness?

That's not a problem for me. I don't know why. I mean, I work hard. I've always been that way. It's a..it's a character trait. I don't find it lonely.

You mentioned that your background prepared you to deal with these kind of people and gave you that determination. Could you talk a little bit about your background and what specifically helped you with this?

Well, I was raised on a farm. I never lived in the city and never. . . When I was growing up, I never got the chance to play with a lot of other kids. I went to a lot of [name of discipline] conferences with my father and so went to a lot of [name of discipline] lectures. But by the time I was seven, we got horses. And I would spend all of my free time doing horses. I even got myself exempt from the school trips that we would do because I would say, "Oh, I think it's stupid, I don't want to go on this trip, I'd rather stay home and ride horses." And so I'd stay home and ride horses. I found them... I grew up finding things like horses more reliable as friends and entertainment than other people who were often, especially when you're kids, and kids are evil, who are mean and

play pranks and whatnot. My father says I was born 35. And it is true that I have never liked kids. Even when I was a kid. I grew up being able to entertain myself. I don't need other people. Doing computer science by myself is just like not having to deal with other people. It's not a problem. As for determination, I don't know. That just came from inside. I don't know where that came from. My brother is not as determined about things as I am. Mind you, maybe he's determined about different things, but … That's just an inside character trait. I don't know where that comes from. To be able to just put your foot down and say this is the way it is. This is the way it's going to be. Like it or leave it.

I'm going to move into a little bit of your schooling background. I'm very interested to know how you've dealt with your adolescent years in school. You've talked a little bit about not going on school trips and that kind of thing. How did you find that?

I loved it. I didn't like school trips cause I really never liked my peers. If you want to go into junior high, especially by then, the love of my life was horseback riding. And there was no one in school I could share that with. There's never been anyone except for my father that I could share that with to the extent that it is my calling. It is my thing. I love just playing with… mind games with the ponies and trying to get them to enjoy what you're asking them to do and whatnot. And there was no one is school I could share that with. In junior high I had friends that were… I would eat lunch with them. I would never do anything with them after school so why would I go on a school trip with people I don't like. I didn't want to do that. I didn't… I think in junior high we did a trip to Edmonton as a class visit to parliament. I thought, "Oh that's stupid". I didn't even like the teacher either. And so it just wasn't going to be fun. I would much rather just stay at home and ride horses. Although I do remember in junior high we organized a bike trip going around [place], and looking at the sites in [place]. Of course, I couldn't convince my parents that I needed a new bike for this and so I brought out my old rickety bike and I hit one curb within the first 10 minutes of the bike trip, popped a tire and that was it. I was out. And so, you know, that wasn't any fun. That was no fun at all, just circumstantial. I don't know. What else about adolescence? I guess I realized really early in life… Well, I mean, my parents never got along around that time either, and so I didn't want to bother them. I didn't want to stay at home. So rather than making a stink about it, the easiest way to independence was to just stick it out, finish my grade twelve and do as best as I could to maximize my scholarships, which I tried to do and did. And then it didn't make any sense to me to go to a different university because I wouldn't get anything for student loans, government student loans. I'd have to get bank student loans. My father wouldn't, probably wouldn't have cosigned a bank student loan because "why go somewhere else when you have a perfectly good university right here?" Plus the fact that in those days we got all our tuition back from the staff tuition scholarship. Now we only get half. So I just figured I'd come here. I thought I was destined to be an art student. So I started in arts, took calculus in my first year and loved it. So I started in math, and then said, "What the hell am I going to do with math?" and so did computer science. And here I am. It's nothing really in my childhood that made me pick computer science. It was

all in university.

What was it about that first, how did you know for sure that you enjoyed it so much, what was it that gave you that indication?

It's not that I enjoy computer science. It's a means to an end. I enjoy horseback riding. I could not make a living doing horseback riding. There are a lot of upstart costs that I just can't cover. However, in computer science, that way the market is right now, you get your job, you can go down to the states, you can make piles of money, you can dabble in stocks and then retire when you're young and then I can do horses. I couldn't do anything in math. I don't think I could handle the research pressures of being a professor in mathematics. It's great when you're in [name of discipline]. Boy, you get four months off every year, eh? Yahoo! Not in math. You spend those four months earning your keep doing serious research. Not for me. You have to take [first level computer science course] and [second level course] in math and I got an A in [the first level]. [The professor] should have given me an A+, I had 94% and then I got an A+ in [the second level course] and thought, "This stuff is easy. Why not? Why not? Why not just do it and then get your good job." I like being good at things and I can be good at that. It's not that I love computers, but it's something that I can be good at. And I like being good at things. I can't do what I love because it doesn't cater to the lifestyle that I want to have. So I'll work hard at being good at doing computers. And then I can like it for a little while without driving myself crazy, and then quit when I'm ready.

Would you have classified yourself as a high school student who was gifted?

No. I have to work hard for everything that I get. Everything. I've had to claw my way every step of the way.

You mentioned a high school teacher that was very instrumental in ..

He was. [name of teacher]. When we started math 30, we wrote the first unit test, and I got 77%. And there's so much hype around math 30, I thought, considering this is math 30, that's pretty good. And that wasn't good enough for my father. I was devastated. It was just "no, that's not good enough. You can do better that that". And so I really didn't know what I could do other than work harder. I had never previously really used any study skills. It was all go to school, learn as much as you can in school, go home and ride horses. Go do school, learn…you know. And I did okay with that but he really helped me do study skills. It just so happened that I had a spare, an open class, the same time he did. And I would do math in that spare. Every time. Because whenever I had a question, I could go to him during the spare he'd just be in the classroom and he would just sit there and help me with everything. And that taught me that with hard work I can exceed whatever natural ability I happen to have. I didn't have any natural ability in math. But with hard work, I could. And that teachers are approachable and teachers will help you if

you ask them nicely. And so I came here with the same attitude and I took calculus. No it wasn't easy for me. I went and talked to my prof often. I'd ask him questions for every assignment. And when I'd get an assignment back and I wasn't satisfied with the mark I'd go talk to him again and get marks back. And that was another good experience. [He] didn't mind that at all. And so it just reinforced it. And that's the way you get through. That's the way someone like me who's not gifted gets through. You do it by working hard and you go and you talk to your profs often and you ask questions.

You obviously feel strongly about this.

Just because I'm not gifted. I went through school with [name of student]. You ask anyone in computer science department about [name] and they will tell you about [name]. I have been in [name's class] since kindergarten. It has been the case for that class from kindergarten to grade 12 where [nmae] gets the top mark. Always. Without a doubt. However he does it, no one ever knew. And then the rest of us would fight for everything else. It's the same thing here. He...everyone knows about [name]. If you're in a class with [name], he gets the top mark and the rest of us are fighting for everything else. So maybe that's another thing. I mean, I've had to fight for whatever since kindergarten. There's always someone who's better. So the one time where I was in a class and I got the highest mark, oh my goodness! You know, that never happens. Never happens.

That's excellent. That's good. What do you think it was about [name] that made him effective as a teacher?

He said himself he used to be a screamer. He called himself. When delinquents would not come to class or come in late, he said he used to just take them outside and holler at them and he said that he found that just didn't work. There are some teachers that have discipline just nailed so that it's so subtle so that when someone comes in late all they have to do is look at you and you feel like you're this big. He could do that. So his class was always just well behaved. He had us working in groups of four. So every time you'd come in you'd get your group of four and he would pick the groups. So there would be one good student, with one not so good student and mediocre and whatnot, so you could all work together and help each other out. And groups of four. That was a breakthrough. No one else does that. Everyone else, every other person in high school says "each student individually". No. He had us working in our groups so that it was comfortable. Our desks were together. If one of the kids in the group had a question, they could answer it. Why doesn't everybody do that? I don't know. He told corny jokes which livens it up a bit. Yes, they're stupid. And everyone thinks they're stupid jokes, but it gives a certain amount of levity to a serious subject. It makes it more accessible to students who are having the trouble rather than just bogging them down in constant surge of information. He was approachable. As I said, I could go talk to him anytime. Anytime.

Do you think you could use those same teaching strategies in a computer class? The

group work and approachability?

The thing that is really ludicrous is that when you go and you work in the computer science industry, it's team. It's all about team work. And in university, it's all about every man for himself. It's stupid. That's this university. That's not other universities. My fiancé is in computer engineering at [name of university]. They do a lot of group work there. And then the way it happens is someone, a couple people end up doing the coding, someone does the write up, they distribute the.. you know, they distribute the tasks. And that's the way it is in the real world. And yes, group work should be encouraged at this university 100% more than it is today.

If you could recommend any changes to the program in high school, obviously that would be one of them to work more in group work. What else would you recommend to encourage women or other students to go into computer science?

I don't know if I would encourage... if I was a high school teacher I don't know that I would encourage other women to take computer science. I think it has to be a decision that people make based on their personality and their personal preference. Because it's... a lot of women in high school know they just want a desk job. They know they just want to be secretaries. This is not a job for people who don't want to work. And a lot of people in high school don't want to work. They get through with C's. You can't encourage those people into this industry. You're not doing them a favour. The learning doesn't stop after university. As a matter of fact, you have to learn faster when you get out because the industry in accelerating faster than an educational institution can keep up. There's nothing that the high school can teach that prepares any kid for computer science classes. I don't think there's anything that a high school can do other than keep trying to teach kids basic skills. You need math skills, you need study skills, you need work skills. And if there are people that can learn work skills, than they're good people for computer science. I don't know that I would encourage ...it's not like I'd encourage everybody to go into computer science. That's ludicrous. Cause there's only...not everybody is suited to the job. You have to be...your parents have to raise you that way. I don't know if the school system can raise kids that way.

Other than hard work, what do you think prevents other girls from considering this field? You mentioned that your math class had a lot of females and not men...

But they're all education. I think there's only three, maybe four, math majors in their senior years. I'm the only one graduating with math this year. The only female.

Why do you think that is?

The rest of them are education. I don't know. Maybe it's hard. Everyone says math is hard. So everyone thinks that math is too hard. I don't know why. Some of these people

that graduate with math education shouldn't be. Shouldn't be. If you don't like math, if you don't understand math, or if you have to take calculus three times to be able to get your D and get out, what are you doing teaching other kids? You obviously find math hard. And it's those people that tell kids that math is hard and that it needs lots of work. Don't tell them it's hard. Teach them how to work at it. I don't understand why these people pick math. Why..I guess it's easy to get a job in math maybe, I don't know. But there are an awful lot of women doing math ed who are not helping the kids of tomorrow, right?, the university students of tomorrow do any better. The ones that make good math teachers are the ones who are good at math, and like math and like working in math. The ones who are like "oh man, got another assignment", or the ones who are like "oh this problem is hard" rather than saying "this problem's challenging". I think that those people hinder people from doing computer science. So there you go. There's kind of an answer. We need teachers who are positive, who call things challenging, who don't call things difficult, who encourage hard work, with I don't know whatever kind of reward they want to give, and who can (and that was the nicest thing about [name], was he knew his stuff). You could ask him any question and he would be able to answer it. Even if it was beyond the scope of Math 30, he just didn't...it wasn't like he was limited to the curriculum. He knew his stuff. And so he could answer your questions in as much detail as you wanted. There aren't very many math teachers who can do that. We need more like that if we want more kids in math and computer science.

I have one last little area. I know time is kind of going here so I'll be real quick. I'm always interested to know how a woman chooses this because it is so male-dominated and it's got the... maybe the idea in our society that it's geeky and isolated and that. You mentioned your fiancé up in [place]. How do you see this lifestyle or maybe that choice of study or choice of occupation fitting in with you life together with him or your view of femininity or yourself as women? How does this work together?

Well, one thing's for sure. When you're doing computer science you don't dress very much like a girl. You don't wear tight shirts, you don't wear tight pants, you don't wear a lot of dresses. [on purpose] On purpose. That's just attracting attention. And the wrong kind. You don't want to be a sex symbol in these classes, so you don't exude femininity. You don't paint your fingernails and your toenails and wear red lipstick and stuff. I mean, you look like you're working. Like you've got stuff to do, more important things to do than your hair and your makeup and all that. There are some people, I think, that succeed in doing both, but not..I haven't seen any of it. Just femme fatales doing computer Science. What was it... you were talking about lifestyle and how it fits in? Well it's, I guess you have to be career oriented. Why do computer science and be a stay-at-home mom?

Do you see yourself as being able to balance the two?

Well, depends. I've never wanted children. Never. So a career is what's left. I've never

wanted children, so I don't see myself ever wanting children. So that's fine for him too. And so we're just going to go and be career people.

Is he into a similar field as you are?

Computer engineering.
Okay. So there's some overlap.

Yeah, a lot of overlap. I don't know if, I don't know if ...just because I'm attracted to intelligence doesn't mean that all women in computer science are attracted to intelligence. I mean, that's just what I go for. I want someone...I'm going to be working all day and I want to be able to come home and talk about what I was working on and have the person understand without me having to give him a Bachelor of Science in computer science. So that's just what I look for in life. I don't think that's a generality at all.

Is there anything else you want to add?

I'm really interested to know why we have these stereotypes in our world. And what has enabled you to overcome those and become the person that you are. Why you choose career so solidly and whether this choice feeds into that a little bit.

Well, as I said, I think is was the way I grew up. When I was first born, my mother was in law school, and of course she finished law school when I was two, and etc. She was busy so I was very much my father's daughter. And I ... when daycare wasn't available, what did I do? I went to [name of discipline] lectures, and [name of discpline] lectures and I could do Venn diagrams by the time I was four, which most people don't learn until second or third year. And I spent my youth with adults. But it's also the case that I know I wasn't a normal kid. When I was a baby, my parents could take me to restaurants and they even got duped into it "This is easy, you can take your kid anywhere. They never cry". When I was tired, well, I would just sleep. It's not a problem. You don't cry about it, you just sleep if you're tired. Then of course they had my brother, and my brother would get tired and say, "no, I'm not tired" and then cry about it. And I didn't understand that. And I think that he is more like your average kid. I think average children like to play. And play was always ...I never understood play. What's play? I remember the first time my parents asked my brother what he was doing and he said, "I'm playing". And I thought, "you don't say that, you say I'm cleaning my room, or I'm reading a book, or you know," That's the way it is. You do things productively with your life. You don't play. And that's the way I grew up. That was my environment. That was the way I was molded. Mind you, I came out with a certain amount of that so it didn't break me. Some kids, like my brother, it's driven him crazy. He can't handle that kind of atmosphere, but I came out with a different mind-set. And so it made me instead of breaking me. That's that. I think I was born that way. It's the only thing that did it for me.

Are you happy with your choice?

Yeah. Or put it this way, I can't see myself doing anything else. I have an excellent job. I'm going down, as soon as I write my last final exam, I'm going down to [place]. I've got a good job down there. It's exciting. I've never…I was born in [place], raised in [place], so going to [place] is an exciting thing. I'll be doing something new. My boss, so far, seems like a really great guy, and I'm really looking forward to a change and the parts of my world that doing this job can open up for me. I don't think it's something that I'll do forever. I know I won't. But, yeah, I'm happy with it.

[At this point I turned off the tape and we continued to talk informally. This lasted for about 20 minutes. During our conversation, she asked to add something, so I turned the tape recorder back on.]

Last summer, I had been working at this company for about 16 months already, not all at once. No, twelve. I had done an 8-month co-op and a 4-month. They assigned me a mentor, but because I had been the only woman that they had ever hired in any technical capability, they had a lot of respect for me. They assigned me a mentor who was new. He was new to the company. They didn't tell me why, which cheezed me off. They should have told me right off the bat that my job was to mentor my mentor. To teach him how to be a mentor. The first day I show up to work and he has on his office door a picture. In computer science there are a whole series of books done by O'Reilly & Associates and they're always the same. They have like Java on the front and then some animal that somewhere in the introduction they say has something to do with Java. Like a camel. And then O'Reilly & associates. Well this guy had one that said porn and had a picture of a naked woman on it. He had this on his desk. And so I show up there on the first day. I see this and you really wonder, "Why did they assign me this idiot? Why?" About halfway through, about three months into my work term, finally a couple girls happened to go out for lunch with us and we said, "have you seen that poster?" "Yeah I saw that poster" "man, that's yucky". And one of them said well..We're all both saying well, I don't want to tell my supervisor because then I'm not one of the boys. Then they're going to think I'm against them and not with them. So you just don't say anything. And you know…I know why it was up there. It was a funny spoof on these O'Reilly associates, right? So, for me to take it to my supervisor, it blows something out of proportion. From their perspective, it blows it out of proportion. Not from my perspective but from theirs. So one of them happened, she was in doc, we call it, where they document the code, it's a writer, a technical writer. So her boss, usually they hire English majors often for this who have some technical background, and she talked to her boss and her boss the next day went and said hey this is inappropriate. But he worked in the opposite side of the building and so never saw it until someone mentioned it to him and then he did it. So it's still there. Even in the workplace. But it is controlled and there are things you can do about it. But again, there's the attitude of I don't know if it's really

there, but I have to be one of the boys. I can't be against them all the time or you don't get help. You get shot down when you ask questions. You don't get your vacation. Like any workplace, right? You have to be friendly, and even though I didn't approve of the poster, I can understand why it was there. It was a joke. Just a kind of a chauvinist, boy, old boys network kind of joke, but it was a joke nonetheless. So you don't want to take it too seriously. Just lucky that there was someone there who was. Even then, I'll forever have the wrong impression of the guy. Maybe he's a nice guy. I just think of him as scum. He's yucky forever. I never talked to him for the whole summer even though he was my mentor.

Did that work?

No, it didn't work at all. It didn't work at all. Just cause they didn't have their eyes open. That's it for that one.

Interview #2

This is interview #2 by Gladys Sterenberg on [date].

What I'd like to do is just go through the topic. We talked a little bit about that previous to putting the recording on. The participant has signed the consent letter and I'm just going to ask her permission if I can tape this. So if it's okay with you I'd like to tape it.

Yes that's fine.

While you're talking, I might be taking notes. That's just to help me organize my thoughts a bit.

Do you want me to state my name on the tape as well?

No, your name's not necessary. I'll try to stay away from saying your name. But if I do, or if you do, in the final transcript, I'll block those out so it won't show up. So there's confidentiality.

Just to get started, just tell me a little bit about yourself and your program.

Okay. Do you want information from my background and my history or just university?

Let's just do university right now. We'll get into the family background…[okay]

I started out in accounting, an accounting program, doing a management degree with a major in accounting. About my second year, I decided I wasn't really enjoying the

accounting classes I was taking. I originally started out in that because I thought that it was a field that not typically very many women went into and I kind of enjoy that groundbreaking type of defining a role definition. So that's why I started out in it. But I found out that there were actually quite a few women. Probably 30-40% of the classes were female. And I also found that I didn't like the job prospects associated with it. Typically you start at very low level positions; you're working 12-14 hour days, not being compensated very well. So I didn't like those factors. At the same time, since this is a liberal arts university, I was taking a variety of other courses. I took a few computer science courses and I found that I did really well in them. I really enjoyed them. I'm a very logical type person and I have that kind of a mind. That's basically what helped me to decide to switch over to the computer science program. Since I didn't want to lose a lot of the management courses that I'd taken, I'd almost completed my degree, in fact, in the management side of it, and so I decided to do a combined degree of management, MIS, with computer science.

How did you find out about career prospects for computer science?

It was all word of mouth, actually. I had a friend that was doing the same program as me, Management and computer science combined degree, and he did a work term up in [place] and told me about some of the amazing opportunities up there. People were getting hired on before even finishing their degrees, they had unlimited expense accounts, the companies were paying for their living expenses and their apartments, they could basically state the hours they were going to work. It was very open because computer science students were in such high demand. I'd kind of known that before, but I'd never really considered it as a career option. Once I started considering it, those were just added benefits to what I had already decided that I liked.

How would you describe a computer scientist?

Do you mean the picture that I see in my head when I think of computer science people? Typically a low status type person. There's not a lot of prestige associated with computer science. You see the archetype of a geek. When you think about a computer science person, I think of glasses, unkempt appearance, sort of a mad scientist type look. That's what the impression that I used to have of a computer science person. Of course I'd like to think that I don't fit that type of stereotype. I think that that's what I think of when I think of computer science people.

You mentioned that that's how you used to think. What has changed or how do you view it now?

Since I've entered the program, I've met a few like-minded people that are the same as me. They have outside interests besides computer science, other extra-curricular activities outside of the university. They're not solely focussed on solving algorithms or playing

around with computers 24 hours a day. They care about their appearance, they have communication skills. I'm not saying that the person I described originally does not exist, because I know that they do, but there are also people in the field that are not like that, that have other skills and that have entered computer science for the reasons I stated earlier.

Have you done any work terms?

I haven't. I'm interviewing currently for co-op positions. Hopefully sometime in the future, I'll possibly get into that.

How does the co-op fit into your program?

You don't get credit for the experiences that you do. You pay a one-time fee, but you are able to continue your full-time status as a student so you don't have any student loan worries about repaying them. You can do 4-month, 8-month or, I think, 16-month work terms. It's a really great opportunity to get some job experience but also to be trained on the job. To get some really practical job experience and to also make some really great networking connections for future career prospects.

Are you then planning on coming back and finishing up? [yes] What year are you in?

I'm actually in my fourth year academically of a five-year program. It's my fifth year here at the university, though.

Getting back to some of your experiences here on campus, have you experienced any obstacles as a woman in the computer science department or in that program that you didn't encounter or were different?

As compared to management and that faculty? Yes. Quite a few, actually. The math and computer science department tends to take a different approach to the way that they teach courses. In management, it's a lot like high school or college type courses where you're spoon-fed the information. They hold your hand through the process and make sure that you understand at every stage of the way. It's an easier learning process. In the math and computer science courses I've taken, you're left on your own; you're left to your own devices to figure out things. The textbooks are not as easy to read. They're at a higher level. There's not as many examples which makes it very difficult to do assignments. Typically you have to tend to work in groups because there's no other way to get the assignment done. They're not as concerned with holding your hand but they're more likely to force you to figure things out on your own. It's almost as if they're trying to weed out the people that aren't sure about whether or not they want to enter that faculty or courses from that department.

You mentioned that you did a lot of group work to overcome those kinds of obstacles. What other things have you done or what things have you found that are effective?

Having friends in the same discipline that reassure you lots of times because it's scary. It's not an easy degree but by building those friendships and realizing there's other people that are in the same boat as you and if you can stick it out, then everything will be okay. Keeping the long range goals in mind as opposed to focussing on individual grades for classes but making sure that you understand what's going on to the best of your ability and focussing on what you want to accomplish in the future. As to problems I've had with individual courses, I exhaust all of the resources that I have. I don't really have any family or relatives or good friends that are in the field of computer science practically. I do go to the library, and there's not that much really for computer science. A lot of it, you have to buy the resource manuals yourself because the libraries aren't current enough. I go to places like Chapters and London Drugs and find the best deals I can on those sorts of books and just basically stock up a warehouse of reading material. I'm making it sound a lot more scary than it is. Not all classes are like that. A lot of them are actually okay. And that's what helps pull you through too are the easier courses that you think, "It's okay, I'm really getting this stuff. I can do it." That's what helps you to go on and tackle the classes that are a bit more scary.

When you're working with groups, you had mentioned that you are one of the only females. Have you found that to be a problem?

Not really. I actually quite like it. I like being one of the few female members of a faculty or department or even just one of the few female members of the class. I like feeling that I'm helping to change a set pattern or stereotype in people's minds.

What do you think gives you that ability, that drive, that enthusiasm for wanting to change things?

I've always been that way. I don't like gender and role definitions. I'm not a feminist per se. I don't actively pursue the rights of women as a whole, but I enjoy feeling that I'm making a difference somewhat in the way that society and our culture develops.

How do you see yourself making that difference in the future?

Even though it doesn't make that big a difference statistics wise, if you think about one person, that one person may motivate other people to make the same change or to enter the same field. I don't think it's an immediate change, but I think that it's a gradual change and every single person helps to make up a huge body of people.

You mentioned earlier that your relatives and close friends aren't in the field. What role did your parents play in this process?

Not a very big one. I have them to thank for that. Because they didn't encourage me to enter one of the two-year type programs that are typically pushed at females, I don't mean to single any thing out, like dental hygienist programs, optometrist assistant, executive assistant type programs. Because they didn't force those upon me or make me feel like that was what I should be aiming for, I aimed above it. It's actually to my advantage that they didn't pressure me or persuade me to enter any specific discipline.

You mentioned you were the youngest of five children. Could you talk a little bit about how your family viewed education?

Education is very, very important in my family. My father is a farmer, and he never finished high school and he didn't want that for the rest of his children. He wanted, in fact, he insisted that especially the males in the family go on and get a university degree. It was all right for the females to get married if they wanted, but he also encouraged them to also pursue secondary education. My oldest brother is a doctor of veterinary medicine. My other brother is pursuing his Ph.D. down at a university in [place] working in botany, cellular biology. My oldest sister almost finished her art degree here at the [name] but got married. Then the sister in between me and my oldest sister, she started university but she got married. I would be the only woman in my family to have actually gotten my bachelor degree which kind of makes me happy too.

If we could switch gears a little bit and talk a little bit about your high school schooling. Could you describe some of those experiences for me?

As relating to computers or just in general?

Just in general, what prepared you for this field?

I had a really solid group of friends in high school. I wasn't afraid of what people thought of me. I wasn't very outgoing. I tend to be a more quiet person. I keep to myself. I don't make a lot of friendship or acquaintance type contacts, but the friendships that I do make are more deep and lasting. With the really solid group of friends that I had, it made it really easy for me to focus on any type of career path that I wanted to. I wasn't that concerned with it. I knew that I would do something that was best for me and that I wouldn't be following them to specific colleges or universities because I didn't know what I wanted to do. I was never really like that. I didn't have anything really set in my mind about what I wanted to do as a career, but I knew that I did want to go to university.

Could you talk a little bit about your math classes?

I did quite well in them. I didn't really enjoy them that much at the time. I've always

really enjoyed solving puzzles and problems but I didn't view math as being really that way until I got into university. The math departmental in my grade 12 year was the worse. I performed more badly on that than I did on any of the others. It brought my mark down to a low A for that class. I did quite well in all of them. My teacher was not discriminating towards females at all. He was always very open-minded and he was a very logical thinker, a very logical man. Not everyone liked his style of teaching, but I really did. So I think that my math courses were better because of that. I've never considered dropping down to the lower level math courses.

Would you classify yourself as a gifted student in high school?

Yes. I was constantly on the honor roll. I graduated second in my class. I tend to do very well in structured courses.

What would you recommend to high school educators now in order to encourage more women to go into computer science? What could they do?

That's a good question. I don't know that I know the answer to it. I didn't really take that many computer courses in high school. I did take two, but they were on my own time. And the professor was very accommodating in allowing me to work in the lab by myself after classes or during noon hour so that I could pick up those extra courses because I felt computer knowledge was very important. I don't know what educators could do. It almost goes back to the mindset of females or even just personality types. We tend to like things like home economics and things and tend to sign up for those classes more readily than we would computer classes especially in high school when you're not really thinking about the future. I've always been more practically minded though, sometimes to my disadvantage. I'm constantly thinking about the future and how that will affect me. That's why in addition to the electives that I took such as band and things that I really enjoyed, I made sure that I had a few more practical courses in there as well. It goes back to changing the mindset of people as to what they want to pursue in the future and what will help them to get there. So maybe, just helping students to view high school in a different light. As opposed to a time for fun and games, it is that, making social connections and friendships, but also to prepare them for the future and any jobs that they might like to get after high school or any career they might want to pursue after high school.

What contributed to your view of the importance of a career?

I never really saw myself getting married I guess. A lot of my friends were solely focussed on that. They felt that they wanted to graduate high school, get married and start a family. And that's all right. I just always felt that that wasn't for me. I wouldn't mind that in the future and I wouldn't have minded if that happened in the past, but I wanted a backup plan. For instance, even if I did get married and start a family, I want to know that

I have a career that I can fall back on in case one or both of us needs to work or if I decide to pursue my career and my husband decides to stay home.

How do you see computer science working into that?

It's an integral part. It's what I'm basing my future on.

As a career, how does it allow you to perhaps balance that in the future with family?

I think it's almost a necessity. If you want to work at home, you have to be able to have computer skills to be able to stay at home and work in an office. It's a career that I could pursue even if I was staying at home with the children. I could telnet into the office and work from home. It's very flexible that way. Not that I would have thought that a few years ago. When you think of career options that females typically pursue so that they can stay at home with their families, things like travel agent or other jobs like that where you're doing a lot of phone work, but I think computer skills are also necessary if you're planning on staying home or even working in an office.

Is there a difference between computer skills like you're talking about and computer knowledge?

There is. The benefit that I reap from my degree is that I learn both. In management, you're more focussed on learning how to use a computer, working with the user interface, playing around with word-processing programs and typical things that you'd use a computer system for. Computer science is related to developing a computer system, developing an operating system, learning system administration type tasks. You're working with the design of the computer as opposed to the actual implementation or usage of a computer. With management courses I've taken, I've learned how to effectively use a computer. With the computer science courses I've taken, I've learned how to design a computer or software program that will work on the computer.

Which do you prefer?

I prefer the computer science, the design of things. I find it more interesting. It's really rewarding to work on a project and know that you've created something and that it works. It's a great skill to have. But I think that the management side of it, actually using the computer is useful. There's no end to the usefulness (laughs) of being able to be comfortable with the computer system and use it. Even just creating text documents, it's great know how to format them and use all the little tiny options that are available within software packages.

You mentioned that you had a very strong group of friends going through high school. Could you talk a little bit about your adolescent years before that and maybe what helped

to form the decisions you made later?

It was actually the same group of friends all through my childhood, my adolescence and my high school years. In adolescence, it was a rougher time. A lot of the friends that I'd made were attending a different school than the one I was. I was somewhat more isolated. I started to hang around with some of the more popular kids but I didn't really fit in with them as well. They were doing things that I wasn't interested in doing. They were experimenting with alcohol and things like that and that goes against my personal belief system. I didn't want to pursue any of those friendships. I stopped hanging around with them and then I was really alone and isolated for a time. That was a little bit difficult. But then when I entered junior high, the friends came back again and I was a little bit more secure in myself because I had such a strong friend group.

You mentioned loneliness. Do you feel that now being one of the few women in this industry?

I do somewhat. I did especially the first year that I switched over. There was practically no one that I felt that I connected with. Most of the other female students were either younger or older than me and I didn't feel that I had anything really in common with them. This past year, though, I've met a really good friend. She's the same age and we really clicked well together. We've formed a really strong friendship and we kind of help each other. It's been really wonderful.

You commented earlier that you like the fact that you're the only female, that you're "defying the norm" is how you put it in your questionnaire. Could you talk a little bit about what that means for you?

I guess I feel that I'm defying the norm because I am one of the few female students. I think it's important for the professors in the class to see that and recognize that a female student can do well in the program. And I also think it's important for other students to see that there's computer science students that are female and that are different from the typical stereotype of the computer science person.

What I hear you saying is that role modeling is important to you, to be one of those people that people look and see yeah, women can be part of this. Have there been role models in your life?

There have. Mostly my family, I think. My grandmother was a very independent, free spirit. She grew up on a ranch in the early 1900's. She was out riding horses, living off a mountainside. Really amazing stories. I think she was a great person. The way that she grew and developed and the person that she became was something that I knew that I would really like to strive for and achieve some day. She was one of those people that you would look at and just instantly fall in love with. She was just such a sweet natured

person, yet very entertaining, very humourous, very intelligent. She lived to be in her early 90's and she still had her wits about her and could make people laugh and smile all at the same time. She was a really amazing person and someone that I still really look up to. Nothing much to do with computers in her era though.

Would you classify yourself as being passionate about computers?

No, I don't think that I am. I really enjoy programming. I think computers are very important but I also think that there's tons of other things in life that are important. I'm passionate about a lot of things: writing, music, creative type things. I love music and I love the arts. I'm passionate about a lot of those things. I wouldn't say that I am passionate about computers but I am passionate about logic and puzzle solving and math. I really love math. Now, I never used to but I do now. And so I think those things enter into the equation. But I'm not passionate about computers per se.

What are your future career plans?

I plan on getting an entry-level position in some organization, a company probably in Canada, in [place] possibly, working as a coder or programmer or in some type of entry-level position type like that. I feel that with my management background and education and training, I'll be able to quickly rise and gain some sort of management level type position and possibly work my way up through the company. Other future career plans involve ... I'm actually starting a company with a few of the team members that I've worked on projects with in the past. We've recently developed a database system that is going to be used here at conference services at the [university]. We're using that as sort of a test sight. If all goes well, then we'll market the product to other universities that have a similar need. The team I worked with, it was just an amazing experience. We really clicked well together. We were very productive and we had a really great time working together. I'm hoping to be part of and possibly own my own company some day.

Is there anything else you would like to add?

I remembered that you mentioned in the original questionnaire, you asked about my experience as a child with computers. We did have a computer in the house growing up. But it wasn't anything to speak of by today's standards. It was a very, very simple system and it had no way of storing anything in memory permanently. So I did have experiences, like maybe at 4 or 5 years old, entering code into a computer to be able to play a game. But it was all written out on a page. So it was basically mindless data entry. But I did have that exposure to computers as a young girl. I don't know if that really affected my decision at all. I never actually had anything to do with computers until later on in high school when I took those few courses on my own time. Math and computer science have always been very intimidating to me. I've always been very frightened of them because it's almost like you need to speak a separate language to feel that you're

comfortable with them and with people that know anything about them. Even still, I still feel intimidated because I don't know everything there is to know and I don't think anyone does. But certainly, lots of people know more than others do, especially in different areas. I think it's a continual learning process with computers and you just have to not be afraid. Once you learn the basics of the language, I've found this both in math and computer science, you're more comfortable with it. It's not as frightening. Knowledge is power. It really is.

I had one question I had missed. This goes back to working in a male-dominated environment. How do you maintain your femininity? Or do you?

You know it's almost by dressing up, wearing makeup, almost going to the extreme of looking like a woman as opposed to wearing jeans and a T-shirt and a sweatshirt or whatever. I tend to feel better about myself when I look more feminine. I don't know. That's a really tough question. You know I don't have a good answer for it.

It's something that I've always kind of wondered. Do you dress down, do you dress up? Do you change to meet that environment? Do you project yourself the other way in order to compensate for all the males around you?

I do both. In my classes, I look the same as other students. I wear jeans and running shoes and t-shirts and things sometimes. But I tend to be a little bit more ... I don't wear t-shirts that often and I especially don't wear t-shirts that have logos or that are fad-type t-shirts. I tend to want to look more professional. I like wearing dress shirts and dress pants and tend to that even on a daily basis. As to whether or not that relates to my femininity, I don't know.

Why do you choose to do that?

I guess because that's the type of person that I want to be. I want to be a professional and a career-oriented person. I don't have a lot of money, so if I start dressing that way now it saves my wardrobe budget in the future. I like to project that type of an aura, I guess. I like to be considered a professional, classy type of person. Someone with intelligence and that cares about their appearance, I guess.

The preceding interview was with participant #2 for master's thesis, [date].

Interview #3

This is interview #3 by Gladys Sterenberg, [date].

Just to get started, we've talked a little bit about the program and how far this participant is. We've also signed a letter of confidentiality and consent. I'm just going to ask her now

if it's okay if we record this on a tape recorder. [yup, that's fine]

What I've done is I've prepared some questions. If you don't feel that they're the right questions or you want to change them, we'll change them as we go.

If you could tell me about yourself.

I'm going to school here obviously at the [university]. I'm just finishing my second year. I have two majors: computer science and history. And so I'm in a Bachelor of Arts and Science, not just a Bachelor of Science. I'm from [province]. I'm from a small town north of here.

Did you grow up in a city?

No. I grew up in a small town and I just moved here when I started school.

Maybe you can explain how you first got interested in computers.

I can't really remember what exactly made me decide to go into computers. I think I was interested in graphics, drawing things on the computer. When I was trying to decide what to go into in university, I was really sort of confused cause I really didn't know what anything was. So I decided I'd try computer science and at that time I think I picked anthropology as my second major. But I changed that later. During high school, I liked the computer courses we had taken, but I was never really interested in them. Like not extremely. I didn't have a computer at home. I really didn't get too much into it until I started university.

What was it about the university courses that made you change your mind?

Change my mind to go into computers?

I actually had picked computers before I went into university. I'm not really sure. I can't really remember why. I just decided it was a good field and there was lots of opportunity and I thought it might be interesting. I haven't changed my mind from that.

You've talked a little bit about this being a Bachelor of Arts and science. Why did you choose to go that way instead of a Bachelor of Science?

Basically because I'm interested in history. I have the two majors. As far as I consider it, computer science is the major that will get me a job later and that will make me successful. Even though, I don't mind computer science. It is interesting. It's a lot of work. Whereas history is something I'm taking not really because it will have any financial benefit, but just because I really enjoy it and I think it would better myself to have that. That's

basically why I'm taking the two majors.

Do you see the two combining at any point?

I do hope to combine them someday. I don't really have any plans for that really soon, but I'm thinking after I graduate finally from school I will probably work in the normal computer science field for quite a few years. As I get more of an idea of what I'm doing and more stable and independent, I might try to do more independent things combining history and computer science, like making computer science programs that would help out history. Again graphics is something I think they use a lot in history, like recreate Roman cities and all that stuff. I think that would be really interesting someday.

How would you describe a computer scientist?

Well, that's really hard to say because there's your general stereotype of computer scientist, but especially after being in computer science, I realize that that's really quite false. Even looking at myself. I'm going to be a computer scientist and I don't think I fit the stereotype. Everyone pictures a geek, a male geek. Not all the males in here are geeks and not all of them are males. It's really hard to say. It could be anyone.

How many are females in your classes?

It varies from class to class. There's certainly less females. I would say probably 20-30 % in each class are females. But it can be less or more.

How many computer science classes have you taken?

Seven at the end of this semester.

Have you faced any obstacles being in computer science as opposed to being in history?

Not really. In computer science, the only obstacles that I can think of is just the fact that it's a difficult major. There's lots of work into it. But no more obstacles than any other course.

What role did your parents play in you choosing to go into this field?

Well, my dad's a farmer and he's pretty much completely computer illiterate. So he didn't play that much of a role. My mom didn't know much about computers for most of her life. In my last year of high school, she entered into college. I think it was in my last year, or second-last year. She started taking secretarial or business stuff but she ended up going into computers. The first year I was taking computers here, she was finishing computers at the college. I'm not sure if that really influenced me too much. It probably

did. Although I wasn't incredibly interested in what she was taking, but it's really hard to say.

Do you have other members of your family that are interested in this?

No. Not really at all. Some members of my family do have computers now and they're basically literate as an end-user. But no one else is really into programming and everything. Besides like I said, my mom. But she goes more towards hardware and I'm more interested in programming.

Why is it that you're more interested in programming vs. being an end-user?

Being an end-user? As an end-user, you basically just use the programs that people have created for you to use. I think programming is really interesting. It's like math, but different. It's like a puzzle. You have to arrange things and move things around so they work like it's supposed to. It's like theoretical math, not dealing with numbers and dealing with more structures. It's really interesting.

What makes you good at the theoretical and the puzzles?

Probably just because I can envision it in my head. If you're dealing with objects which don't really exist but in a computer sense they do like a linked list or something. I think it's pretty easy to envision that and I think that really helps. If you can't really see that, than you'd be in trouble.

You mentioned that you've taken a couple courses in high school. What was it about those courses that helped influence you? Or did they?

Most of the courses, or all of them, I took in high school were end-user. So it would be how to use the word-processing program or spreadsheet program or the graphics program. Just using the mouse. I did think those were interesting. It wasn't incredibly fascinating. As far as influencing me to go into computer science, the only one that really did would be probably the graphics one. And it wasn't even really graphics. It was just draw a picture with the mouse. And I thought that was interesting and I liked to do that so I thought computer science would be something good to go into. But again, another major factor for me choosing computer science was just the fact that I thought it's an industry where you could really be successful. There's lots of jobs available and the pay when you get out is pretty good.

How did you find out about the career options that you have in computer science?

Before I went into university, I didn't really. It was really hard to find out about career options in computer science because I didn't know any computer scientists. I never even

met one. In high school, it's not even something that they really suggest for you as a field. I never found. You could go into math or you could go into science or English, but there wasn't go into computer science. And so I didn't really know what computer scientist did. I still don't really know. I'll find out soon. I sort of have an idea now from what I'm learning.

You made the connection between computer science and math. Did you feel that it was a hindrance or a help to you to have the math background?

It was definitely a help to have a math background. And even in university the more math courses you take, the easier computer science can get. There is definitely a difference between computer science and math. It is possible to be good at computer science without being very good at math. But it helps. Having math background in high school did help and it helps having more math in university. I haven't gotten as much of it as I like, but I plan to take more later.

Could you describe your experiences with math in high school?

I was always fairly good at it. That's sort of one of the things about high school, is that I had pretty much the same mark in every course. I didn't really know what to go into. But with math, I found it was a little bit difficult. Probably more difficult than a lot of the other courses, just because I found there was a whole lot of information that they were trying to teach you. You really had to move faster. It was a bit more advanced that any of the other high school courses you were taking. Even though now, compared to university, it seems really nice. My experiences in math were pretty good. I took 10, 20 and 30 and then I took math 31, too, which is calculus. So I took it as far as I could in high school.

Would you classify yourself as a gifted student in high school?

Yeah. I was the valedictorian, so…yes.

What would you recommend to high school educators in order to encourage more women to go into computer science?

I don't know. It's really hard to say. I personally don't understand why women don't go into computer science. I know that there's sort of a stereotype, again, of computer science: you have to be a geek. But I see it: geeks make money. I really don't care. So to encourage women, I guess it would just be …I don't think you'd encourage women any differently than you would encourage men. Just by providing them with more computer science education: An introduction into computers in all sort of areas, hardware, using computers, maybe programming computers. Just making sure, like you do in math, that you're trying to make it so everyone's involved. Not be more focussing on the males and the females, just make sure that you put across the point that there's nothing wrong with

being a girl and interested in computers.

How can you involve students in the learning that occurs in computer science?

I think with computers, as opposed to a lot of other fields you go into, it's really easy to involve students in the learning as long as they have a computer. Whereas in math you just sit there and write and in English, you sit there and read, in computers you can be hands-on and have your own computer while the professor is speaking or the teacher, and you can do actually what they tell you to do. You can use the program or do programming or you can have your own computer and take it apart a little bit. I don't know if they want to encourage that in high school. It's easy to get student participation if they have their own thing to do. You do what you see being done and it's easier to pay attention that way, I think.

You talk about students doing their own thing. How important is it to be an independent learner?

It's really important because I probably do more learning in computer science on my own than in class. It's gotten more that way recently. In the first year, I paid really good attention in class and I learned a lot through that and through labs. But in the last year especially, I go to class but I don't really...I couldn't really say understand. Most of my learning takes place more at home when I sit down and try and study it and when I sit down and try and do the programs. That's when you really learn is when you sit down and try and do it. You have to go over and make sure you know what's going on. It's really important to be able to do that because if you can't, you're in trouble. You can go and ask for help, but they can only help you so much. A lot of times being university, as opposed to high school, there isn't quite as much help available. Not so much babysitting. You really have to be able to do it yourself. At least to a point.

Do you get lonely doing this kind of work?

No. Because I find that in our computer labs, we have computer labs specifically for computer science. I'm in there with all of the people that I go to class with. Even though we're working individually and working on our own work, we're always discussing things with each other about the assignment. Do you do this? Do you do that? We're always bouncing ideas off each other, just talking to each other. I don't find it lonely at all. Even though you're working on your own thing, you're working beside other people. It's good that way.

Have you found a strong study group?

I have. In the first year, I didn't really so much because the classes were larger. You'd have 100 people in class. Probably not that much, it's more like 50. Even though in first

year computer science, there's lots in them because everyone has to take them. Anyways, now that I'm getting into courses where there's fewer and fewer people, I've developed a pretty strong study group. I know even the people who I don't hang around with all the time; I know a lot of the other people. So if worse comes to worse, you can ask a question. I guess it is a support system because a lot of times you can get help with academic advisors, that's not so bad. It's fairly easy. But to go and talk to the professor a lot is more of a pain so we ask each other and it works really well.

In your opinion, what prevents girls from pursuing computer science fields of study?

Well, again, with me, I really don't see anything preventing me so it's kind of hard for me to imagine for the girls that are prevented what exactly is going on in their heads. I think, again, it might just be the stereotype. The general stereotype that girls don't like science, or girls don't like technical math or computers and stuff. I guess they're raised to think that it's boring and that it's something you don't want to go into. Really, I think it's not boring at all. Well, some of it is. With computer science, compared to history, I think it is a little bit dull. But there's a lot of interesting things you can do. You just have to get over the stereotype of it being boring and not interesting.

How do you do that?

The only way that I've done that is just to go and learn it. In high school, I was never really discouraged by sciences and math as opposed to other courses. I don't really know why. Maybe it's my natural tendencies. I thought some of them were maybe more boring that English or social, but I still did fairly well in them. Going into computer science, the more I learn about it, the more I realize that a lot of it is really fascinating. It's sort of like a lot of tedious details, but when it comes together as a whole and you find that you know enough to do something practical with it, it's really nice. It's empowering.

You use the word empowering. Do you think a lot of girls don't experience that?

I don't know. I suppose it's possible. That's probably one of the reasons I like computer science so much. Certainly not the only reason. When you finally get to a point where you can sit down and program something, to someone who wouldn't know about computer science, that's pretty impressive. It's really nice to be able to do that and to have the knowledge to do that. And to know that you have a practical skill, so I don't know if other women in other fields would feel that. I suppose in some cases they would, but that's hard for me to know.

Going back to your adolescent years, was there anything that happened there that made you prepared for this kind of field?

Even in junior high and elementary school, we did work with computers. I think the first

time I was introduced at all to computers was grade three. It was a really old computer, with a green screen. I did enjoy that a lot. Part of the reason why I enjoyed it so much was because they let you play games all the time. It wasn't too practical. Then I think, later on in elementary school they introduced newer model PC's. We had Macs in there and I thought that was really cool. The things we had to do with them were again like typing, but I thought it was really neat. Later, in junior high, I think we had a class where we went in and worked on computers. But it was I think only half an hour as opposed to an hour (like math would be an hour, English would be an hour). And the stuff we did in there, a lot of it again was fairly boring because most of it was typing, this is the mouse and stuff like that. Even then, I thought that was interesting. Fairly interesting. I think that to promote interest and stuff like that, I think it's a good idea to let students just basically play around. I know people sort of don't think playing computer games is not really a good idea, it's not really practical but doing stuff like that probably helped develop my interest in it, in computers because you play the games, but then you think how does it work? It seems impractical, but it really is.

Did you get involved in games just through elementary school?

Because I didn't have a computer at home, I never really played computer games that much besides a little bit in elementary school. I played Nintendo and I think that also, even though it's separate from computers, I think that actually helped probably influence me going towards computer science because it's kind of the same thing. Especially because originally when I went into computer science, I was interested in graphics and creating games like that. I think playing those games influenced my to go into computer science.

How did you become interested in playing games?

I think it was because all my friends were doing it. I was 10 or 11 when Nintendo came out and everyone was excited. All my friends were playing games. I liked doing it because it was a challenge and it was interesting and a good way to waste time.

How do you maintain an idea of femininity in a male-dominated work environment? Or do you?

I don't ever really think of it too much. That's not really my goal. I'm not sitting there in computer science thinking how can I make them think I'm a girl. My goal is to learn and to do well and as far as me being a girl, if anyone cares, they should realize it without me having to tell them. I don't really worry too much about thinking Oh, are they going to be thinking of me being a tomboy or not being feminine. Even though you're surrounded by guys, I don't really care that much. That's not what I'm here to do. I don't really worry about trying to be feminine because the only way I can think of to do that is ...I'm going into the stereotypes. There's a sort of a stereotype of girls being maybe not as smart,

maybe ditsy and happy. I'm not going to try and do that to make people think of me as being a girl. Besides that being really silly, it's going to hinder my school. I'm just going to as best as I can. That's about it.

What makes you successful in computer science?

Probably, just having a general ability to grasp the concepts, that's definitely important. I think one of the major things that's important is having a lot of dedication. The assignments that I have assigned every week take 10, 12, 15 hours to do. It really takes a lot of patience, too, because they're the kind of assignments where it's sort of like math in a way. Either it works or it doesn't. But you can have it working but yet one little thing won't work and then you have to spend hours and hours trying to find this one little tiny error. It can be something as simple as you forgot an equal sign or a semicolon or something like that. It can be really frustrating. It takes a lot of patience to be able to sit and go through it and do all that. Again, it takes dedication. It's just sort of an aspect of my personality. I guess a bit of perfectionism. If I don't have it done, I'm not happy with myself. So I sit and work at it until I have it done. That really makes you successful.

What limits you from reaching your full potential?

I think time, almost. One of the things that I found that makes university so difficult, especially in computer science, is not so much that you can't get the things done, you're not smart enough or it's too difficult to figure out. It is difficult. You really do have to think about it. But a lot of times, if you have enough time to sit and figure it out, you can get it done. It's just the problem of it takes so much time. On top of that, you have your classes and you have 5 different classes. Right now I'm taking three computer science classes and you just don't have time to do it. It's not so much that you can't, just no time.

What are your future career plans?

I have quite a long-range plan. I finish my second year, of course, at the end of April. I was hired two months ago, not even that long ago, for a 16-month co-op in [company]. So I'm moving to [place] for 16 months. I'm going to be working there. I'll be finished in [date]. Then I have to come back and finish the next two years of my undergraduate degree. Then after that, I really want to get my master's. So I may work a year after that just cause I've run out of money. But I plan to go back to probably [province] because school is so much cheaper in Canada as opposed to the States and they have pretty good computer science schools in [province]. [Names of two universities] are pretty good. So I'm going to try and get into there for my master's. Then I would like to get my Ph. D. as well. I think I would probably like to do it. The only think about that is getting your Ph. D. in a field where there's a lot of demand, it actually narrows your focus. There's a lot of jobs you couldn't really take with a Ph. D. that you could with a master's. I still think

it's something I'd like to do. Although I don't really know what specific field of computer science I would like to go into. I think it would be towards the software but it's still pretty early to tell. So anyways, I'll get my Ph. D. and then after that I don't think I want to teach. At least not right away. I probably want to work in industry for 5 - 10 years. So that a long 10 - 15 years.

What makes you so career oriented?

I don't know. I think I see that as the way to accomplish things in life and the way to get things you want in life. One of the things that I'd really like to do that's not too much related to my career is I'd like to see the world. I'd like to travel to different places and experience different cultures. Like live on the other side of Canada, live in the States, live in Europe. To be able to do that you need to have obviously money, but also the kind of job where there's enough demand that you could work wherever you want. That's one of the things I really like about computer science is that there's freedom. The only limit is like in a place like [place]. You can't find too much jobs. You have to stick to major centers. Besides that, you can go anywhere. That's really nice.

How do you envision motherhood?

I don't know. I don't envision it soon, that's for sure. If I were going to do it, it would probably be after I get my Ph. D. and after I've been working for a while. Of course, assuming I find a father, that would be nice too. I can't ever see myself giving up my career no matter (I can't see myself having that many kids) but even if I have one or two, I probably will take a year or two off and then go back to work. As far as I'm concerned, if I've spent 10 years trying to get my Ph. D. in computer science, I'm not going to quit 5 years later and have children and just not do computer science for the rest of my life. It's still certainly possible to, especially with computer science, because you can work at home so much and you don't really even have to go to the office. Just send all your stuff through email. It is possible to be a mother, I guess, but it's not at the top of my list as far as goals is. It might happen, but I'm not really in any hurry.

Are you passionate about computers?

It's hard to say. When I compare myself to a lot of the people I go to school with, they're hobbyist computers. They get home at night and they play with their computer and they do things with their computer. I do a little bit, but not nearly to an extent that they do. So when I'm doing my assignments and things, I am fairly passionate because I think they're interesting and I want to get them done. I can see as I get more into computer science and get better at what I do, wanting to maybe to work at it at home. I don't know. It's hard to say. In some ways I am and in other ways I'm not. I'd still probably rather read a book than do a computer program. I guess, moderately.

Is there anything else that you want to add?

In high school, the idea of being a computer scientist, I don't think I even realized that until I started to go into computer science. I think that's kind of a big deal. When they suggest things for you to be when you grow up, you can be a math teacher or a biologist. Never did I even hear anyone mention computer science. It's silly, especially considering the great demand for it now. That's probably all I can think of.

That's the end of interview #3.

Interview #4

This is interview #4 by Gladys Sterenberg, [date].

I've prepared some questions. I'd like you to help me understand the situation of being a woman in computer science. If you don't mind, I'll tape that. [okay]

Could you tell me a little bit about your schooling and your education here at the university, what program you're in?

I went to high school in [place]. I graduated [ten years ago]. I did some upgrading, then I got married, then I got divorced, and then I went to the college here for two years. I graduated with honors but was unable to find work so I went into computer science here at the university. I'm finishing up my second year.

The college program you were taking was in ...

At the [place] College. Agriculture technology.

We're going to talk a little bit about your interest in computer science. If you could tell me how you became interested in computers ...

As a child, we had the typical Commodore 64. I guess I'm dating myself. We always had that. I've worked in office situations on computers. When I was at the college, whenever we had computer stuff, I always helped out in class. I seemed to know more than they did. When I couldn't find work, I thought, why not just go into computer science? It's something I enjoyed. There's a demand out there.

You did write in your questionnaire that you had worked in an office environment. Could you explain how that ties in?

I worked as an executive assistant in an architect firm. I worked on Macintosh computers and I also worked on Pmt's, which is like a huge camera that architects use and

blueprinting and that sort of stuff too. In [place], I worked for [company]. On that we were working on a PC and then we switched over to Unix. I was the assistant for the purchasing agent and I was involved in the transition from the PC to the Unix. When I came [here], I worked at [company] and it was PC-based. All of their [company] chains, which includes [company], were switching over to a new system. Because of my experience at [previous company], they had just switched over, they asked me to go to the meetings. So we decided on a Unix-based system because it was a lot faster and more efficient. I helped out and implemented their transition there. Every so often, I'll still go back there and help them out with some inventory stuff.

You have a lot of experience.

You mentioned that your daughter was 6. Could you talk about how having a family has nfluenced your interest in this field? Or has it?

It has. In fact, there was a questionnaire at her kindergarten that refers to technology and how much more technology I, as a parent, would like to see in the school system and if I think there is enough. And I put down, no, I don't think there is enough. Right now it's a lot better than what it used to be. They have two computers at the kindergarten themselves. But I feel they could have more as they progress in school years. I feel that it doesn't matter what industry they're going into, without computers – you have to know computers. It's just out there everywhere. It's more efficient for your job. I think that for our children to succeed in life, they need to have the hands-on as soon as they can. My daughter has been on the computer at home since she was literally a baby. Right now, I have her own desktop set upon Windows98 at home that has all the Scooby-do stuff because that's what she likes. But she knows how to get into the control panel, how to get into the screen savers and she's been doing that since she was four.

Do you think there's a difference between access to computers and the kind of work that you're going to do with programming?

It's integrated. It's integrated because if you've never done the user end, as a programmer you won't know what the user needs. I believe a good programmer needs the experience on the users end in order to understand what they need and be able to proceed from that. Give them what they need.

Is it a natural leap from the user to something like what you do?

For me it was. I don't know about anyone else but for me it was.

What made that transition easy?

Natural aptitude. Just an interest.

Could you talk about a natural aptitude?

Well, I enjoy being on the computer. If you're the type of person that cannot stand sitting in front of a terminal, in front of a monitor, typing away for literally eight hours straight, then it's not the occupation for you. But if you're the type that enjoys problem solving, because there's a lot of problem solving in programming. For instance, just the other day we finally completed our assignment. I had this great feeling inside of me and I'm so excited and so proud because yes I accomplished this, yes I solved this. If a person has no interest in that, then no, it won't be a natural transition. It depends on what type of person you are.

How do we encourage more people to think like that, to enjoy problem solving?

I don't know. I'm trying to teach my daughter that. Encouragement. The more experience they have at it. Let's face it. If we're just starting something for the first time, we're scared. But if it's something that we have been doing for years, from the very beginning, it's more natural. It's like when you're first learning to walk. It's kind of scary at first. But now you're running around and everything. It's the same thing with problem solving. I believe that if a child is in an environment where they're able to experience the problem solving, as they get older, it's more natural and they're able to pick up more, more, more. Just like that.

What role did your parents play in that process for you?

I'd say, for instance, when I was a child and they bought us that little commodore 64. As far as computers goes, my dad is self-taught. He taught himself when he opened up his business and that was about six years ago. My mom, I taught her, because she had her own business and that was about 10 years ago. My mom has worked on computers in an office environment as well and she is right now. I come from a family where they do encourage you. For instance, after my divorce and I decided I wanted to go back to school, my dad was trying to convince me to go into computer science because he knew I liked it. As it turns out, my dad was right. I wish I had of listened to him before because then I would be finished now. My parents have always encouraged me in whatever I did and that's important. Without that encouragement, I don't know if I would be here.

What role do you see high school teachers playing in that encouragement process?

It's a little bit different. When I was in high school, we really didn't have computers like we do today. We had one computer class and that was it. And that was optional. It wasn't like it is now. Because it's been over 10 years, it's hard for me to say. I can't really answer that one. Someone who has just come out of high school might be able to answer that one a lot better.

You mentioned that your dad wanted you to become a computer scientist. How would you describe one?

A computer scientist? A programmer? An average person who likes, like I said, likes doing good problem solving, likes to [work away on] the computer, just like any other occupation. How does someone describe a banker, how does someone describe a veterinarian? Someone who enjoys their work.

You mentioned that it has to be someone that enjoys sitting at a computer for eight hours [yes] problem solving and stuff. Do you find that to be a lonely process?

That all depends on the environment. Here at the university in the lab...If I'm working at home, then I have my daughter with me which is ideal. That's my dream job. To be able to work from home so I can be there with her. But if I'm here at the lab, everyone's there. It's not lonely. We joke around with each other, we help each other out. No, it's not lonely.

Is working from home the motivation for going into this? Is that your dream job?

Yeah. My motivation is my daughter.

Could you talk about that and where you see her future fitting into this?

I'm encouraging her right now because I have all sorts of computer games and learning programs for her at home. Plus sometimes she'll help me out if I'm working over modem through telnet on a computer program. You can find that her name comes up quite often in my variable names because she'll be sitting in my lap and she'll be typing her name whenever that variable comes up. Also, I bought her an electronic digital keyboard for piano lessons. The reason why I wanted the digital is because you can integrate it into the computer. Later on she can have the experience of that aspect as well.

What prevents girls from pursuing careers in computer science?

Maybe they don't know what it is. Maybe they haven't had the experience. Maybe they're scared. Maybe they don't have the self-esteem. Maybe they think that it's just a man's world. It's funny, because when I'm in classes, there's only a handful of us that are women. The rest are men.

How do you deal with the man's world?

Most of my friends are men because my classes are mainly men. I have no problem with it at the moment.

How do you maintain your femininity in the male-dominated places that you just described?

Well. I don't think I've lost it at all. Maintain…in what sense?

Do you find yourself acting differently because it is male-dominated?

No. For instance, one man swears an awful lot. I tease him about that and I've noticed that his language has been a little bit more curbed. It's getting better. So I think I'm influencing them as well as them influencing me. It's like a symbiotic relationship. It goes hand in hand. I help them out, they help me out. Co-existence.

Do you see yourself as having a specific role as a woman in the industry?

I think it's harder for me because I am a woman. I know when I was in the office environment, there was a definite difference. The pay scale, for instance. I believe the reason why I couldn't get work after graduating with honors from the college – there were men in my class who were just barely passing, they got jobs right away – I couldn't even get an interview. And if I did, the first question was, "Do you have kids?" The second question is, "Are you married?" Which is illegal for them to ask but they still ask it. One thing I do notice about this industry, I don't know if it's a different mentality, but the interviews I've been on, I haven't been asked that. After I have the job offers, and I've talked it over with my daughter and I found out that it was better for me not to take the job because of the separation, and I told them, they were completely understandable. In fact, one job said, "If your situation changes, and you're able to come, just give us a call. You have a job." I greatly encourage women to seek out this type of field because the maturity level is a lot higher. The mentality is a lot better. I think the men see the women more as an equal, so it's a great advantage.

Do you think that's changed?

Yeah. I think it's changing. I really do.

What's contributing to that?

I don't know. Maybe it's the fact that there are more women in the industries all the time. Maybe it's because it's still a fresh industry. With a fresh industry, comes fresh ideas and fresh ways of looking at things. In this industry, with the problem solving you have to find new ways of approaching tasks and problem solving. I think by training the mind with this problem solving, you've also trained your mind with seeing, "Okay it's not a male/female anymore." It's not okay: "The female cannot work as hard as the male." I think it's more of an equal basis. Because the mind's been trained with problem solving

and different ways of approaching ideas, different perspectives. But that's just my opinion.

I'd like to talk about your school experiences. Could you describe what you went through as an adolescent in choosing the courses that would allow you to be strong in problem solving? Did you find that constraining or a challenge?

I've always had a natural aptitude for math. I think that's where you have problem solving. The English courses I was good at and I enjoyed reading that, but the math courses is where you have problem solving and those are the only courses I can think of.

In math courses through high school, did you find that difficult to be in those environments with friends or did you find that challenging?

Challenging, yes. I'm the type of person where I like challenges. I feel good about myself when I've met a challenge and overcome it. I wish there were more courses that were more like the math courses where there were problem solving. I really can't think of any that they can add or that are out there right now. But I'm glad that they will be putting computer science in the high schools. It's a big advantage.

The types of programs that are going into high school are user-type: using spreadsheets, using word processors. How do you feel about that?

Well, a definite advantage for anybody. But as far as the computer science field, there is talk that they're going to have programming, C++ and those languages, high level languages which I think will be even better.

What are your future career plans?

My future plans? I want to remain in [province], preferably [city]. I want to work as a programmer and I would like to have the type of job where I have the option where I can work from home as well as in the office. Let's face it. You can't do all the work from home. You have to go into the office for meetings and that. That is my dream. This way I can work and be there for my daughter. Being a single parent, it's very important for me to be there for her. How many jobs allow me to do that? Not very many. I believe that this is one field that does.

How did you come to that realization that you could blend career and family in that way?

I don't have a choice. I'm in the situation where I have to have a career that would pay enough money so that I can raise my daughter and this is one of those. Either I go into a field where I'm working all the time in an office or somewhere else, or I go into a field where I can do that plus be at home for her. After researching and talking to a bunch of

people, I found out that yes, I've made a good decision going into computer science. One of our academic assistants just came out of the job force. He's been telling me that depending on what team you're on, quite often they will let you work from home and go into the office on set days so that everyone's there and they can have their meetings. I just hope I'm lucky enough when I'm finished to find a job like that.

It's a lot of flexibility.

Yes. When you go to the career fairs, and you're talking to potential employers, they tell you, "Yes, we do offer flexibility."

Do you consider yourself passionate about computers?

Yes. I enjoy it. I find that if I go a week without going onto the computer, I'm antsy. I can't wait to go on.

What makes that interesting to you?

I don't know. I really couldn't tell you. I don't know. It's something that's inside of me. It's something that's been taught in a sense. Well, I don't know. I don't think you can teach it. There are quite a few people who don't even do their assignments, which I don't understand. Ever since I've been at the university and I've taken my first computer course, I liked it so much that I just wanted to keep going. For instance, this summer I'm going to learn more languages on my own, which I think will be beneficial. I think the more experience that you have, the more of the desire builds inside of you to learn more. It's like an addiction, almost. In a good sense.

Can you do this job without passion?

Yes. You can do any job without passion. Whether or not you enjoy it, that's different. What's the sense in working at a job you don't enjoy?

How important is it to have the ability to self-teach or to self-learn?

I think it's very important. This is an industry where you're constantly learning. If you don't have that ability to teach yourself, then when you have your degree and you go off into the job force, and there's new languages out there and you don't know how to teach yourself, you won't survive.

What limits you from reaching your full potential?

Myself. I have a tendency to have self-doubt at times. Location-wise also. I want to be in [city]. Right now the jobs are down east. If there were more here in [province], that

would help me reach my potential.

Do you see yourself doing this for the rest of your life?

Yes. I wouldn't mind doing some work on my own. On the side. With some programming. Come up with something that maybe I could market. I don't know if that's possible, but it's a dream. It never hurts to have dreams. We all have dreams. I think it's healthy.

Do you consider yourself a computer geek?

No. [why not?]. There are some people in my class that are more into it than I am. Big time. For instance, they go on the Internet a lot more than I do. Some of them contract work out right now. Besides, what is the typical computer geek? What would you consider as stereotypic computer geek?

I'm not sure. That's why I asked you.

No I was curious. You're not in the computer science field, and what you may see as a geek, maybe I am or maybe I'm not.

You've heard the stereotype of a guy that works at his computer all day and has very little social skills.

No. No. If you know the people in my class, you would not agree with that. They are very sociable. You're thinking about the one with the pocket protector and the nerdy glasses. I've never experienced that. In fact, the people that I've worked with and I have in my classes, they go out, they have fun. We kid around and joke around in the lab. I don't see myself as the computer geek. And I don't see any [others] as the computer geek either. Unless there are some and I haven't met them yet.

Is there anything else you'd like to add?

I think you've pretty much covered everything. One thing I would like to see. We did lose some very good computer Profs last year. Other universities, especially some down in the States, offered them more money. I think we should be paying, especially the very, very good profs, more money to keep them. As a student, we can only succeed as far as what they will allow us. The Profs that we lost, I think we're suffering because of that.

What made them good Profs?

Their teaching skills. There're Profs up there that are excellent in research, but they lack in teaching skills. For instance, there's this one. I was looking forward to having him again

this year, and in the summer he was snatched up by a university down in the States, down in Texas. He had the teaching skills. He had the knowledge. You could talk to him freely. You could joke around with him. You felt at ease with him, which is very important. If you feel uncomfortable about talking to your prof about a particular assignment or a problem you might have, then you're not going to talk to him and you won't find out what's wrong, what obstacle, how to overcome it.

You mentioned that as being important to helping you get through and get interested that you could ask a lot of questions and talk to people. Is that necessary in this climate?

I think it's necessary in any situation you're in. If you're afraid to ask questions, how do you learn? If you're making the same mistake over and over again, and you don't know and somebody doesn't tell you, you're never going to learn the right way of doing it.

Anything else?

This is the end of interview #4.