WOMEN OF OPPORTUNITY: CHARACTERISTICS OF EXPERIENCED WOMEN IN COMPUTING AND INFORMATION TECHNOLOGY CAREERS

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CHAPTER I

INTRODUCTION

Focus and Rationale for the Study

Visit a high school or college classroom where students are engaged in computer programming or in the type of computer learning that aims to control the computer. Look around the classroom. Who is in the class? How do the students feel about their work with computers and who plans on pursuing it as a career? Visit several other similar classrooms and ask similar questions.

What you would find in your visits to these classrooms was what I lived for the 15 years that I taught computer programming classes in a local high school. The majority of students who took the classes were boys. There were a few girls each year who were interested in computers and willing to take a computer programming class. The boys who took the class often had considerable experience working with computers at home and just wanted to hone their computer skills at school. Many of the boys who were students in my other classes would not even sign up for the computer programming course because they thought they already knew how to program a computer and did not need to take a course in it. On the other hand, the girls in the class often did not have a computer at home but were interested in learning more about using computers. Some girls initially approached the computer with fear that something they typed in would break it.

My experiences are echoed in literature accounts. Shashaani (1997) found that fewer girls than boys had computers in their homes. Callan (1996) reported that women indicated more concern than men about physical hazards and/or malfunctions when asked about working with computers. Linn (1985) mentioned that some sources attribute women's lack of enrollment in computer courses to a fear of technology.

At first my school only offered a one-semester introductory course in programming in the BASIC language. Then we added an advanced course in BASIC and eventually a course in another language, Pascal. This Pascal course was taught in an independent study format, with the students physically in the same class as the BASIC students, but working independently. This course's independent format required that students be willing to learn programming in Pascal with limited help from me. It only attracted students with a strong desire to learn more computer programming. Of the girls who successfully completed the introductory course in BASIC, only a few chose to take the advanced course, and even fewer took the Pascal course. In fact, of the eight students who completed the full two years of computer languages, only two were girls, which means 25% of the students who completed two years of computer programming at this school were girls. In these courses I also found attitudinal differences along gender lines. Boys took the more advanced courses even though some did not achieve as well and showed less in-depth understanding than some of the girls who chose NOT to continue. Many of the girls who chose to take the first class were very good BASIC programmers and demonstrated their keen attention to detail. But often these same girls did not choose to continue, stating a lack of interest, lack of self-confidence in the subject, or desire to take other courses instead of an advanced programming course.

This experience with my students was not unique. Treu, in his letter to women considering a computer science major (Prey & Treu, 2002), mentions that some male college computer students think they are great at computing but earn lower grades than some of the female students who earn high grades but have less confidence in their abilities. Balcita, Carver, and Soffa (2002) as well as Fisher, Margolis, and Miller (1997) observed that many young women lack confidence in their computing abilities when they begin their college courses. Treu and Skinner (2002) reported that the statistics on high school women in computing showed the young women performed at equal or better levels in computing courses than the young men did, but most young women chose not to take further computing courses.

The personal observations in the computer courses I taught were based on experience with approximately 240 students over 15 years, but such gender differences in computer usage are supported in the literature. Janssen Reinen and Plomp (1997) used data from the Computers in Education project to investigate gender equity issues involving computers in schools internationally. They reported that females in schools enjoyed using computers less than males did and females had more problems using programs than males had. Shashaani (1994) investigated secondary students' attitudes towards computers and computer-related experiences in the Pittsburgh area; she discovered that male students had more computer experience than female students had, boys showed a more positive attitude towards computers than girls did, and boys more often planned on taking additional computer classes than girls did.

During my years of teaching computer programming, I often tried to encourage more girls to take the introductory course and to continue in the more advanced courses if they had the desire and ability to do so. But my encouragement did not seem to have any effect on the low enrollment of girls in the computer programming courses and the extremely small number of young women who were choosing it as a career. I often asked myself why women participated less than men in computer classes and careers. Articles on computer equity issues did not provide any satisfactory conclusions either. Others (Balcita et al., 2002; Dryburgh, 2000) investigating the cause of women's underrepresentation in computing career fields have also reported on the lack of clear reasons why.

Statement of the Problem

There is an underrepresentation of women earning computing degrees. Table 1 shows the percent of degrees in computer and information sciences earned by women in selected years. The years shown in the table are representative of the trends in the percentage of degrees earned by women over the 25-year period represented by the table. Table 1 shows that the percentage of bachelor's degrees earned by women in computer and information sciences at first increased from about 33% in 1980-1981 to about 36% in 1985-1986, decreased to about 28% in the years from 1990 to 2000, then decreased further to about 22% in 2004-2005 (U.S. Department of Education, 2001, 2007). From 1980 to 2005, the percentage of master's degrees in computer and information sciences earned by women increased from 23% in1980-1981 to about 30% in the years from 1985 to 1991, decreased in 1995-1996, increased in 1999-2000, then decreased to about 29% in 2004-2005 (U.S. Department of Education, 2001, 2007). Even though the percentage of women earning doctorates in computer and information sciences shows a steady increase, it remains abysmally low, going from about 10% in 1980-1981 only to about 19% in 2004-2005 (U.S. Department of Education, 2001, 2007). The percentage of bachelor's degrees awarded to women seemed to fluctuate around 30% from 1980 to 2000, but dropped closer to 20% by 2005. The percentage of master's degrees earned by women has remained around 30%. Even with a continual increase in doctorates awarded to women in computer and information sciences over the past 25 years, only about one in five doctoral graduates is a woman. The percentage of women earning doctorates in the future could level off or even decrease because of the trends for decreasing percentages of women earning bachelor's and master's degrees.

Table 1.

Percent of Degrees in Computer and Information Sciences in the United States Earned by Women in Selected Years From 1980-2005

Year	Percent of bachelor's degrees earned by women	Percent of master's degrees earned by women	Percent of doctorates earned by women
1980-1981	32.5	23.0	9.9
1985-1986	35.7	29.9	13.1
1990-1991	29.3	29.6	13.6
1995-1996	27.5	26.7	14.5
1999-2000	28.1	33.3	16.9
2004-2005	22.2	28.7	19.1

Note. Calculated from data in *Digest of Education Statistics, 2001* (U.S. Department of Education, 2001) and *Digest of Education Statistics, 2007* (U.S. Department of Education, 2007).

Table 2.

Percent of Women in Selected Occupations (U.S. Department of Labor, 2006)

Occupation	Percent women	Occupation	Percent women
Computer and mathematical occupations	27.0	Engineers (all types)	8.8
Computer scientists and systems analysts	30.3	Medical scientists	45.9
Computer programmers	26.0	Biological scientists	48.7
Computer software engineers	21.9	Elementary, middle school, and secondary teachers	72.4
Computer network, database, and systems administrators	21.2	Data entry keyers	82.2
Computer systems and data analysts	24.6	All professional occupations	56.3
Computer operations research analysts	50.5	All employed people 16 and over	46.4

Next consider women in career areas. Table 2 shows percentages of women in certain occupations, in all professional occupations, and compared to all employed people aged 16 and over (U.S. Department of Labor, 2006). The percentage of women in the employed population is about 46% and the percentage of women in all professional occupations is about 56%. However, both employed women as a group and professional women tend to be more concentrated in certain occupations than in others. The percentage of elementary, middle school, and secondary teachers who are women is around 72%, women comprise 27% of the mathematical and computer occupations, but only about 9% of engineers are women (U.S. Department of Labor, 2006). However, not every profession in mathematics or science shows such a small percentage of women. Both biological scientists (about 49%) and medical scientists (about 46%) show a much larger participation by women. These areas require many years of science and sometimes an advanced degree. This suggests that women's lower participation in most mathematics or science professions is not due to the nature of mathematics or science or women's lack of interest or lower ability in those areas. There seem to be other reasons for differential participation in these career areas.

Other entries in Table 2 show the percentages of women in computer-related fields. Women comprise about 82% of data entry keyers (U.S. Department of Labor, 2006). The job of data entry keyer requires the person to know how to type data into the computer or a rudimentary knowledge of a computer software program; it does not require a technical understanding of how the computer works or a college degree. The first column of Table 2 shows the more technical careers of (a) computer scientists and systems analysts; (b) computer programmers; (c) computer software engineers; (d) computer network, database, and systems administrators; (e) computer systems and data analysts; and (f) computer operations research analysts. These all require a minimum of a four-year college degree and in-depth technical understanding of how a computer works and how to control computer operations. Table 2 shows that most of these careers have 20-30% participation by women, except for the almost 51% of computer operations research analysts that are women (U.S. Department of Labor, 2006). The reason for this higher percentage of 51% is unclear but there could be some interaction between this level of participation and the 30% of master's degrees earned by women (see Table 1). All the other technical computer-related occupations, as well as computer and mathematical occupations as a whole (27%), show a much lower participation by women than the 47% of the entire workforce that are women or the 56% of professional occupations that are held by women.

The underrepresentation of women in computing careers has several effects. The computing/information technology field is missing the additional talent and broader range of perspectives which increased participation by women would bring to it (Balcita et al., 2002; Borg, 2002; Johnson & Miller, 2002; Lazowska, 2002). Individual women with a talent for computing but who avoid the field are missing out on the personal fulfillment from these careers (Eccles, 1987). Since computing careers are generally well-paid positions, the lack of women in such jobs decreases the economic well-being of women as a whole (Eccles, 1987) and subsequently decreases society's economic well-being.

No clear cause for this lack of participation by women in computing careers has been established. Some researchers (Huff, 1996; Kiesler, Sproull, & Eccles, 1985) have hypothesized that the smaller number of women in computing starts in childhood. With this in mind, some studies (Chappell, 1996; Kiesler et al., 1985; Wu, Cohoon, & Neesen, 2006) have investigated the software produced by the industry. One study that reviewed 30 randomly selected software programs used in the U.S. found that "of the 3,033 characters noted in the graphics and text, only 30 percent were female" (AAUW, 2000, p. 29) and that "80 percent of all characters featured in 'adventure' or 'leadership' roles were male" (AAUW, 2000, p. 29). Since many people first experience and gain an interest in computers via software and/or games, perhaps the predominantly male nature of the software may dissuade girls from an interest in computers at an early age. In any event, the small number of women in computing careers translates into a lack of role models in computing careers for girls and young women (Jepson & Peri, 2002; Johnson & Miller, 2002; Treu & Skinner, 2002).

Purpose of the Study

The lack of women in computing courses and careers has been investigated in several studies. Janssen Reinen and Plomp (1997) studied data from the Computers in Education project and reported a large discrepancy in computer access for males and females in all countries studied. The United States showed a slightly better access for females than in other countries studied, but it was still less than the access for males. Frenkel (1990) proposed that reasons for lower computer use among females could include (a) the predominantly male nature of computer software, (b) the problem of access for girls who don't participate in after-school computer clubs, and (c) the inadequate training of many pre-college teachers of computer science. Girls' access to computers can be a problem. Barbieri and Light (1992) reported that boys controlled the mouse almost all the time when mixed gender pairs of students were working on a task at the computer. It may appear that girls have as much access to computers as boys do because of the availability of a large number of computers or many computer activities in a coeducational setting. But if girls are not really participating in such activities or do not use the computers as much as boys do, girls do not have full access to them. Access to computers should mean full participation by girls in computer activities, not just greater numbers of computers available in a coeducational setting, whether classroom, lab, or library.

Other studies have investigated why women leave the computing field in college. An important study by the Association for Computing Machines' (ACM's) Committee on the Status of Women found that factors which could lead to young women dropping out of computer science included (a) sociocultural attitude toward computers (as a male field), (b) lack of mentoring and role models, and (c) gender discrimination (Pearl et al., 1990). These previously cited studies shed light on the differences between men and women in their approaches to computing careers and possible causes for the small percentage of women choosing computing as a career.

After an extensive review of the literature, a void of research information was found about women who are successful in computing careers. Therefore, rather than comparing men and women using a deficit model, this study looked at women who have chosen a computing career and choose to continue in the field. The lives of women who chose the career, persist in it, and are successful in their career path contain important information that can help inform women's choices in this field. This study considered the background, education, choices, and experiences of women with at least five years of experience in computing careers to investigate factors which influenced them to choose and to continue to work in computing. This was done using a mixed-methods design. First, the researcher conducted an electronic survey at a website which asked experienced computing women questions about their backgrounds and careers. Second, follow-up telephone interviews were conducted of 44% of the 50 surveyed women for greater clarification and to gain greater insight on some of the survey issues.

Research Question and Subquestions

The research question and its parts which guided the investigation of this study are: What factors or combination of factors influence women to choose and to continue in a computing career? This investigation included the following subquestions:

1. What factors, if any, in their family backgrounds influenced computing women to choose this field?
2. What were the common childhood play and leisure preferences, if any, of women who chose computing careers?
3. What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?
4. What college experiences, if any, influenced women in computing careers to choose and to continue in the field?
5. What factors, if any, in computing women's career situations influenced them to continue in their careers?
6. Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?

Definitions

So that the scope and application of this study will be clear, certain terms need to be defined. These terms are (a) computing courses, (b) computing careers, (c) information technology, and (d) access to computers.

For this study, *computing courses* are courses which involve controlling what the computer is doing. They include but are not limited to courses in software or hardware design, computer programming, information management, database management, or systems management. They do not include courses in data entry or learning to use a particular piece of software.

For the purposes of this study, a *computing career* is one which requires at least a four-year degree with extensive work in computing courses as described above. Some of these careers require a graduate degree. Job titles for this study include but are not limited to (a) computer information scientist, (b) computer programmer, (c) computer software engineer, (d) computer hardware engineer, (e) computer systems analyst, (f) database administrator, (g) network and computer systems administrator, (h) network systems and data communications analyst, and (i) operations research analyst. Jobs which are not included are computer support specialists, computer operators, and data entry keyers because these jobs do not require the four-year degree and extensive technical knowledge of computer management and design that are required by the previously mentioned careers.

In this study, *information technology* (IT) refers to the various ways in which computers and peripheral devices are used to access, manage, use, and generate knowledge in all its forms. It can include Internet and area network sources, as well as desktop or laptop computers and their peripherals.

For this dissertation, *access to computers* means the full participation by all members of a group in using the computers available, not only the physical availability of computers at a particular facility.

Assumptions

Several assumptions underlie this study. One of the most basic is that men and women are equally capable of working and succeeding in a computing career. Another is that men and women can play an equally valuable role in the computing/information technology field. This study also assumes that it is important to have women in the computing field both for their own benefit as well as the benefit of the computing field itself (Borg, 2002; Eccles, 1987; Johnson & Miller, 2002; Lazowska, 2002).

An assumption in the methodology of the study is that women in computing careers will correctly and accurately remember and answer questions about their lives. This study also assumes that by examining the backgrounds and experiences of women in the field, information can be gained about why the women in the study have chosen the field as their career.

Significance of the Study

There is an underrepresentation of women in computing careers. It starts in the school years when girls self-select out of computer courses (Johnson & Miller, 2002; Kiesler et al., 1985). It continues during high school when young women's participation or lack of participation in high school computer courses affects their future participation in technology-related college majors and in computing careers (Balcita et al., 2002; Dryburgh, 2000).

Learning which factors or combination of factors in a woman's background or experiences influence her to choose and to continue in a computing career has implications for society. This research can inform school-related organizations about the factors which influence women to consider careers in computing/information technology. Research into these factors can help colleges, universities, and other organizations to recruit more women into the field by supplying them with research-based information on characteristics of women in the field. This research can help groups to design and implement more effective intervention programs to recruit and retain women in the field in college and at work. Companies who would like to hire and retain talented computing women will be able to use this research-based information to help them attract and retain highly qualified computing women. It is thought that having more women in higher-paying computing careers will help raise the economic well-being of women in society. Increasing the economic well-being of women will raise the financial well-being of society as a whole as women move from lower-paying to higher-paying jobs.

An increase in knowledge about the factors that influence women to choose and to continue in a computing career can also impact the lives of individual women. Using knowledge gained in this study, changes could be made to (a) educational programs, (b) computer software, (c) parenting approaches, and/or (d) company recruiting/retaining practices which could cause a young woman with talent in the field to choose computing and find a fulfilling career she might not otherwise have found. As a result of intervention programs which could be implemented using knowledge gained in this study, an adult woman with the desire to change careers may embark on a previously unknown career in computers, find greater fulfillment in her life, raise her standard of living, and ultimately attain a better life.

CHAPTER II

LITERATURE REVIEW

Introduction

There is an underrepresentation of women earning computing degrees and the situation has worsened over the last 25 years. In 1980-1981, about 33% of the bachelor's degrees in computer and information sciences were earned by women (U.S. Department of Education, 2001, 2007). This percent dropped to about 29% in 2004-2005 (U.S. Department of Education, 2001, 2007). A lack of women earning degrees in computer and information sciences is closely related to the underrepresentation of women in computing careers. In the latest government statistic, the percentage of women in most computing careers was 20% to 30% (U.S. Department of Labor, 2006). The percentage of women in the employed population is about 46% and the percentage of women in all professional occupations is around 56% (U.S. Department of Labor, 2006). This persistently small percentage of women in computing careers needs to be investigated.

Other studies have investigated factors that are lacking in women's abilities and/or backgrounds which could cause this situation. Instead, this study examined women who had chosen a career in computing/information technology and continue in the field. Investigating the characteristics which distinguish successful computing women from the majority of women who have not chosen computing provides a perspective from which to understand the underrepresented group. This increase in knowledge about women in computing can be used to make recommendations for ways to recruit and retain women in the field in order to increase the percentage of women in computing/IT.

The research question and its parts which guided the investigation of this study are: What factors or combination of factors influence women to choose and to continue in a computing career? This investigation included the following subquestions:

1. What factors, if any, in their family backgrounds influenced computing women to choose this field?
2. What were the common childhood play and leisure preferences, if any, of women who chose computing careers?
3. What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?
4. What college experiences, if any, influenced women in computing careers to choose and to continue in the field?
5. What factors, if any, in computing women's career situations influenced them to continue in their careers?
6. Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?

Since women are underrepresented in computing careers, computing would be classified as a "nontraditional" career for women. The literature review will begin with a discussion of studies which examined women's involvement in nontraditional careers.

Women in Nontraditional Careers

Several studies were conducted to investigate characteristics among women who chose a career in which male participation greatly outweighs female participation. Studies ranged from a comparison of women with master's degrees in male-dominated versus female-dominated professions, to a study of personality characteristics of women in nontraditional vocational fields, to a model postulated to explain women's achievement-related decisions.

Lemkau (1983) studied professional women who earned at least a master's degree and compared the characteristics of those who were in atypical professions (ones in which at least 75% were male) with those who were not in such professions. She reported that the women professionals in atypical professions were more likely to be firstborn and have mothers who were employed after marriage. She also found that the women in atypical careers were *not* less likely to have brothers, which contradicted her expectation. In Lemkau's study, the women both in male-dominated and female-dominated professions were highly competent and were less concerned with sex-role stereotyping. Sex-role stereotyping here refers to the attitude that certain personality or achievement-related characteristics (like assertiveness or ambition) are considered to be "male" characteristics and other characteristics (like nurturing) are considered to be "female" characteristics. Lemkau determined that the highly educated women in her study, whether in male- or female-dominated professions, tended to have a low level of stereotyping of such roles. The women in Lemkau's study who made an atypical career choice more often had a male influence in this choice, while the women who were in a female-dominated career more often had a female who influenced their career choice.

Another study scrutinized 470 women in California's vocational education programs who were training for traditional or nontraditional careers. Houser and Garvey (1985) used a questionnaire to examine the influence of the following factors on the women in the study: (a) demographic/family background, (b) social support/encouragement from others, (c) peer experience with nontraditional programs, and (d) personality and sex-role orientation. They discovered that the women in nontraditional career programs differed from those in the traditional programs in all four of the previously listed factors, especially in the increased amount of support and encouragement that the nontraditional women received from both males and females. Houser and Garvey also discovered in this study that the women in nontraditional programs had more friends enrolled in a nontraditional program than did the women in the traditional program. Women in this investigation who were enrolled in a nontraditional program differed from those who only considered but did not enroll in a nontraditional program in getting more encouragement from school personnel. The mothers of students enrolled in a nontraditional program were also employed more years than the mothers of those students who only considered but did not enroll in a nontraditional program.

Nevill and Schlecker (1988) investigated the relationship between self-efficacy and willingness to engage in a traditional or nontraditional career of 122 undergraduate women. Self-efficacy is the "belief in one's ability to execute successfully a certain course of behavior" (Busch, 1995, p. 147). In this case, strong self-efficacy means that the women believed that they would be successful at a particular career. Nevill and Schlecker's study found that strong self-efficacy correlated positively with willingness to engage in nontraditional careers. But this investigation was only based on willingness to engage in nontraditional careers, not on actual participation in a nontraditional career or on training in a nontraditional career program, like the Houser and Garvey (1985) study.

Eccles (1987) proposed a model to explain the influence of several factors on women's educational and career choices (Figure 1). In this model, Eccles sought to explain why there are persistent gender-role differences in the career paths of men and women. The model is Eccles' way of explaining how achievement decisions, which in turn affect career decisions, are made within the context of a "complex social reality" (Eccles, 1987, p. 143) in which each individual is presented with a wide variety of choices. The middle part of the model hypothesizes how it is the child's perception and interpretation of experiences and of others' beliefs that influence her goals and decisions, rather than the events themselves. Further to the left, the model accounts for how the child's perception and interpretation of experiences are affected by (a) the cultural milieu (including stereotypes involving subject matter, occupational characteristics, and gender role); (b) the child's socializer's beliefs and behaviors; (c) the child's aptitudes; and (d) the child's previous achievement-related experiences. Following the arrows from their origins to their results shows how this model credits the effect of these different childhood experiences. This model postulates that it is the child's perception and interpretation of her experiences, within the social reality, that affect her goals (center

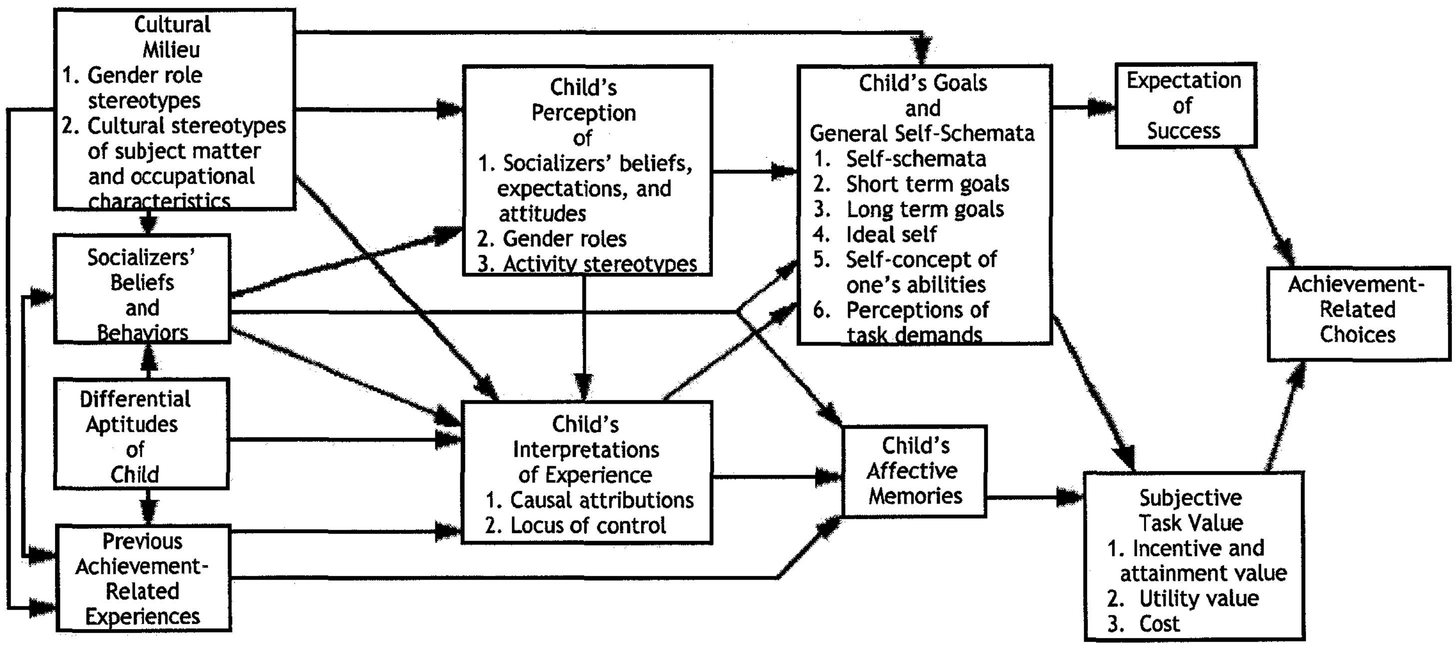

Figure 1. Model of achievement-related choices (Eccles, 1987, p. 139).

right part of model). The child's goals, self-concept, and affective memories influence her own expectation for success at a particular task as well as the value she places on the task at hand (right part of model). The child's expectation of success at the task and the value she attributes to the task then influence her achievement-related decisions.

Several key features of this model of achievement-related choices (Eccles, 1987) include an emphasis on the individual's own perceptions of her experiences and how individual choices are embedded within the larger social culture. This model also hypothesizes that people will choose tasks and careers at which they believe they will succeed and which have a high subjective value for them.

Women's choice of a computing/IT career and persistence in it may be similar to women's choice and persistence in nontraditional careers in the areas of mathematics, science, or engineering. This paper will now consider the literature about these nontraditional careers. Much of this literature focuses on comparing men and women's attitudes and choices or discusses the lack of women in the field. Seldom have research studies investigated women's career choices from the perspective of experienced women who have persisted in their careers.

Women in Mathematics, Science, or Engineering Careers

Both Gavin (1998) and Ely (1998) researched students' interest in mathematics and science among students with high mathematics ability. Ely interviewed 12 men and 30 women in college who had high scores on SAT-M and mathematics placement exams and found no gender differences in course selection, attitude towards mathematics, or career choice. Gavin perused results from the National Educational Longitudinal Study of 1988 which surveyed 24,599 students from 1,052 schools when they were in 8^{th}, 10^{th}, and 12^{th} grades. When Gavin evaluated the characteristics of males and females with high mathematics ability, no gender differences were found in performance or participation in mathematics courses. Gavin's study also reported that males rated the usefulness of mathematics higher than females did. Results of the study also showed that females with high mathematics ability who intended to pursue a quantitative field were more likely to consider mathematics as useful to their future and earned more credits in calculus than the females with high mathematics ability who did not intend to pursue a quantitative field. These results seem to indicate that having a positive attitude toward the usefulness of mathematics is an important factor in women's choice to pursue a mathematics-related career.

Similar studies were conducted involving science ability and interest. Some girls who are high-achievers in science do not continue in science because they do not perceive science as directly applicable to their everyday life (Kelly, 1987b). Catsambis (1995) scrutinized eighth-grade students' science achievement and discovered that even though girls achieve at the same or on a higher level than boys do, girls had a less positive attitude toward science and aspired to science careers less often than boys did. In a meta-analysis of the science literature from 1970 to 1991, Weinburgh (1995) reported gender differences in attitude toward science, with boys having a more positive attitude than girls had. When Weinburgh then correlated attitude with achievement, she found a strong correlation between attitude and achievement for both sexes in biology and physics, but the correlation was stronger for girls than for boys. This may indicate that attitude toward science was more important for high achievement of females than of males.

Other studies have postulated that smaller numbers of women in science or mathematics careers could be attributed to the lack of informal (outside of school) and formal (in-school) experiences in those areas for women. Toh (1993) reported that in Singapore eighth-grade girls were just as successful as eighth-grade boys in solving problems by doing practical, hands-on tasks in science. But the girls preferred tasks with content familiarity. Both Moody and Gifford (1990) and Kelly (1987a) discovered that in mixed-gender laboratory groups in science laboratory situations, boys tended to do the hands-on experiments while the girls watched. Jones and Wheatley (1988) suggested that differences in science achievement may be due to the greater opportunities that males have to experience science outside the classroom.

Similar results occurred in some mathematics studies. Linn and Hyde (1989) conducted a meta-analysis and process analysis to analyze gender differences in standardized tests like the SAT, DAT, and NAEP tests from 1973 to 1986. They detected a declining difference in quantitative ability between males and females, with the differences declining essentially to zero. These analyses disclosed differences between males and females in spatial skills, but these differences only occurred within a few types of spatial tasks in which males outperformed females. Linn and Hyde's study found that these spatial-task differences respond to training and may be associated with differential experiences of boys and girls inside and outside of school. Simonis (1982) emphasized the importance of participation in hands-on activities to enhance creativity, spatial abilities, and engineering skills. Such activities may be even more important for girls to experience in school as compensation for the lack of informal (outside of school) experiences for girls.

Another reason for fewer women than men in mathematics, science, and engineering careers could be charged to the popular cultural image of people who are scientists, engineers, or in mathematics careers. Kelly (1987b) postulates that the seemingly "masculine" image of science may be part of the reason that fewer women than men pursue careers in the field. Walkerdine (1987) argues that science fields may contain fewer women because historically the nature of science is bound up in a masculine view of the world and the exclusion of females from participation in such “masculine” endeavors.

The previously cited research studies have concentrated on a lack of women in science and mathematics or compared males’ and females’ achievement or participation in mathematics and science. Next, this paper will consider the characteristics and responses of females and/or males who *have* chosen to study mathematics or science or who *have* chosen a related career.

Baker and Leary (1995) interviewed girls in grades 2, 5, 8, and 11 to determine what factors influenced them to choose to study science. Their research detected that two influential factors were positive attitude about science and high self-confidence in the ability of women to do science. Additionally, girls offered different reasons than boys did for choosing a science career. Girls in the study mentioned being influenced by someone close to them and/or a desire to help people as reasons to choose a science career.

Two studies exhibited a connection between parental education and their children's education. Jagacinski (1987) conducted a survey comparing male and female engineers in 1981. She reported that the parents of female engineers were more highly educated and held more professional positions than did the parents of male engineers. Her survey also indicated that the male engineers made their decision to become an engineer earlier in their education than the female engineers did. Gavin (1998) also discovered a correlation between parental levels of education and expectations for their children, with the more educated parents projecting higher goals for their child's education. In Gavin's study, high SAT verbal scores and teacher emphasis on further study in mathematics were significant predictors for males to continue to study mathematics, while credits in calculus and high SAT math scores were significant predictors for females.

Two other studies discovered factors contributing to the choice of a mathematics-related or science-related college major or career. Dick and Rallis (1991) found that parents and teachers had more influence on the career choices of high school seniors who chose careers in engineering and science compared to those students not choosing careers in those areas. In Dick and Rallis' study, teachers often played an especially important role in influencing the women who chose careers in engineering or science. Maple and Stage (1991) reported that the amount of mathematics and science courses completed by the end of high school was a strong predictor of both males' and females' choice of a mathematics or science major in college.

Farmer, Wardrop, Anderson, and Risinger (1995) and Farmer, Wardrop, and Rotella (1999) investigated aspects of a longitudinal study to identify factors related to women's persistence or non-persistence in science, mathematics, or technology careers. Farmer et al. (1999) reported that women in science compared to other careers were more likely to value mathematics and science for future career goals. Farmer et al. (1999) also discovered that both men and women in science careers completed more elective high school science courses by personal choice, aspired to higher prestige careers, and more often attributed mathematical success to ability than those in non-science careers.

Farmer et al. (1995) proposed a conceptual model for the contribution of factors leading to persistence or lack of persistence in a mathematics, science, or technology career. They proposed this model as a result of a longitudinal study surveying high school students in 1980 who were intending a science, mathematics, or technology career, then surveying the same people again in 1990. The model is shown as Figure 2. On the left side of the model (marked 1980) are factors that influence a high school student's career aspirations. Farmer et al. (1995) postulate that the student's choice to take elective mathematics and science courses is influenced by the student's demographics and cognitive and environmental characteristics. In turn, the four areas from high school: (a) choice of mathematics/science courses, (b) demographics, (c) cognitive characteristics, and (d) environment together affect the person's later cognitive and environmental

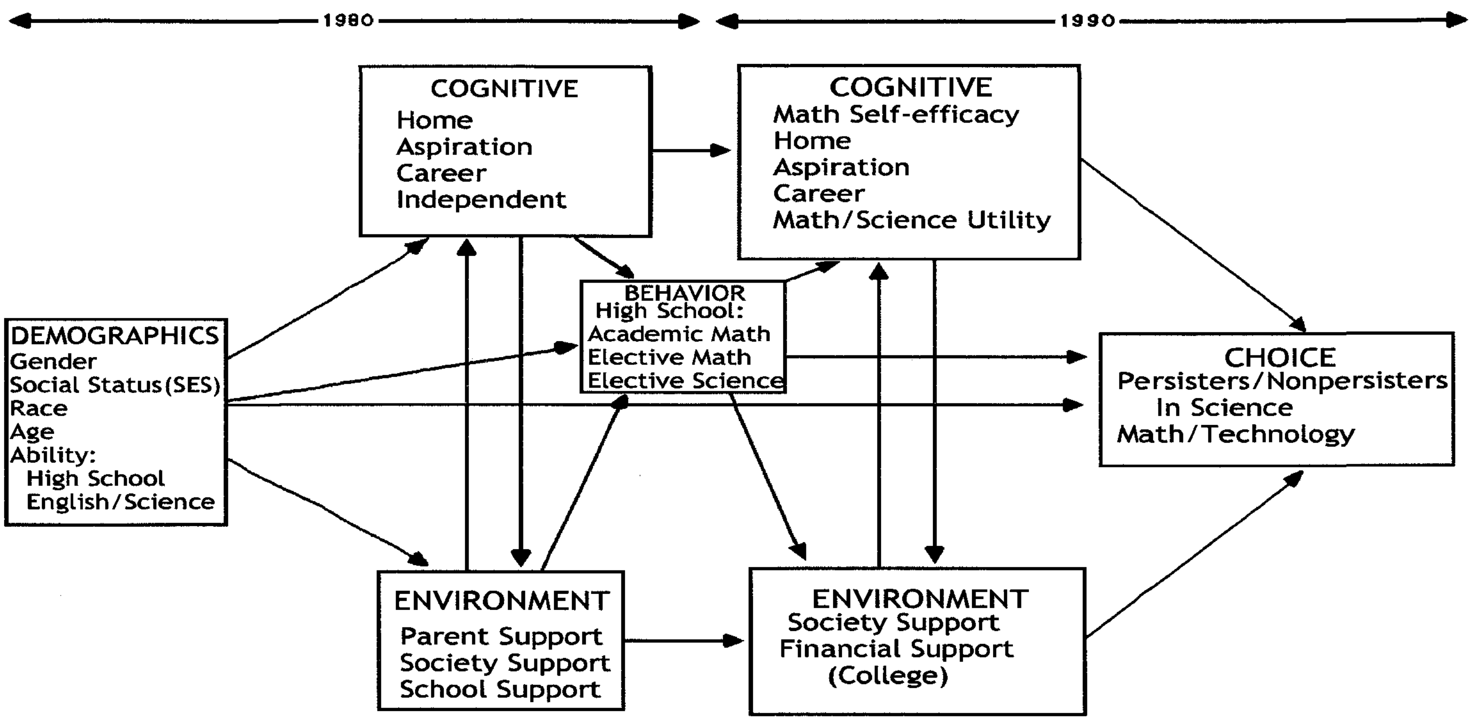

Figure 2. Model for factors contributing to persistence or non-persistence in a science, mathematics, or technology career (Farmer et al., 1995, p. 156).

situations (shown on the right side, under 1990). The cognitive and environmental characteristics (on the right side of the chart), as well as high school courses and the person's demographics, ultimately affect the person's choice to persist or not to persist in a mathematics, science, or technology career. Farmer et al.(1995) had proposed this model to show the complicated combination of factors which influence a person's persistence or lack of persistence in a science, mathematics, or technology career.

Frazier-Kouassi et al. (1992) examined what attracted or inhibited women from choosing advanced studies in mathematics or physics. Part of this investigation included focus group interviews with 23 women who were mathematics or physics graduate students at the University of Michigan. In those interviews, the women discussed their experiences in undergraduate and graduate courses and their attributions for their current success. The interviewed women considered encouragement essential to their success; the encouragement could come from parents, another family member, a faculty member, a mentor, or a friend. Frazier-Kouassi et al. also discovered that more of the women who were enrolled in graduate science programs had earned undergraduate degrees from women's colleges, small departments, or colleges with a high percentage of women faculty members than from public coeducational institutions. The graduate women who were interviewed also disliked competition in classes and considered low-quality teaching a stumbling block to their success.

From a discussion of the factors influencing women to choose careers in mathematics, science, and engineering, this paper will next consider studies involving the experiences of girls and women while using computers.

Women and Computer Use

Many studies have investigated reasons why there are so few women in computing careers. One common reason cited is that girls and women in their formative years do not use computers as often as boys and men do. Some have postulated that the availability of computers for girls and women is less than that for boys and men. Janssen Reinen and Plomp (1997) used the Computers in Education project to investigate gender equality in computer access and use. They detected a large discrepancy between genders in computer access in all countries studied, with slightly more equitable access between genders in the United States than in most other countries in the study.

Other research reported it was not that computers were less available to females, but it was the way students were grouped in classes using computers that affected females' practical computer experience. Corston and Colman (1996) probed whether the gender composition and presence of an audience affected the achievement of a computing task for males and females. In Corston and Colman's study, females were more successful at a computer task when there was a female audience or no audience than when there was a male or mixed male-female audience. Lee (1993), after observing fifth- and sixth-grade Korean students assigned to four-student gender groupings for a cooperative learning computer task, determined that the gender composition of the group had an effect on interaction patterns. In Lee's study, females were more willing than males to interact in all but the majority-male groups. Lee also detected that the adequacy of help students gave to other group members depended on the group's gender composition. In this case, males more often gave inadequate help in all groupings except the majority-male groups, where females more often gave inadequate help. Barbieri and Light (1992) scrutinized 11- and 12-year-olds in England who were assigned to various gender pairings to complete a computer problem solving task. They discovered a marked difference in interaction patterns in the different gender pairings, with boys' dominance in the boy-girl pairs including an almost exclusive control of the mouse.

Other research has investigated the effects of all-female groupings on computer study. Crombie, Abarbanel, and Trinneer (2002) compared high school students in all-female and mixed-gender high school computer courses. They discovered that females in all-female classes reported more teacher support, higher confidence, and more positive future academic and occupational intentions than females in the mixed-gender classes. Jones and Clarke (1995) compared the attitude of girls towards computers in all-female and coeducational settings in Australia. Their investigation concluded that girls from single-sex high school settings have more experience with computers and more positive attitudes toward computers than girls from coeducational high schools. But once Jones and Clarke factored out the effect of greater experience, it was the diversity of computer experience (experience with many kinds of software), not the educational setting, that was the strongest predictor of positive attitude toward computers in high school girls.

From considering girls' and women's use of computers, this paper will now examine the cultural environment surrounding computer use. Several studies have been conducted to investigate the computing environment, including childhood experiences with computers. It is thought that the computing environment affects a person's attitude toward computers, which in turn affects a person's decision whether or not to choose a computing career. Investigations of these topics will be discussed next.

Women and the Computing Environment

It is important to consider computer games and software because it is thought that many computing professionals' interest in computers began with childhood computer games or experience with elementary school computer software. Studies involving computers and children, especially software use, will be described next.

Chappell (1996) investigated characteristics of 17 top-selling educational mathematics software programs aimed at preschool through high school students. She concluded that the percentage of both violence and competition increases as the grade level increases, and the percentage of female characters and voices decreases as grade level increases. Huff (1996) investigated the relationship between the design of computer software and the gender of the intended audience by conducting a study in which teachers were told to design different pieces of educational software for boys, girls, or children (of unspecified gender). Even though the teachers in the study were mostly female and were aware of possible male bias in software, the software they designed for boys was game-like, the software designed for girls looked like tools for learning, and the software designed for children in general was very similar to the software for boys. Analyzing the data, Huff concluded that the "design of the software itself was affected by the social expectations of the designers" (Huff, 1996, p. 7).

Some journal articles were written about the consequences of the present computing climate for children. Wu, Cohoon, and Neesen (2006) remark that educational software design and the way teachers use educational software can cause technology use to appeal more to boys than to girls. They then suggest that this gender imbalance in students' technological educational experience could ultimately reinforce the gender imbalance in science and technology careers. Kiesler et al. (1985) attribute the lack of women in computing to the male culture of computing which starts in children's elementary years with male dominance of computer use as well as computer games being more appealing to males. Klawe (2002) found that boys, girls, teachers, and parents all continue to view computers as a "boy-thing," even into the 1990s when computers became prevalent in classrooms and homes. The effect of this attitude is to make computer careers much less appealing to girls.

Several researchers have investigated people's attitudes toward computers and reported mixed results. Several studies conducted in elementary and secondary schools reported that males had a more positive attitude towards computers than did females (Durndell et al., 1995; Kadijevich, 2000; Shashaani, 1993). Mitra, LaFrance, and McCullough (2001) determined that males had a more positive attitude toward university-wide computerization at a liberal arts university than did the females in the study. On the other hand, other research (Tsai, 2002) detected no difference in attitude toward computers between the genders. But the complexity of the situation is shown by the conflicting results from the research. Some studies determined that even when experience is controlled, males still exhibit a more positive attitude toward computers than females do (Kadijevich, 2000). Other research concluded that prior exposure, especially having a computer at home, had a stronger positive effect on attitude than gender (Levin & Gordon, 1989), or that age and computer experience, not gender, influenced computer attitude (Pope-Davis & Twing, 1991). In another case, diversity of computer experience (knowledge of a wide range of software types) was important in creating a positive attitude toward computers in high school girls (Jones & Clarke, 1995).

Some researchers examined whether the type of delivery or the environment affected females' attitudes toward computers. Pope-Davis and Vispoel (1993) reported that additional computer training on the college level resulted in women students becoming more confident in their computer ability, with no significant gender difference in attitude toward computers among the students in the study. Cooper and Stone (1996) discovered that when the method of presentation on the computer is changed to make it more compatible with females' learning style, the female students became less anxious during computer-assisted instruction. Ames (2003) observed that certain learning styles were associated with a positive attitude toward computers, while other learning styles were tied to computer anxiety, and that most women in the study had the type of learning style associated with computer anxiety. Huff (2002) reported that when children tried software designed for the opposite gender, they reported more situational stress than when using software designed for their own gender. However, this only occurred in a public setting, not when trying it privately. This led Huff to emphasize that the social context of computer software use should be considered.

The complexity of the relationship between gender and attitude toward computers is not solely a North American phenomenon; it cuts across international lines. Kadijevich's study (2000) occurred in Yugoslavia; Levin and Gordon's came from Israel (1989); Tsai's study (2002) was conducted in Taiwan; Durndell et al. (1995) completed their research in Scotland; Jones and Clarke (1995) conducted theirs in Australia; and the others (Ames, 2003; Cooper & Stone, 1996; Huff, 2002; Mitra et al., 2001; Pope-Davis & Twing, 1991; Pope-Davis & Vispoel, 1993; Shashaani, 1993) were completed in the United States. What is not addressed in these studies is what part the interaction of culture and gender may play in peoples' attitudes toward computers. However, the consistency of the problem across cultural lines points toward gender, not culture, as a major explanation for the differences in peoples' attitudes toward computers.

Dryburgh (2000) reviewed the1990s research involving girls and women in computer science from United States, Australian, and Canadian sources. She organized the research by the educational level at which the study was conducted (elementary, secondary, and post-secondary) and what aspect of computing was researched (attitude, experience, grouping, etc.). In the studies she reviewed involving computer attitude, Dryburgh concluded that the research does not point clearly in one direction as to what causes a positive attitude toward computing.

From considering the cultural environment surrounding computing and peoples' attitudes toward computers, this paper will next discuss post-secondary computing courses. Women's experiences in such courses can greatly affect whether they choose and persist in a computing career. Several studies have investigated computing experiences of women in college courses and college experiences of women who are computer science majors. This research will be discussed next.

Women and the Post-Secondary School Computing Experience

Clarke and Chambers (1989) studied factors influencing gender differences in computer use in college students by surveying 222 students enrolled in a compulsory first-level course in statistics and computing concepts at an Australian university. Their study discovered initial gender differences in computer experiences and attitudes, and that the women were less likely than the men to pursue further computing studies, even when their achievement was comparable to the men's achievement. For both men and women, they reported that prior computing experience was related to high achievement in the computing course, and intention to pursue further computing studies was related to computing attitude. For men, mathematics experience was related to high computing achievement. For women, both mathematics experience and attitude toward statistics was related to intention to pursue further computing studies.

Busch (1996) studied gender and computer group interaction among 150 college students in business administration at a Norway college. He investigated the effect of group composition, self-efficacy, and gender on cooperation, giving and getting help, and level of activity for a group computer-related task. Busch discovered that students in majority-female or majority-male groups interacted the most, and that students in majority-female groups cooperated the most of any group type. His research also reported that females received more task-related help and gave less task-related help than the males in the study. Busch postulated that this could be due to females' lower self-efficacy. (In this case, self-efficacy refers to a person's belief in being able to successfully execute a computing task.) In this study the female students had less previous computer experience than the males, less self-efficacy, and had received less previous encouragement to work with computers than the males in the group.

Shashaani (1997) investigated gender differences in computer attitude and use among 202 college students. She found that females were less interested in computers and exhibited less confidence in using them than males did and that males were more experienced in using computers. In this study Shashaani also reported that neither female nor male students held gender-stereotypical views about computer users. Seventy percent of the students in Shashaani's study reported that a male was the main computer user at home; the study also found that more computers were located in male students' homes. Shashaani also discovered a link between parents with a gender-biased attitude toward computer use and their daughters' exhibiting less interest in computers and less confidence using computers. This gender-biased parental attitude purports that the study of computers is more appropriate for males and that men have more ability in computing than females do.

The next two studies were conducted in introductory computing courses. Taylor and Mounfield (1994) surveyed 656 students who were non-computer science majors (mostly business majors) in an introductory college computer programming course. They reported that females were as successful in the course as males were and that prior computer experience had a more beneficial effect on success for females than for males. Pope-Davis and Twing (1991) surveyed 207 students in an introductory college computer skills course. They discovered that computer experience was not significantly related to a more positive computer attitude; there were no significant gender differences in computer anxiety, confidence, liking, or usefulness of computers among the students surveyed.

Lips and Temple (1990) surveyed 305 undergraduate students in introductory psychology and sociology courses (general courses taken by many 1st-year and 2nd-year students); their goal was the testing of a model used to predict a student's intent to major in computer science. Lips and Temple's model worked for the group as a whole but did not fit when applied separately to the men as a group nor to the women as a group. In this study, attitude toward mathematics played a stronger role in men's intent to major in computer science than in women's. Previous experience in computer science played a positive, stronger role in women's than in men's plans in this study. One caution for this particular study was that the researchers only investigated intent to major in computer science and did not conduct a follow-up survey to ascertain whether or not the students actually majored in computer science.

Jagacinski, LeBold, and Salvendy (1988) studied over 3000 undergraduate students majoring in computer science, computer technology, electrical/computer engineering, and industrial engineering. They investigated which high school achievement characteristics contributed to the students' persistence in the previously listed majors. Jagacinski et al. found similar persistence rates for men and women in all majors studied except for computer science, in which fewer women than men persisted. Unlike the other majors it considered, this study found few significant differences between the women who persisted in computer science and the women who did not persist in the field, upon considering the achievement characteristics in its survey. Because the women in this study with high grade point averages in high school often did not persist in computer science in college, Jagacinski et al. proposed that another factor for persistence could be a student's expectation of her own level of success in beginning computing classes. The study's findings also led Jagacinski et al. to suggest that peer and/or faculty support may be another factor influencing women's persistence in computing.

Fisher et al. (1997) interviewed 20 women and 29 men who were undergraduates in computer science at Carnegie Mellon University, as well as nine students who were not majoring in computer science at the same university. They investigated influences on choosing and not choosing computer science as a major. Fisher et al. reported that both the men and the women who were majoring in computer science in this study were first introduced to an interest in computers by a parent. The men differed from the women, however, in their type of interest in computers; the men in the study spoke of an early attachment to computers (before 10 years old) and a fascination with how the machine works, as well as a strong desire to spend a lot of time exploring it. On the other hand, the women did not speak of an early fascination with the computer but instead referred to using computers as a tool to help investigations in other fields like education, medicine, communication, art, or music. When asked for their reason for majoring in computer science, the men in the study often spoke of their intrinsic interest in computers. American women in the study mentioned an intrinsic interest in computers, but also mentioned positive classroom experiences and the sense of promise of the computing field. Women in the study who came from other countries more often cited pragmatic factors like greater employability, not interest, as their reason for choosing computer science. This study also cited a large gap between men and women in precollege computer experience. In spite of this lack of extensive prior experience, the women still earned good grades and exhibited an understanding of computing concepts in their computing classes. Fisher et al. also remarked that once the women computer science students achieved success and junior or senior status, they showed increased confidence, even though they had begun college less confident in their computing ability than their male classmates.

Howell (1996) investigated the experiences of three male and two female 1st-year computer science majors during their first two college terms and also analyzed the experiences of two computer science instructors. The study relied on interviews, classroom observations, e-mail journals and casual conversation. Howell concluded that many students knew little about careers in computer science. Female students in the study wanted a career to involve work they enjoyed. The students in this inquiry valued support and struggled with lack of support when advised; they experienced inadequate study skills, especially regarding mathematical proof and computer programming. Howell also reported the presence of subtle gender discrimination, although no one mentioned it overtly.

Rasmussen and Hapnes (1991) examined the computer science environment at a university in Norway by interviewing computer science students and faculty. (They did not include the actual number of students and faculty interviewed in their article.) The faculty members spoke most highly of a group of male students who earned good grades and spent a lot of extra time at the computers, but expressed frustration with the female students who also earned good grades but seemed less motivated to study computing because of their lack of "total absorption and daring" (Rasmussen & Hapne, 1991, p. 1115). The women students felt marginalized by the dominance of certain male students who spent hours at the school computers and also much of their free time working with computers. These women also expressed an interest in computers but rejected the fascination with machines that was prevalent among many of the male students. The women students cited attraction to the subject of computer science and its use as their reason for choosing computer science. They viewed computers as a tool and chose areas of study where they could apply computing to solving practical problems.

The computing professionals' organization, the Association for Computing Machines (ACM), published a report from its Committee on the Status of Women (Pearl et al., 1990) in which they studied the college environment for women in computer science. The commission reported that factors which could become obstacles for women who were pursuing a computer science degree included societal attitude toward computers as a male field, lack of mentoring, lack of role models, and gender discrimination. In the same publication, Frenkel (1990) reported on the recommendations made for encouragement of women in computer science at the National Educational Computing Conference in 1989. These recommendations clustered around the three areas of exposure, attraction, and retention of females in the field. With respect to exposure, the group believed that while all of K-12 computing education needed some improvement, the most critical area was the attraction of more middle school girls to computing. In the area of retention of women in computer science in college, the group discussed (a) decreasing the time-consuming nature of computer programming classes, (b) changing the way that beginning computer science courses are taught, (c) increasing computer access by putting computers in dormitory rooms, (d) pairing computer departments with high schools and graduate students with undergraduates, (e) inviting graduates as guest speakers to talk to undergraduates in computing departments, and (f) providing better financial aid. With respect to attracting more women to computing, the group recommended better parental education that girls can be good at computers too, as well as aligning software to girls' interests. The workshop also discussed the cumulative effect of women's disadvantages in computing and how important it is to improve women's representation in the computing field both for the overall good of women as well as for the overall good of the computing field.

Camp (1997) investigated the number of women in computer science and how women's share of bachelor's degrees in computer science are *decreasing* at the same time as women's share of bachelor's degrees in science and engineering are *increasing*. She conducted a comprehensive study of institutions with a graduate program in computer science and their awarding of bachelor's degrees in computer science during the school years of 1991-1992 and 1992-1993. Camp discovered that if the computer science department was located in the college of engineering, there were significantly less women graduating with bachelor's degrees, proportionally, than if the department was located in the college of arts and sciences.

The post-secondary computing environment is one of the factors which affects a woman's choice of a computing career. A woman's career choice can also be affected by her perceptions of different careers. Some researchers have examined whether students understand what a computing professional actually does. Some have also investigated whether the image of a computing professional encourages or discourages a women considering a computing career. Research on the image of the computing professional will be described next.

The Image of the Computing Professional

The stereotypical image of the computing professional is that of an isolated male who sits at the computer all day, interacting mostly with the computer but not often with people. A few studies have been conducted to investigate how prevalent this image is among students and if the stereotype has a basis in fact. These studies will be examined next.

Durndell and Thomson (1997) conducted a longitudinal study of 16- to 18-year-olds at 3-year intervals from 1986 to 1995. They discovered that the antisocial image of the computing professional was the main reason students gave for *not* choosing to study computing. This occurred in spite of the increase in student knowledge of information technology concepts on the part of both sexes over the years of the study, and with computer use being essentially equal between the two genders. Schott and Selwyn (2000) examined the social competency and gender of frequent and infrequent computer using students in grade 12 in England. They reported that frequent computer users were just as likely to be female as male and that frequent computer users were no less sociable or popular than the infrequent users. However, the negative stereotype attached to frequent computer users persisted most often among students with low frequency of computer use (Schott & Selwyn). Both the male and female computer science students interviewed at Carnegie Mellon University by Fisher et al. (1997) remarked that they did *not* fit the antisocial negative stereotype of a computer user. The students made the point that they had varied interests, not just computing.

Clarke and Teague (1996) investigated the image of the computing professional held by university students, high school students, and women who are computing professionals by interviewing people from each of the three groups. They concluded that the high school and college students in the study perceived the job of a computer scientist in a very different way from the way the computing professionals talk about their jobs. The women computing professionals described their work as challenging, not boring, and as giving them the opportunity to work with and to help people. This contrasts with the prevailing attitude expressed by the high school girls that computing work is boring and not challenging, with most of the workday spent at the computer. The results of this Clarke and Teague study are echoed in the comments of the women computing professionals who wrote about their backgrounds and careers and gave examples of related mathematical problems in the Mathematical Association of America publication *She Does Math!* (Parker, 1995). These computing women described their computing jobs as challenging and mentioned a high level of job satisfaction (Parker).

Colley, Hill, Hill, and Jones (1995) studied the degree to which computer activities were gender-stereotyped by 150 male and female undergraduate students. The students were presented with male and female figures, with each figure experienced in one of three categories: (a) word processing, (b) computer programming, or (c) playing games. The students then assigned attributes to each of these figures. Colley et al. reported no gender stereotyping, no significant differences in the way the male and female computer-using figures were perceived, and similar findings among all three types of computer uses.

The studies mentioned so far in this literature review have compared men and women in the computing field or considered aspects of the computing field that tended to influence women *not* to choose computing careers. Only a few studies have been conducted to investigate the characteristics of women who choose to spend time on computing activities or who have chosen computing careers. Research with this aim will be discussed next.

Women Who Choose Computing Activities

Robbins (2001) studied the online activities of girls aged 12 to 14 who were major users of computer technology. To provide an environment for them to develop competence and confidence in technology use, Robbins found that it was important for the girls to have support from parents, peers, and others.

Clarke and Teague (1996) interviewed 19 women with jobs in computer science or who used computers extensively in their jobs. These computing women described their jobs as challenging and liked being able to help people in their jobs. Clarke and Teague discovered that very few of these computing women chose computing by majoring in computer science in undergraduate college. Instead, most moved into it as a second career or from some related field because they had the necessary background in computer courses and/or took more advanced courses in the field. The interviewed women also mentioned the importance of continuing studies to keep current and/or to acquire new skills in the computing field.

Lips and Temple (1990) surveyed 305 undergraduate students. Their study concluded that women who choose to study and possibly major in computer science have an interest in computers, are comfortable and confident in using computers, and report positive experiences in using computers. These computing women also were capable enough in mathematics to handle the mathematics required for their major, although they often did not revel in their mathematics ability.

Henwood (1996) interviewed four female software engineers in southeastern England and reported that the women chose a computing career in spite of any male disapproval and the predominantly male climate in computing. The interviewed women noted a sense of pride in their work. They also mentioned putting up with some teasing and having to prove themselves at their jobs. The interviewed women in Henwood's study also cited some difficulty in their social lives because of their profession.

Fisher et al. (1997) interviewed 20 computer science women at Carnegie Mellon University and concluded that some of these women found gender a non-issue in their field and felt experienced at handling a male environment. A few women in the study felt disrespected by their male peers because of their gender and had concerns about the male environment. However, only one female student in the study mentioned faculty members who were not supportive.

Teague (2002) conducted e-mail interviews with 15 female computing professionals, most of whom worked in the United States. She asked them about their reasons for choosing a computing career and what they liked and disliked about working in the computing field. Some of the computing women chose their career while still in high school, some chose it in college, and others made the choice after working at another career. The interviewed women's reasons for choosing computing clustered in two areas: (a) events and influences which caused them to consider a computing career, and (b) characteristics of the career or of themselves. The interviewed women mentioned a high level of satisfaction with their careers, and their stated likes included (a) problem solving,

(b) the challenge and variety, (c) the money, (d) opportunities for travel, (e) the flexible hours and working environment, (f) interaction with other people at their jobs, and (g) the respect earned for a job well-done. Overall, the interviewed women expressed more likes than dislikes with their careers. But their dislikes included (a) programming, (b) being in a minority, (c) employers having differential pay rates for men and women, and (d) enduring the competitiveness of some male colleagues in the industry. A minority of the women interviewed for this study mentioned each of these dislikes. The older women in the study tended to mention more things they disliked about the people they worked with than the younger women in the study did.

Studies about women who choose computing highlight the challenges to women in the computing field. Programs have been implemented to motivate girls and women to choose courses and careers in fields of study where they are underrepresented. Some of these programs will be discussed next.

Recruitment of Women into Mathematics and Science Careers

Special programs to increase the participation of women in fields where they are underrepresented are sometimes called recruitment or intervention programs. They may be of short duration, like a workshop, lecture, or special day, or of longer duration, like a program continuing for a week, month, or year. Descriptions of some of these follow.

One program aimed to influence girls to choose to take more mathematics and science courses in high school. Koontz (1997) reported on a program she conducted for sixth- and seventh-grade girls twice a week for an entire school year. The girls experienced hands-on mathematics and science activities, group problem solving, role-model contacts, and encouragement. After they finished high school, the group completing these activities showed a significant positive difference in both attitude and number of high school courses taken in both mathematics and science compared to a control group. The girls' attitudes toward the subject areas of mathematics, science, and computing correlated highly with the number of courses completed in those areas.

As a result of her experiences in projects to encourage young women in science, Simonis (1982) listed several recommendations to encourage more girls in science: (a) hands-on student-oriented laboratory activities; (b) role-model programs to encourage women in science and technology to visit classrooms and act as tutors/mentors such as the Women in Science days at colleges and universities that are sponsored by the National Science Foundation and/or the Association for Women in Science; (c) an extern program which pairs a senior college woman with a woman scientist, engineer, or technician, including participation in job shadowing; (d) the adaptation of metaphors used in teaching science to interest girls, such as talking of hot-air balloons instead of projectiles; (e) encouragement of young women by teachers, counselors, and parents to perceive science as helping humanity.

From a description of efforts to interest girls in mathematics and science, this paper will next discuss some programs aimed at recruiting women into engineering programs and careers. Because of the similarities in the lack of women in engineering careers to the lack of women in computing careers, the recruitment programs in engineering can shed light on those for women in computing.

Zastavker, Ong, and Page (2006) discussed the results of a pilot program that uses project-based learning as its main teaching practice in a small, gender-balanced engineering school. The program's results demonstrated that both men and women benefit and show heightened interest in engineering as a result of many of the project's components, including small-group work, hands-on activities, and "real-world" applications.

The next two articles approach recruitment of women into engineering careers from a different perspective than most other recruitment efforts. Schafer (2006) described an attempt at the University of Woolongong in Australia to change the prevailing culture of engineering by incorporating a "diversity lecture" in a 4th-year engineering course. This lecture included an assigned reading, a reflective assignment, a 2-hour lecture, a 2-hour tutorial, and an assignment with bonus credit. Speakers included local engineers as well as university speakers who talked about the benefits of women in engineering and discussed topics involving women in the engineering workplace. Tietjen (2004) proposes a theory that the real problem in the recruitment of more female engineers is the public image of engineering and the lack of understanding by the public of the major contribution of engineers into people's everyday lives. To improve this image she recommends a greater emphasis on programs and outreaches of organizations like The National Society of Professional Engineers. Tietjen also encourages individual engineers to participate in programs like The Girls Scouts of America's pro-science and technology campaign for girls and special programs like the Women in Science and Engineering programs at colleges and universities. Tietjen also advises individual engineers to address school students on engineering topics; as an example she mentioned her friend who runs a water treatment equipment company and speaks to students about the satisfaction of her work as well as how engineering makes a difference in peoples' lives.

Previously cited efforts to recruit women into mathematics, science, and engineering fields can provide information and background for recruitment efforts in the computing field. A description of some programs to recruit girls and women into computing and information technology courses and careers will be described next.

Recruitment of Women into Computing and Technology Careers

Recruitment, intervention, and retention efforts with the aim of encouraging girls' and women's greater participation in computing and technology have been implemented. These efforts tend to be one of the following: (a) special programs for middle school/high school girls, (b) recruitment and/or retention efforts in colleges and universities, (c) changes inside college and university classrooms, or (d) special programs sponsored by outside groups.

Several programs have been created to encourage an interest in technology among girls (and sometimes also boys) in middle school and/or high school. Doerschuk, Liu, and Mann (2007) described a daylong summer camp for middle school girls in 2006. Included were hands-on activities in (a) robotics programming, (b) computer hardware, and (c) webpage development. Doerschuk et al. reported that the participating girls enjoyed the technology camp and showed a significant increase in their computing knowledge and confidence in their ability to accomplish tasks using technology. Cannon, Panciera, and Papanikolopoulos (2007) discussed a 2-week summer robotics camp for underrepresented populations (including girls) in Minnesota. At the end of the camp, Cannon et al. stated that students showed an increased interest in technology and an increased desire to pursue a career using computers or robots, although these results were not statistically significant. Jepson and Peri (2002) reported on The Backyard Project, which sponsored computer camps on college campuses for high school girls from 1998 to 2001. This project eventually became an eight-city, weeklong program in which high school girls learned technology fundamentals and met professional computing women. Countryman, Feldman, Kekelis, and Spertus (2002) discussed Techbridge, a 3-year program in California which provided technology resources and experiences for middle and high school girls. The girls in the program learned about hardware and worked with programming software. Techbridge was sponsored by the National Science Foundation. Huggard and McGoldrick (2006) described an outreach program aimed at Grade 10 students (both boys and girls) and sponsored by the computer science department at Trinity College in Dublin, Ireland. The program was a 3-day event where students (a) participated in hands-on activities in technologies and computer science, (b) experienced technical and critical analysis skills as they worked on team projects like creating a Lego robot, and (c) interacted with computer professionals who work for high-profile technology companies.

From a discussion of efforts to interest middle and/or high school students in technology, this paper will next discuss college programs. Recruitment of women into college computing programs and efforts to increase women's retention in computing programs have been instituted at many colleges and universities worldwide. Descriptions of such programs follow.

Roberts, Kassianidou, and Irani (2002) described strategies implemented over a 10-year period at Stanford University in California with the goal of increasing the number of women in the university's undergraduate computing programs. These strategies have included: (a) a redesign of the introductory computing sequence of courses to improve access to a wider audience, (b) a program to involve undergraduates in faculty research, (c) attention to role models on all levels from undergraduates to faculty members, and (d) special programs to help undergraduates over the "problem spots" which often lead to students dropping out of the program. An example of one of these "special programs" is a monthlong summer program which includes hands-on experiences in engineering and computer science and is offered the summer before the students' first year in college. This recruitment program at Stanford increased women's enrollment in the introductory computer science course from less than 10% in 1992 to about 20% in 2001 (Roberts et al.).

Fisher and Margolis (2002) discussed the programs instituted at Carnegie Mellon University to recruit and retain women in computing science. These programs include: (a) curricular changes, including research shared with computer science faculty about how a broader view of computer science could help recruit and retain women students; (b) interdisciplinary courses which bring students of diverse backgrounds together to work on multifaceted problems and other courses which stress the social-service dimension of computing; (c) changes in entry into the computer science program, including a special entry program to allow students with less prior computing experience to "catch up" and smoothly integrate into the curriculum; and (d) the creation of an Advisory Council which gives the department regular feedback and is composed of representative women from all levels in the computer science department. As a result of these programs, Carnegie Mellon University increased women's percentage of entrants into the undergraduate program in computer science from 7% in the fall of 1995 to 42% in 2000 (Fisher & Margolis).

Clayton and Lynch (2002) depicted activities aimed at recruiting and retaining more women in the computing programs at Central Queensland University in Australia. During the years from 1991 to 2001, both recruitment and retention strategies were implemented to improve women's participation in information technology courses at the university. These strategies included encouraging women to develop the prerequisite skills for the computing courses as well as efforts to help women in computing programs obtain necessary skills for employment in the field. During the program's tenure, there was an increase in domestic women's participation in the Bachelor of Information Technology program from 13% in 1992 to 24% in 2001 (Clayton & Lynch). Unfortunately the program was disbanded after 10 years as a result of lack of funds.

Randall, Price, and Reichgelt (2003) studied the enrollment of women in computer science, information technology, and information systems within the University System of Georgia. They found a greater female enrollment in information technology and information systems than in computer science. Since information technology and information systems emphasize the use of applications, Randall et al. postulate that women may be successfully recruited into the computing field by placing a greater emphasis on applications of technology. Employers who want to hire more women in computing, Randall et al. also suggest, should not only consider computer science majors, but also people with degrees in information technology and information systems.

Sometimes a recruitment program is aimed, not at freshmen or sophomores at the college/university, but at people later in their lives. Some computing women have chosen their computing careers after starting in another field (Clarke & Teague, 1996;Teague, 2002). Erikson (1982) wrote of different life stages including (a) "Adolescence," when peer groups have a significant influence; (b) "Young Adulthood," when decisions are made based on patterns of cooperation and competition; and (c) "Adulthood," when "Care" is a motivating factor. Sheehy (1976) also wrote that adult life has stages and that decisions made in a person's twenties set one on a "life pattern" such as "caregiver," "paranurturer," or "transient," with men's and women's life patterns being different from each other. With this in mind, it is understandable that women often make the choice for a computing career at a different time in their lives than men do. (For example, in Erikson's "Adolescence" stage, peer groups have a great influence, and this peer-group influence could work in a different way for females than for males.) Two recruitment efforts which have helped women become qualified in the computing field at a later time in their lives will be discussed next.

Humphreys and Spertus (2002) described a reentry program at The University of California at Berkeley for recruiting women and underrepresented minority students into computer science. The university's CS Reentry Program opened the way for women and underrepresented minority students without degrees in computer science to acquire a computer science core education, then enter graduate study there or in another university if they so desired. The CS Reentry Program was in existence from 1983-1998, but was ended as a result of the passage of Proposition 209, which prohibited programs providing educational benefits based on gender or ethnicity. Mills College in Oakland, California, has offered a New Horizons certificate program for men and women with bachelor's degrees in other fields (Humphreys & Spertus, 2002). Students could earn the certificate or an M.A. in Interdisciplinary Computer Science by taking a series of undergraduate computer science courses as well as affiliated mathematics courses.

Efforts to interest girls and women in technology have not only been implemented in colleges and schools; groups outside the educational community have also sponsored activities or programs to help recruit and retain girls and women in the computing/information technology field. Descriptions of some of these follow.

The North Carolina Girl Scouts sponsor a website: "Girls are I. T.!" at www.girlsareit.org where middle school girls (aged 11 to 14) can learn about technology careers ("Girls can get I. T.", 2006). The group also sponsors a bus, called the Mobile Technology Classroom, that stops at different locations throughout the region to give students the opportunity to learn about technology careers. Lynn, Raphael, Olefsky, and Bachen (2003) suggested approaches to creating computer or website content for girls to increase their interest in computers. Their recommendations include focusing content more clearly on computer design and appealing both to girls' traditional and nontraditional interests. Lynn et al.'s test of a prototype website that used this approach showed significant interest in computers and heightened motivation and sense of relevancy for using computers among the girls who tried it, but this test consisted of only one 20-minute session at the website.

Francioni (2002) studied the effect of participation in the Grace Hopper Celebration of Women in Computing on seven undergraduate women students. Immediately after the conference, the undergraduate participants reported that the conference was mostly a positive experience; they especially mentioned their positive reactions to presentations by women in the field. The students noted that their interactions at the conference increased their self-confidence and made them more aware of the wide range of job options involving computing and other fields. When interviewed a year and a half later, the students considered attendance at the conference an even more positive experience. They mentioned that they either directly used something they heard at the conference and/or experienced something firsthand that had been described at the conference. The participating students also felt a heightened sense of community among women in computer science as a result of attendance at the conference (Francioni).

The Grace Hopper Conference, mentioned in the last paragraph, is an activity sponsored by The Institute for Women and Technology. This organization also sponsors The Systers online discussion group for computing women and the Virtual Development Center. The VDC (Virtual Development Center) was established in 1999 to research issues involving women in computing (Montano, 2002). As of 2002, there were eight of these centers throughout the United States; each center sponsors technology projects which benefit the community and were suggested by nontechnical women and girls in the local community. These sites together form a collaborative network, with each project serving as community outreach as well as a way for students working on each project to see the social benefits and social uses of computing (Montano, 2002).

Gabbert and Meeker (2002) described several types of support communities for women in computing. These organizations offer websites containing information about activities and meetings, and some also offer virtual communities for interaction. The focus of each organization could be information, research, communication, mentoring, and/or activities specific to their members. These support organizations include, but are not limited to: (a) ACM Committee on Women in Computing, (b) Committee on the Status of Women in Computing Research, (c) Institute for Women and Technology, (d) Women into Computing UK, (e) Association for Women in Computing, and (f) Women in Technology International.

The research on women in computing shows diverse findings. Some researchers found that females have a more negative attitude toward computers than males do (Durndell et al., 1995; Kadijevich, 2000; Mitra et al., 2001; Shashaani, 1993), but others found that females do not have a more negative attitude (Tsai, 2002), especially once experience is factored in (Jones & Clarke, 1995; Levin & Gordon, 1989; Pope-Davis & Twing, 1991). The computing environment tends to favor males (Kiesler et al., 1985; Klawe, 2002; Pearl et al., 1990; Rasmussen & Hapne, 1991); but it is not always a detriment to women (Fisher et al., 1997; Henwood, 1996; Lips & Temple, 1990). The stereotypical male image of the computing professional does not encourage women to choose computer science (Durndell & Thomson, 1997), but it is not necessarily the predominant belief among those who use computers (Clarke & Teague, 1996; Colley et al., 1995; Fisher et al., 1997; Parker, 1995; Schott & Selwyn, 2000). Some aspects of the post-secondary school computing environment do not encourage women (Howell, 1996; Pearl et al., 1990; Rasmussen & Hapne, 1991), but this occurs more often in some institutions than in others (Camp, 1997; Fisher et al., 1997; Jagacinski et al., 1988). Women who favor a computing career tend to like computers, have had positive experiences with them, and are often not bothered by the predominantly male environment (Fisher et al., 1997; Henwood, 1996; Lips & Temple, 1990; Teague, 2002). Women tend to be interested in using computers as a tool, not the fascination with a machine that males in computing often express (Fisher et al., 1997; Rasmussen & Hapne, 1991). Efforts to encourage women to choose computing careers have included special programs in middle and high schools (Cannon et al., 2007; Countryman et al., 2002; Doerschuk et al., 2007; Huggard & McGoldrick, 2006; Jepson & Peri, 2002), efforts based on college campuses (Clayton & Lynch, 2002; Fisher & Margolis, 2002; Humphreys & Spertus, 2002; Randall et al., 2003; Roberts et al., 2002), and programs sponsored by outside groups (Francioni, 2002; Gabbert & Meeker, 2002; "Girls can get I. T.", 2006; Lynn et al., 2003; Montano, 2002).

Summary

The literature on women in nontraditional careers points to a variety of influences on women to choose a career in a nontraditional field: cultural, individual aptitude, family background and beliefs, and previous experiences. The model by Eccles (1987) emphasizes the importance of (a) a girl's interpretation of her experiences, (b) her perception of her cultural and family background, and (c) her self-efficacy and perception of the utility of a particular field of study. These factors then contribute to her achievement-related decisions, which in turn affect her career choices.

Applying this information to a woman's choice to pursue a career in mathematics, science, or engineering, this choice is not only affected by her mathematics and/or science ability and self-efficacy, but what she perceives as the value and usefulness of mathematics and/or science. The model by Farmer et al. (1995) highlights the importance of taking the high school mathematics and science courses needed, as well as the need for emotional and financial support, in order to achieve successful persistence in a career in mathematics, science, or engineering.

The information on women's choices of nontraditional careers or careers in mathematics, science, or engineering can furnish background and lens to the consideration of women's choice to pursue a computing career. But the choice of a computing career has aspects and influences different from those in mathematics, science, or engineering because of the prevalence of technology in society. There is a societal image of the computing professional and a computing culture. Of the research on the image of computing users reported in this literature review, three out of five studies (Clarke & Teague, 1996; Durndell & Thomson, 1997; Schott & Selwyn, 2000) found that young people held a negative stereotypical image of computer users and computer professionals, while two studies (Colley et al., 1995; Shashaani, 1997) did not find a gender stereotypical image of computer use in young people contemplating careers. Of the research on women's experiences studying or working in the computer field mentioned in this literature review, two studies (Henwood, 1996; Rasmussen & Hapnes, 1991) out of six found that women reported a negative environment like teasing on the job or lack of support from male peers. Another two studies (Clarke & Teague, 1996; Lips & Temple, 1990) of the six declared that women had a positive experience or high job satisfaction while working or studying in the computer field. The last two studies (Fisher et al., 1997; Teague, 2002) of the six disclosed mixed results, with some women feeling disrespected or treated unfairly by male peers and teachers, while other women considered gender a non-issue and expressed confidence at handling the male environment. Unlike the mixed findings just reported, the literature was clear in its assessment that women do not choose computing for the same reasons that men do, nor do women have the same attitude toward using computers that men have (Fisher et al., 1997; Rasmussen & Hapne, 1991). Most computing women see computers as a tool to accomplish goals that are best or most easily done using computers (Fisher et al., 1997; Rasmussen & Hapne, 1991) and want to use its power for what it can accomplish in other fields like science, communications, and the humanities (Clarke & Teague, 1996; Fisher et al., 1997).

Ways to interest girls in mathematics and science courses (Koontz, 1997; Simonis, 1982) and recruitment and retention efforts in the engineering field (Schafer, 2006; Tietjen, 2004; Zastavker et al., 2006) shed light on some of the efforts to recruit and retain women in the computing/information technology field. These recruitment and retention efforts in technology include programs for middle and/or high school girls (Cannon et al., 2007; Countryman et al., 2002; Doerschuk et al., 2007; Huggard & McGoldrick, 2006; Jepson & Peri, 2002), recruitment and retention programs for women in colleges and universities, including classroom changes there (Clayton & Lynch, 2002; Fisher & Margolis, 2002; Humphreys & Spertus, 2002; Roberts et al., 2002), and special programs sponsored by outside groups (Francioni, 2002; Gabbert & Meeker, 2002; "Girls can get I. T.", 2006; Montano, 2002). At the present time it is unknown how successful these programs will be for the ultimate goal of increasing the percentage of women in computing careers.

There is a lack of studies investigating what influences women to choose computing careers by asking experienced women in the computing/IT field about (a) their family, school, and college backgrounds; (b) their individual preferences and personal characteristics; (c) when and why they chose a computing career; (d) their likes and dislikes about their careers; (e) why they remain in computing; and (f) who and what has influenced them to choose and to persist in a computing career. But that is what this study has done.

CHAPTER III

METHODOLOGY

Introduction

Women are underrepresented in computing careers. This study sought to examine the situation by searching for common factors in computing women's backgrounds and/or experiences which have influenced their choice of and persistence in their careers. The participants in the study were computing women having at least five years experience and at least a bachelor's degree. By looking for commonalities among experienced women in computing careers, this study approached the question from a different perspective than earlier studies that compared characteristics of men and women in the field (Howell, 1996; Rasmussen & Hapnes, 1991). Instead of comparing men and women, this dissertation examined women who not only initially chose a computing career, as other studies have done (Lips & Temple, 1990; Pearl et al.,1990), but who also chose to continue in the computing/information technology field. Investigating the characteristics which distinguish successful computing women from the majority of women who have not chosen computing provides a perspective from which to understand the underrepresented group. This additional knowledge can help increase the percentage of women in computing/IT by making recommendations for ways to recruit and retain women in the field.

Research Question and Subquestions

The research question and its parts which guided the investigation of this study are:

What factors or combination of factors influence women to choose and to continue in a computing career? This investigation included the following subquestions:

1. What factors, if any, in their family backgrounds influenced computing women to choose this field?
2. What were the common childhood play and leisure preferences, if any, of women who chose computing careers?
3. What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?
4. What college experiences, if any, influenced women in computing careers to choose and to continue in the field?
5. What factors, if any, in computing women's career situations influenced them to continue in their careers?
6. Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?

Mixed Methods Design

Sometimes a single type of methodology does not completely elucidate a topic under consideration. In order to thoroughly investigate a question, it is sometimes desirable to study the question using multiple methods.

> One important way to strengthen a study design is through triangulation, or the combination of methodologies in the study of the same phenomena or programs. This can mean using several kinds of methods or data, including using both

quantitative and qualitative approaches. (Patton, 1990, p. 187)

This study combined two research methods, survey and interview. It also used both quantitative and qualitative methods. The researcher first used a survey to collect data from a large number of people in order to reveal descriptive characteristics of that group. The survey contained both quantitative and qualitative aspects. It was quantitative in that most of the survey questions were structured questions of a multiple-choice format, and statistics were calculated for questions having a numerical answer. For example, mean, median, range, and standard deviation were calculated for the women's high school and college GPAs as well as for the number of children the computing women raised. The researcher also calculated chi-square for appropriate pairs of survey data to search for significant relationships between the members of each pair. The survey exhibited qualitative aspects in that many of its questions, in addition to offering a list of choices, also allowed the participant to choose more than one answer, rank-order her answers, or add comments or answers not included in the listed choices. After the survey was completed, the researcher interviewed a subsample of the surveyed women to clarify and further study ideas that surfaced in the survey. The interviews were qualitative in nature because the questions were predominantly open-ended, and the interviewer encouraged additional comments or clarification by the interviewees. This use of mixed methodology sought to strengthen the investigation of the research question and subquestions because of its use of both survey and research methods as well as both quantitative and qualitative aspects of research.

Survey Research

"The purpose of survey research is to describe specific characteristics of a large group of persons, objects, or institutions" (Jaeger, 1997, p. 449). The use of survey research is especially appropriate when the goal is to obtain information about a large group, or when the study's objective is to discover trends or commonalities in a large group when these commonalities have not been previously found. Jaeger (1997) writes that survey research is especially appropriate under certain conditions: (a) when the goal is to obtain specific facts about a large group, (b) when there is a well-defined group under consideration, (c) when the aim is to investigate the present conditions of the group rather than investigating the result of a change to the group, and (d) when the information can be obtained by asking the right people. Under such circumstances, survey research is the best way to obtain the information that the study is seeking.

There are many reasons why survey research was appropriate for this study. This investigation's goal was to obtain specific facts about women with careers in the computing and information technology field; this is a large group for which the study sought to find commonalities not found by other studies. The group under consideration consisted of women who had at least five years experience in computing/IT careers and who had earned at least a bachelor's degree. The job titles for women who completed the survey were specifically identified as one of the following: (a) computer information scientist, (b) computer programmer, (c) computer software engineer, (d) computer hardware engineer, (e) computer systems analyst, (f) database administrator, (g) network and computer systems administrator, (h) network systems and data communications analyst, (i) operations research analyst, or (j) any other related job title for similar work. This is how the group under consideration was well-defined. This study's goal was to investigate the present situation for computing women, including an investigation of their lives, careers, and personal characteristics; the purpose was not to see the result of some change to the group. The information needed for this study could be obtained by asking computing women; in fact, some of it could only be obtained by asking the women themselves about their own experiences, feelings, and intentions. For the previous reasons, survey research was appropriate for this study.

Interview Research

"The purpose of interviewing is to find out what is in and on someone else's mind" (Patton, 1990, p. 278). In some studies, the best way to obtain the desired information is through asking the people themselves who have experienced the situation. Sometimes interviews are also used to verify or expand information obtained from other studies. Certain conditions or situations cannot readily be observed, like a person's previous actions, or someone's thoughts, intentions, or feelings. Asking the people themselves about these situations is sometimes the only way of obtaining the desired information. As Merriam (1988) expresses it, "Interviewing is necessary when we cannot observe behavior, feelings, or how people interpret the world around them. It is also necessary to interview when we are interested in past events that are impossible to replicate" (p. 72). In such situations, interviews help the researcher to understand the participant's perspective in a way that no other research method can.

The use of interview research was appropriate for this investigation for several reasons. The researcher interviewed a subgroup of the survey participants after the survey was completed in order to clarify and expand ideas which surfaced in the survey; the interviews were thus used to expand ideas from the survey. Some of these ideas included (a) when the women chose their computing careers, (b) if they experienced any discrimination during the time they studied and worked in computing, and (c) how they felt about computers after their first experiences with them. Obtaining information about these ideas cannot be accomplished through observation but can be achieved by asking the computing women themselves. The interviews included questions about the computing women's feelings about their first computing experiences and their careers; these questions were about previous events or the computing women's feelings and intentions. Information can best be obtained about such past events or feelings by asking the computing women themselves about them. For these reasons, interview research was an appropriate method for this study.

Design and Procedures of the Study

Overview

This study used a mixed methods design by combining survey and interview types of research and using both qualitative and quantitative methods. The survey method is especially useful to discover commonalities in a diverse group of computing women. This study's survey was a descriptive study of 50 computing women. It asked questions about the women's backgrounds, childhood play choices, school and college years, career choices, and job experiences to investigate the factors which influenced them to choose and to persist in a computing career. The survey contained structured questions of a multiple-choice format. Many of its questions, in addition to offering a list of choices, also allowed the participant to choose more than one answer, rank-order her answers, or add comments or answers not included in the listed choices.

After the survey component was completed, the researcher conducted interviews with 44% of the 50 surveyed women. The interviewed women had volunteered to participate in the follow-up telephone interviews. The interviews followed a general interview guide approach, with semi-structured questions that searched for corroboration of the survey's findings as well as exploring related issues or trends in greater depth. The interview questions were generative in nature, with some of the questions precipitated from the survey results.

Population and Participants

Because the goal of this study was to discover which factors influenced women to choose and to persist in a computing career, its target population consisted of women in computing careers who hold a bachelor's or more advanced degree. It specifically targeted women included in one of these occupational titles: (a) computer information scientist, (b) computer programmer, (c) computer software engineer, (d) computer hardware engineer, (e) computer systems analyst, (f) database administrator, (g) network and computer systems administrator, (h) network systems and data communications analyst,

(i) operations research analyst, or (j) any other related job title for similar work.

This study had purposely chosen to concentrate on studying women and was not a comparative study of men and women in the computing field. Those studies which concentrate on a comparison of men and women often assume a deficit model to explain why women are underrepresented in certain fields (Campbell, 1995; Damarin, 1995). A deficit model is usually used to compare women (underrepresented in the field) with men (with high populations in the field) to determine what women need in order to succeed in a computing career based on male-determined standards. Instead, this study sought to specifically study the characteristics of women who have chosen a computing career and successfully persist in it. By using such a purposefully chosen population, the study concentrated on the actual characteristics of the successful women themselves instead of targeting the differences between men and women.

This study examined common background characteristics and commonalities in school and work experiences which may have influenced women initially to choose and subsequently to continue in a computing career. By identifying common characteristics, this study can help illuminate which characteristics are common to women who have initially chosen computing or information technology as a career and what experiences and influences have helped such women to achieve and to persist in that goal.

The target population for this study consisted of women who had at least five years experience in their computing/information technology careers. The study had chosen to exclude those who first chose a computing major then changed majors, or those who started in the field but soon decided that it was not the type of career they really desired. Women who have changed majors to something other than computer science or terminated their computing careers have been studied (Frenkel, 1990; Pearl et.al., 1990). This dissertation took a different perspective by targeting experienced computing women. By surveying and interviewing successful experienced computing women, this study's goal was to better illuminate factors which influence women's choice of and retention in computing careers than results offered by studies that compared men and women (Rasmussen & Hapnes, 1991).

This study used purposeful sampling because it asked experienced computing women themselves about their careers. The participants were computing women whose jobs require at least a bachelor's degree and whose occupational titles are included in one of the following: (a) computer information scientist, (b) computer programmer, (c) computer software engineer, (d) computer hardware engineer, (e) computer systems analyst, (f) database administrator, (g) network and computer systems administrator, (h) network systems and data communications analyst, (i) operations research analyst, or (j) any other related job title for similar work. As the study progressed, it became apparent that there were other occupational titles in the computing field which were not on the list but required a college degree and extensive computing skills, like the occupations of solution architect, three-dimensional artist, and producer. Women holding these jobs were also included as participants. A purposeful sample was used because this project studied computing women from the women's own point of view by asking the computing women themselves questions about their background, childhood play choices, school and college years, career choices, and job experiences. In order to accomplish this, it was required for the population and sample to consist of women with such backgrounds, not for the women to be chosen randomly.

The participants in this study were women who work in computing careers in the United States. The survey consisted of a questionnaire which was completed online from a website created specifically for the study. Because the survey was accessible to people from all areas of the country, attempts were made to include participants from as many states as possible and as many different types of employers as possible. Women were invited to participate through personal and professional contacts made by the researcher. In some cases, the researcher contacted a male in the computing field who then directed the e-mail invitation to professional computing women he knew. Participants themselves were asked to invite other women in the field also to participate in the survey. Some of the participating women invited several other computing women to respond to the survey. This created a "snowball effect" in which a greater number of computing women actually participated in the survey than the number of invitational e-mails sent by the researcher. The researcher invited participation in the study via e-mail with an invitational letter attached. Appendix A contains a copy of the invitational letter. This letter explained the reasons for the study and invited prospective participants to complete the survey on the Internet website. Those who received the letter were asked to encourage others to participate by directing them to the location of the website survey. In this way, 50 participants completed the online survey. For the small number of potential participants who did not respond to the initial e-mail, the researcher followed up with a second e-mail, which usually elicited a response.

Survey Design

This study's survey was cross-sectional; it involved collecting data from computing women during a single time period. Because the survey participants themselves answered questions about their backgrounds and experiences, the survey is classified as a self-report instrument. The survey was in the form of a questionnaire in which all participants answered the same questions via an Internet website. Most of the questions were of a semi-structured format in that the listed answers were multiple-choice, but there were many opportunities to add comments or another choice if the participant's answer was not listed.

Selection of Sample

The researcher invited computing women to participate by sending them an introductory letter via e-mail. The letter introduced the study to the participants and explained the study's purpose. It also listed the job titles included and that five years experience was required for each participant. The text of the introductory letter is in Appendix A. The sample was a purposeful sample of computing women who had at least five years' experience, whose jobs required at least a bachelor's degree, and whose job titles are included in one of the following: (a) computer information scientist, (b) computer programmer, (c) computer software engineer, (d) computer hardware engineer,

(e) computer systems analyst, (f) database administrator, (g) network and computer systems administrator, (h) network systems and data communications analyst, (i) operations research analyst, or (j) any other job title for similar work. The survey was conducted via an Internet website. Since computing women were invited to participate through e-mail contacts that were not limited to one geographical area and the survey was located online, participants included computing women from several areas of the country and women working for several different types of employers. It is desirable to include women from diverse backgrounds, employers, and geographical areas in order to improve the applicability of this study to computing women beyond this study's participants.

Survey Instrument

The survey instrument consisted of a questionnaire containing items that were a checklist or ranked item format, as well as a few free-response items. Because the survey was intended to discover commonalities among computing women who chose and persisted in a computing career, many of the survey items also included additional space to add comments or to add an answer that was not listed among the choices. Due to the nature of these items, the questionnaire was semi-structured. It was also a self-reporting questionnaire because the survey participants themselves answered questions about their backgrounds and experiences; many of the questions referred to experiences that could only be answered by the computing women themselves.

The researcher composed the survey questions and choices based on her study of previous research on gender issues in computing, mathematics, science, engineering, and women's nontraditional careers. For example, questions 40 and 41 ask the participant how much her mother worked outside the home and what the participant's age was when her mother started to work. The inclusion of these questions was influenced by Lemkau's finding (1983) that many women in male-dominated professions had mothers who worked outside the home. Question 51 asked about the person who supported or encouraged the computing woman's efforts in the field. The inclusion of this question was influenced by Frazier-Kouassi et al.'s finding (1992) that women who continued in college physics were most often encouraged by another person to continue in the field. These are two examples of the ways in which each question's inclusion in the survey was influenced by previous studies.

The survey items were piloted in the summer of 2003. The participants in this pilot survey included a teacher of high school computing technology courses who also had experience in teaching adult business and vocational courses, a teacher of high school computer applications courses, a middle school teacher of mathematics and computer applications courses who also has a business education background, and a high school English teacher. Their suggestions were used to increase the clarity of some questions and to add others. For example, question 55 was originally written to refer to the computing woman's *employer*, not *present employer.* The wording was changed to *present employer* and question 56 was added as a similar question but one that referred to a previous employer for those computing women who had more than one employer. These changes were made after one of the women piloting the survey noted that her sister, who is a computing woman, would have a hard time answering the question as it was written because her experience was with many employers. An example of an addition to the survey after piloting it was the addition of the choice "playing with dolls/stuffed toys" to question 4 because a person piloting the survey suggested that addition.

The survey instrument is contained in Appendix B. This paper will now discuss the survey items by groups of questions.

The electronic survey allowed for each participant to complete some questions, save her answers, then come back to the survey later. In order to do this electronically, the first question on the website was: "Please select one: ☐ I am starting a new survey. ☐ I am returning to continue an existing survey." In order to identify each participant's survey without using her name, the beginning of the survey asked, "Please fill these in to help identify your survey: Your Initials _ _ _ (Use First, Middle, Last) and Birthday (Month/Day): _ _/_ _"

The second page of the survey gave the directions, "Please answer the following questions to the best of your ability. If your answer is not listed, add it using the space below the question or the place for comments (#59) at the end of the survey." The participant was then asked some demographic questions:

1. I am a woman in the computing and/or information technology field.

   True ☐ False ☐

2. I have been in the computing and/or information technology field for ☐ years. (Please give approximate number of years in the field. It should be 5 or more

years for participation in this survey.)

3. My job title is: ____________ (Add short description if necessary.)

In questions 4 through 6, the survey asked questions about the participant's activities and pursuits as a child. Questions 4 and 5 are listed as examples of this group of questions.

4. Which type of play activities did you engage in most as a child in elementary school? Please number your top 5 choices from this list from greatest engagement (1) to least engagement (5).

☐ computer/technology games ☐ building things

☐ organized team sports ☐ taking apart things to see how they work

☐ individual sports ☐ informal neighborhood sports

☐ nature activities ☐ art & music activities

☐ group play activities ☐ writing/reading

☐ playing with paper dolls ☐ playing with dolls/stuffed toys

Other/comment ____________________

5. Which type of playmates did you typically have as a preschool/elementary school child? (If more than one applies, rank the top 3 as most often (1), second most often (2), to least often (3).)

☐ played alone ☐ several girls

☐ one girl playmate ☐ several boys

☐ one boy playmate ☐ mostly sibling(s)

☐ group of boys & girls ☐ I don't remember

Other/comment____________________

Survey questions 7 through 9 asked the participant questions about her elementary school experience. Fifth grade was chosen as the ending point for elementary school experiences in this survey because of the change which often occurs in girls' attitudes towards their abilities and school during 6th, 7th, or 8th grade (AAUW, 1992). It is for this reason that grades 6 through 8 are grouped together in this survey even though some middle schools begin with 5th grade, and some school systems organize 7th and 8th grades as a junior high school. Questions 7 and 8 are listed next as examples of this group of survey questions.

7. Which type of school did you attend in grades K-5? (For predominant number of years in K-5).

☐ public ☐ public magnet school

☐ private, with religious mission ☐ private, no religious mission

8. Who were your classmates in grades K-5? (For predominant number of years in K-5.) ☐ boys and girls ☐ all girls

☐ mostly girls (only a few boys) ☐ coed with some classes single sex

In questions 10 through 12, the survey asked similar questions about the participant's experiences during 6th through 8th grades. Questions 11 and 12 are shown as examples of these questions.

11. Who were your classmates in grades 6-8? (For predominant time in grades 6-8.)

☐ boys and girls ☐ all girls

☐ mostly girls (only a few boys) ☐ coed with some classes single sex

12. What was your favorite subject in school in grades 6-8? If more than one applies, rank the top 3 as (1) liked the most, (2) liked second most, through (3).

☐ math ☐ science

☐ English ☐ other language(s)

☐ history (or social studies) ☐ art

☐ music ☐ reading

☐ computer courses ☐ physical education

Other/comment_______________

Questions 13 through 23 dealt with the participant's high school experience (grades 9-12). Questions 16, 17, 21, and 23 are shown as examples of this group of questions. Appendix B includes all survey questions in their entirety.

16. The number of years of mathematics courses you completed in high school:

☐ 1 ☐ 1 ½ ☐ 2 ☐ 2 ½ ☐ 3 ☐ 3 ½ ☐ 4 ☐ more than 4

17. In which type(s) of math did you do well in high school?

☐ Geometry ☐ Algebra

☐ Statistics/Probability ☐ Every type of math

☐ Not very good at math ☐ I don't remember

21. What influenced you to take science courses in high school? If more than one

applies, order from greatest (1) to least (5).

☐ I did well in science ☐ It was needed for my career

☐ I like science ☐ I was encouraged to take it

☐ I took only what was required

Other/comment________________

23. By the end of high school, with which type(s) of software programs did you have substantial experience? Please check all that apply. (Consider all of your computing experiences in grades K-12.)

☐ word processing ☐ spreadsheets

☐ programming language(s) ☐ web design

☐ presentation software ☐ authoring/publishing software

☐ databases ☐ games

☐ email ☐ Internet use

☐ data acquisition software ☐ I don't remember

☐ None of these ☐ did not experience any computer software in K-12

Other/comment______________________

Survey questions 24 through 32 asked about the participant's college experiences. Questions 26, 31, and 32 are shown as examples from this group of questions.

26. For the majority of your computing courses, in which college were the courses located?

☐ Arts and Sciences

☐ Engineering

☐ Business

☐ Education

Other: ______________________

31. When did you pursue the majority of your studies in the computing/information technology field?

☐ 1960's ☐ 1970's ☐ 1980's ☐ 1990's

32. Which best describes your experience while studying in your computing/IT courses? (Check any that apply.)

☐ I had a female friend who took classes in the field with me.

☐ I had a male friend who took classes in the field with me.

☐ I had a female college friend who encouraged my efforts in the field.

☐ I had a male college friend who encouraged my efforts in the field.

☐ I continued despite opposition from others in the field.

☐ I continued despite opposition from my friends.

☐ None of the above applies to me.

Comment:___________________

Questions 33 through 42 referred to the participant's family background. Questions 33, 34, 40, and 41 are shown as examples.

33. Your position in family birth order: (Please fill in each blank with the appropriate number.) I am # ______ of ______ children.

34. Which best describes your sibling group?

☐ only girl among boys ☐ all girls

☐ approximately half girls and half boys ☐ only child

☐ mostly girls, one boy

40. If your mother worked outside the home, check the one which applies:

☐ always part time ☐ always full time

☐ sometimes part time, sometimes full time

☐ at first part time, then it became full time as children got older

Other: ____________________

41. If your mother worked outside the home, how old were you when she started to work? ____________________

The next two questions referred to the participant's own demographics:

43. What is your race? (Please check one.)

☐ Asian or Pacific Islander

☐ Black or African American

☐ White or Caucasian

☐ American Indian or Alaska Native

Other:____________________

What is your ethnicity? (Please check one.)

☐ of Hispanic origin

☐ Not of Hispanic origin

44. What is the total number of children that you are raising or that you raised?

☐ none ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

If more than 6, write the number here: ____________

Survey questions 45 through 56 asked the participant about her computer experiences, characteristics, and career decisions. Questions 45, 46, 47, and 51 are listed as examples from this group of questions. All survey questions are listed in Appendix B in their entirety.

45. Which best describes your first experience with computers?

☐ We had a computer at home and I first used it there.

☐ I first used computers in school in grades K-12.

☐ I first used computers in college.

☐ I first used computers at a friend's house.

☐ I first used computers at a relative's house.

☐ I first used computers at the community library.

☐ My first experience with computers was with one I bought or built myself.

Other: _________________

46. What first interested you in computers? If more than one applies, rank them as 1 (most influential), 2 (second most influential) through 3 (third most influential).

☐ the inner workings of the computer

☐ the computer's ability to do complex operations

☐ the usefulness of the computer as a tool to accomplish other tasks

☐ the job possibilities of the computer field

☐ I saw someone else using it and wanted to learn about it too

Other: ________________

47. How do you consider yourself? (Check as many as apply.)

☐ confident	☐ sociable
☐ likable	☐ independent
☐ a leader	☐ I prefer others to take the lead
☐ I like to work on my own	☐ I like most to work on a team
☐ none of these	

51. What is the best description of the person(s) who supported/encouraged your efforts in the computing/information technology field? (If more than one applies, pick the 2 most important and rank them as 1 (most support/encouragement) and 2 (next most support/encouragement).)

☐ female friend	☐ female sibling
☐ male friend	☐ male sibling
☐ father/stepfather	☐ mother/stepmother
☐ male teacher	☐ female teacher
☐ husband	☐ wife
☐ son	☐ daughter

☐ my children (son(s) and/or daughter(s))

☐ group of mostly male friends

☐ group of mostly female friends

☐ group of male & female friends

☐ no one; did it on my own

Other(specify):___________________

Question 57 asked the participant if she knew any women who started in the computing/IT field and then dropped out. Question 58 then asked those respondents who knew a woman who dropped out of the field about the reason(s) why. Survey question 59 gave the participant an opportunity to express any comments she had about any of the survey questions or about her career.

Survey question 60 explained about the importance of the follow-up telephone interviews and asked the survey participant about her willingness to participate in the telephone interview. This was the wording:

60. In addition to this survey, I will be conducting telephone interviews with a number of survey participants for clarification of some answers. It is essential to my research to probe some questions in greater depth; please consider allowing me to interview you by telephone. (Your name will not be used in reporting the findings.) The interview will only take a small amount of your time, but it will help my research tremendously. The day and time will be at your convenience.

Please check one of the following:

☐ I AM ☐ I AM NOT willing to answer these and other related questions in greater depth in a telephone interview that will be audiotaped. If you are willing to be phone interviewed, please fill in your email address: ____________________

Once the participant had finished the survey and submitted her answers, she received the message, "Thank you for your time and willingness to help us learn more about women in computing careers."

Procedures

The researcher placed the above questionnaire on a website, participants completed it, and the data was returned electronically. Computing women were invited to participate via e-mail, with an introductory letter sent as an e-mail attachment. The data collected from the website was saved electronically, with electronic and paper backups. Computing women who did not respond to the first e-mail were sent another invitational e-mail or an e-mail asking if they had questions. Participants answered anonymously by the use of the coding system at the beginning of the questionnaire. This coding also allowed for participants to begin to answer the survey, save their answers, and come back to it later. Of the 72 responses recorded by the website, 22 responses were disregarded for the following reasons: (a) 3 were test surveys; (b) 7 were incomplete; (c) 7 were begun by people other than computing women, like male bosses or colleagues who tried the survey before passing it along to computing women; and (d) 5 were from women who did not have the bachelor's degree required for this research study. In this way, there were 50 usable surveys from participants.

Interviews

Participants

The participants in the telephone interviews were survey participants who volunteered for the follow-up interviews. There were 22 interview participants. The purpose of the interviews was to clarify and further study ideas that surfaced in the survey. The interviewees lived in seven states and their employers included four different colleges, the federal government, and eight different companies in the private sector. Their ages ranged from 28 to 62, and their experience in the computing field ranged from 6 to 37 years.

Questions

The interview questions were generative in nature, with the questions based on the survey results. Appendix C contains the interview questions. The questions were semi-structured, with the researcher asking the same questions of all participants, except for question 11, which was added after the first two interviews. For some questions or some interviewees, the researcher asked additional probing or clarifying questions if the interviewee did not give enough information or her information was unclear. For example, question 1A asked, "When did you decide on a career in computing?" For this question, the researcher asked the interviewee for the circumstances and time frame for her decision, if she did not discuss these items on her own. The interview questions themselves will be discussed next.

The first three questions asked the interviewee about her decision to pursue a computing career. This is how the questions were worded:

1. A. When did you decide on a career in computing? B. What was your age then? What is your approximate age now?

2. Why did you choose computing as a career?

3. Was there a person who gave you the most encouragement to pursue a computing career or did you mostly do it on your own? Tell me about it.

Question 4 asked the interviewee what she likes about computing and why she continues in the field: "4. A. What do you like about working in computing? B. Why do you continue to work in computing?"

Question 5 asked the interviewee what she dislikes about computing and if she encountered any discrimination in the field. The wording was: "5. A. What do you dislike about working in computing? B. Did you encounter discrimination or obstacles in school or at work because you're a woman in computing? Explain."

Question 6 asked the interviewee about her personal strengths in computing: "What personal characteristics do you have that make you good at your career?"

Question 7 asked the participant about her first experience with computers and her reaction to it. The wording was: "7. A. How old were you when you had your first experience with computers? Describe that experience. B. Were you drawn to computers then? In what way?"

The researcher believes that much can be learned about a woman's attitude toward her career, what she thinks are important qualifications for a career in her field, and how she reacts to new people in the field by asking her for the advice she would give to a young person starting out in the same career. With this in mind, question 8 asked, "What would you say to a young woman interested in a computing career right now?"

The next question gave the interviewee an opportunity to talk about women in computing if she wanted to add something on that topic. The wording was: "9. Is there anything else you would like to say on the topic of women in computing?"

Question 10 basically asked the participant demographic questions and gave her the chance to choose her pseudonym. This was the wording:

> 10. A few quick demographic questions: A. In which state do you live? B. How long have you been working in computing? C. What kind of work do you do? What is your job title? Where do you work? D. Since references to you will not use your actual name, what name would you like me to use instead?

After the researcher interviewed the first two interview participants, she added question 11 to give the interviewee a chance to add comments or to ask the researcher about her project: "11. Is there anything else you'd like to say or any questions that you have?"

Procedures

The researcher selected the participants for the follow-up interviews from those who had volunteered by answering affirmatively to survey question 60:

> Please check one of the following:
>
> ☐ I AM ☐ I AM NOT willing to answer these and other related questions in

> greater depth in a telephone interview that will be audiotaped. If you are willing to be phone interviewed, please fill in your email address: ____________________

The researcher then contacted volunteers via e-mail for their phone numbers and a convenient time to be interviewed. The 22 interviewed women included computing women from seven states; their employers included four different colleges, the federal government, and eight different companies in the private sector. Each interview was conducted by telephone, and an audio recording was made with the participant's permission.

Timeline

The survey was available on its website for approximately four months during the spring and summer of 2006. This allowed time for initial contacts, for the respondents to complete the survey, and for follow-up contacts as needed. After the researcher compiled and considered the survey results, she then composed the interview questions. Next, the researcher contacted the interview women to make appointments to conduct the interviews. The follow-up interviews were completed in approximately six weeks in the fall of 2006.

Data Analysis

Survey

The survey results were compiled, categorized, and analyzed. Data analysis included calculation of frequency percentages for each question; some results were also displayed in graphic form. For some questions, answers were also grouped into categories to facilitate additional conclusions about the results. For these questions with grouped responses, frequency percentages were calculated and displayed for the categories. The researcher also calculated descriptive statistics for those questions with numerical answers. For example, mean, median, range, and standard deviation were calculated for the computing women's ages when they chose their computing careers and for the number of children the computing women raised. The researcher also calculated chi-square for appropriate pairs of survey data in order to look for significant relationships between the items in each pair. In these ways, the data analysis sought to find commonalities among background, schooling, motivation, encouragers, and experiences for the women surveyed.

Interviews

The researcher coded the interview transcripts, then noted patterns and trends. The purpose was to detect patterns in interview responses in order to discover commonalities among the computing women's backgrounds, schooling, and/or experiences. Frequency percentages were calculated for categories of responses. To strengthen reliability, a second researcher listened to two randomly chosen interview recordings and checked for interviewer bias and coding. The second researcher recently received her Ph.D. and has experience in qualitative research and women's issues.

Validity and Reliability

This study sought to strengthen its validity and reliability in several ways. One was the design of the research; it used a mixed methods design composed of both survey and interview types of research as well as both quantitative and qualitative methods. This study triangulated the survey and interview data with results from previous research studies on similar women. To increase the validity of the survey, the survey instrument contained numerous questions which allowed participants to add a category or comments. Survey participants were from a variety of ages, backgrounds, and work experiences. As mentioned earlier, to increase the reliability of the interview research, another researcher reviewed two randomly chosen interviews. In these ways, the researcher sought to strengthen the validity and reliability of this study.

CHAPTER IV

RESULTS

Introduction

Data for this study were collected in two ways. First, an online survey was conducted using the questions shown in Appendix B. Second, 44% of the 50 women who completed the online survey were interviewed via telephone using the questions in Appendix C. The results from these two data collection methods will be presented and discussed in this chapter.

This analysis of results has been divided into two main parts. The first part discusses the results of the online survey questions, first with a presentation and discussion of the results of the questions, then with a discussion of the chi-square analysis of the survey data. The second part discusses the results of the telephone interviews, first with a presentation and discussion of the results of the interview questions, then a discussion of another researcher's opinion on the neutrality of the interviewer's questioning and consistency of coding of the results.

The research question and its parts which guided the investigation of this study are: What factors or combination of factors influence women to choose and to continue in a computing career? This investigation included the following subquestions:

1. What factors, if any, in their family backgrounds influenced computing women to choose this field?

2. What were the common childhood play and leisure preferences, if any, of women who chose computing careers?
3. What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?
4. What college experiences, if any, influenced women in computing careers to choose and to continue in the field?
5. What factors, if any, in computing women's career situations influenced them to continue in their careers?
6. Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?

Survey Results

Participants

There were 50 usable, completed online surveys. Of the 72 responses recorded by the website, the 22 responses not used in this study were disregarded for the following reasons: (a) 3 were test surveys used by the software developer in charge of setting up and running the survey and by the researcher; (b) 7 were never finished by the women who started them; (c) 7 were begun by people other than computing women (like male bosses/colleagues who tried the survey to see what it was like before passing it along to computing women); (d) 5 of the women responding did not have the required bachelor's degree for this research study and their responses were disregarded. Throughout this section, most of the tables and graphs only include choices that participants actually marked; the survey choices not chosen by any participants are mentioned in the narrative. All survey choices can also be found in Appendix B, which lists all survey questions.

Because the survey was an online survey, and the respondents were invited to participate from several different locations, participants included computing women from at least 8 different states, including Ohio, California, Hawaii, Florida, Massachusetts, Colorado, Texas, and New York. There were also a variety of employers, including ones from the public sector (such as state universities and NASA), large companies (such as Electronic Data Systems, Prudential, and Autodesk), a video-games company, and a small educational games company on the West Coast. Work settings varied among home (using telecommuting), a university setting, a small office setting, as a consultant on a job site, a large office setting, or working in one location to remotely control data located elsewhere. This participation by computing women from a variety of locations, settings, and backgrounds strengthens the validity of the results.

Table 3.

Participants' Years of Computing Experience

Group for years of experience	Percent of participants (n=50)
5 - 9	22
10 - 14	10
15 - 19	24
20 - 24	20
25 - 29	20
30	4

The survey began with some questions about participants' job experience. Survey question 2 asked respondents to complete the statement, "I have been in the computing and/or information technology field for ________ years." The results showed a range of experience from 5 to 30 years, with a mean of 17.3 and a median of 18. Table 3 displays the participants' years of experience in groups. The data in the table were grouped at five-year intervals; there were survey participants in all of these groups. Consequently, the experiences mentioned by the surveyed women are from women with a variety of years of experience. Even though only 50 computing women participated in this survey, the participants came from a variety of job classifications, states, employers, and years of experience, which strengthens the validity and applicability of the study.

Question 3 asked respondents for their job titles. Since there was a large variety of answers to this question, the job titles have been grouped into types. These job types are displayed in Table 4. These job titles are listed to show the wide range of job types that computing women hold, as well as illustrating the range of jobs held by survey participants.

Table 4.

Participants' Job Titles

Job title	Percent (n=50)
Engineers	24
Computer (8%)	
Software (8%)	
Artificial intelligence (4%)	
Networking (2%)	
Type unspecified (2%)	
Systems workers (software)	18
Advanced system administrator (2%)	
Associate director of application systems (2%)	
Systems analyst (4%)	
Systems consultant (2%)	
Systems coordinator (2%)	
Systems officer (2%)	
Systems security analyst (2%)	
Systems specialist (2%)	
Architects	12
Solution architect (6%)	
Portfolio architect (4%)	
Technical architect (2%)	
Analysts (software)	10
Applied (4%)	
Information (4%)	

Job title	Percent (n=50)
Software support (2%)	
Programmers	8
Programmer only (6%)	
Programmer & analyst coordinator (2%)	
Managers	6
Practice manager (2%)	
Product manager (2%)	
Network project manager (2%)	
Consultants	4
For applications (2%)	
For information protection (2%)	
Director of technology	4
3D artist	2
CEO	2
Database administrator	2
Director	2
Lecturer in technology	2
Multimedia developer	2
Project lead	2

Early Years

The next group of questions referred to participants' childhood experiences at home and at school during their K-8 years. Question 4 asked, "Which type of play activities did you engage in most as a child in elementary school?" Respondents were to rank-order their answers. Their first-choice responses are displayed in Table 5, and a bar graph of the results is displayed in Figure 3. The participants chose "writing/reading" as their most frequent response, with 42% marking it as their first choice. The choices for this question which are not listed in the table because no one marked it as her first choice were "computer/technology games," "nature activities," and "playing with paper dolls."

Table 5.

First-Choice Responses to Question 4, "Which Type of Play Activities Did You Engage in Most as a Child in Elementary School?"

Type of activity	Percent (n=50)
Writing/reading	42
Group play activities	16
Informal neighborhood sports	12
Art & music activities	8
Building things	8
Playing with dolls/stuffed toys	6
Individual sports	4
Organized team sports	2
Taking apart things to see how they work	2

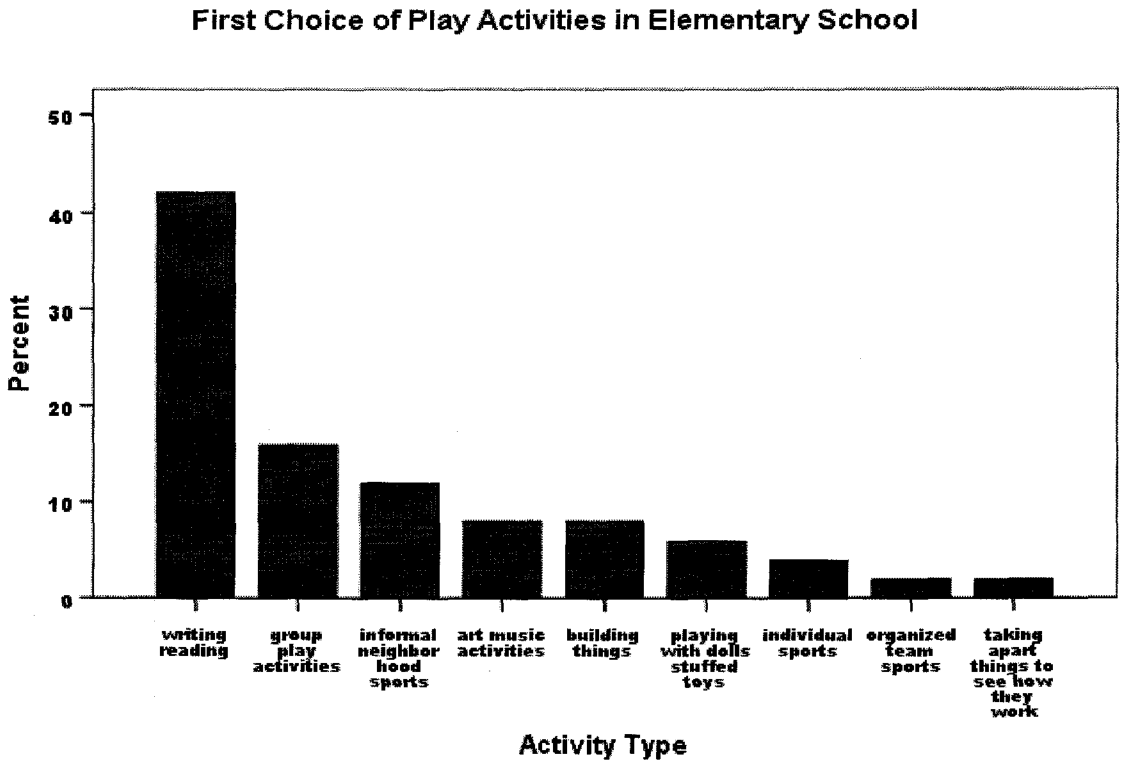

Figure 3. First-choice responses to question 4, "Which type of play activities did you engage in most as a child in elementary school?"

Survey question 5 asked, "Which type of playmates did you typically have as a preschool/elementary school child?" Since the responses for this question did not show anything notable for this study, the results can be found in Appendix D in Table D1.

Table 6.

First-Choice Responses to Question 6, "Which Type of TV Programs Did You Like to Watch Most as a Child?"

TV program	Percent (n=50)
Cartoons/animated	36
Sitcoms	18
I watched very little or no TV.	14
Variety/music	10
Dramas	6
Science fiction	6
Nature/science programs	4
Action programs	4
Programs about how things work	2

Question 6 inquired, "Which type of TV programs did you like to watch most as a child?" Respondents were again asked to rank their choices. The first-choice responses to this question are listed in Table 6 and displayed in Figure 4. A large percentage of respondents, 36%, favored "cartoons/animated" for their TV watching, but 14% watched little or no television as a child. The choice which is not listed in the table because it received no response from participants was "talk shows."

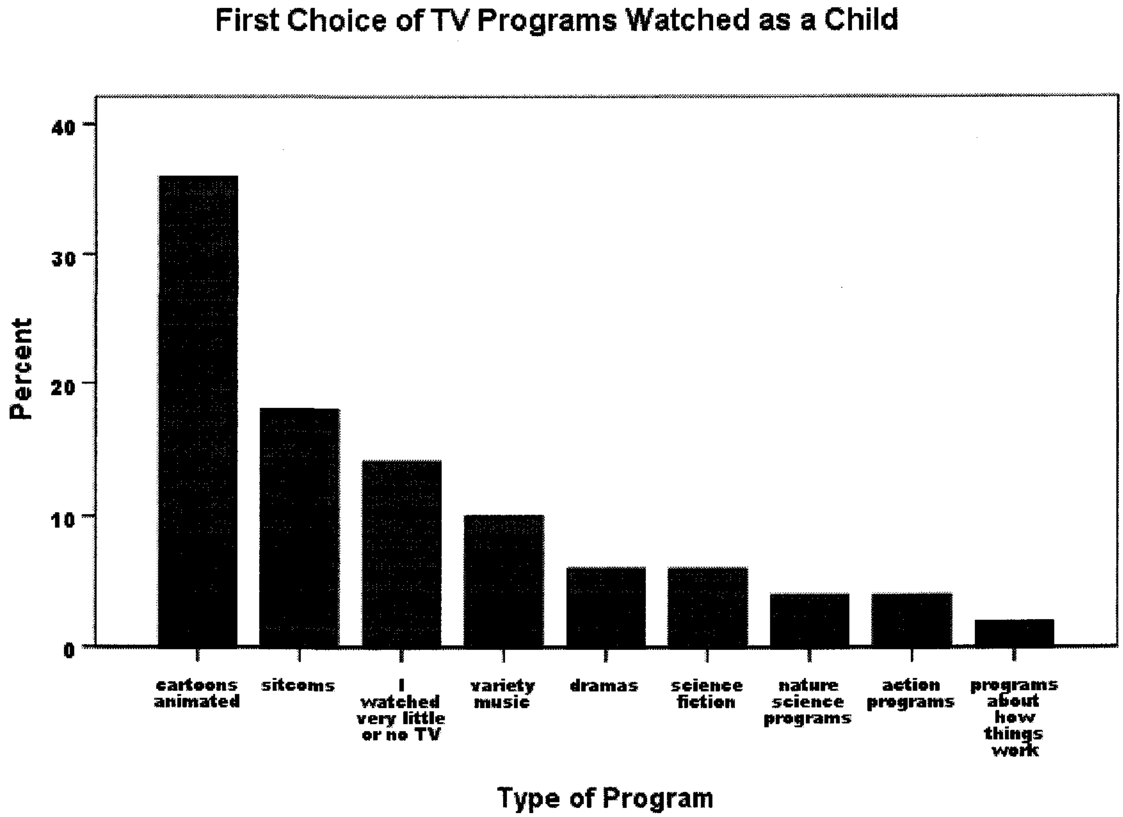

Figure 4. First-choice responses to question 6, "Which type of TV programs did you like to watch most as a child?"

Survey questions 7 and 8 asked participants for the type of school they attended and the gender makeup of their classes in grades K-5. Participants' responses showed that the overwhelming majority, 86%, attended a public school, and an even greater majority, 96%, attended a coeducational school. All of the results are displayed in Appendix D in Tables D2 and D3.

Table 7.

First-Choice Responses to Question 9, "What Was Your Favorite Subject in Elementary School (K-5)?"

Subject	Percent (n=50)
Math	38
Reading	20
Art	18
English	14
Science	6
Music	4

Question 9 of the online survey, "What was your favorite subject in elementary school (K-5)?" asked respondents to rank their choices. The first-choice responses to this question are shown in Table 7 and as a bar graph in Figure 5. The largest number of respondents, 38%, reported math as their favorite subject during these grades. No one chose "history (or social studies)," "computer courses," "other language(s)," or "physical education" as her first choice of favorite subject in grades K-5.

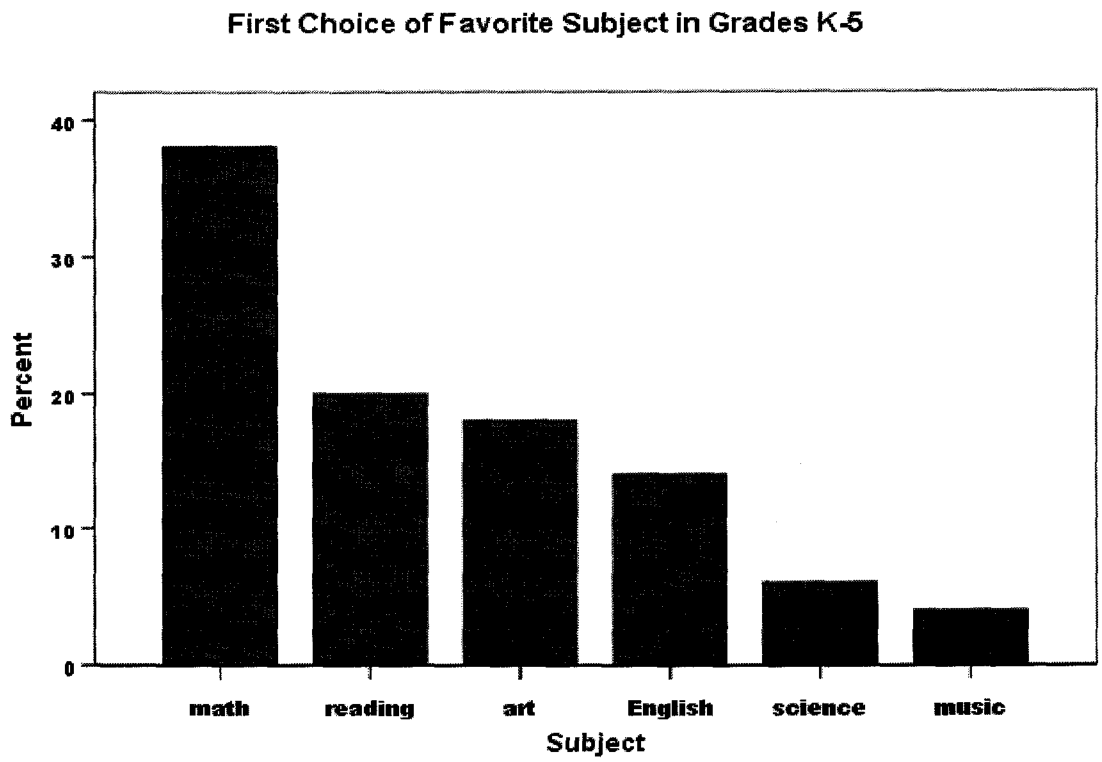

Figure 5. First-choice responses to question 9, "What was your favorite subject in elementary school (K-5)?"

Questions 10 and 11 asked respondents for the type of school they attended in grades 6 through 8 and for the gender composition of those schools. Results showed that again a majority of 84% attended a regular public school in these grades and that another majority of 94% attended a coeducational school. To see the rest of the percentages, refer to Appendix D, Tables D4 and D5.

Table 8.

First Choice of Favorite Subject in Grades 6-8

Subject	Percent (n=50)
Math	48
Art	16
English	14
Science	10
Reading	4
Computer courses	2
History (or social studies)	2
Other language(s)	2
Physical education	2

Question 12 asked, “What was your favorite subject in school in grades 6-8?” Participants again ranked their responses. Respondents’ first-choice responses are displayed in Table 8, and Figure 6 displays a bar graph for these data. Math was the first choice, with 48% of respondents choosing it. This compares to 38% of respondents choosing math as their favorite subject in grades K-5, as shown earlier in this section in Table 7. No respondents marked “music” as her first choice of favorite subject in grades 6 through 8.

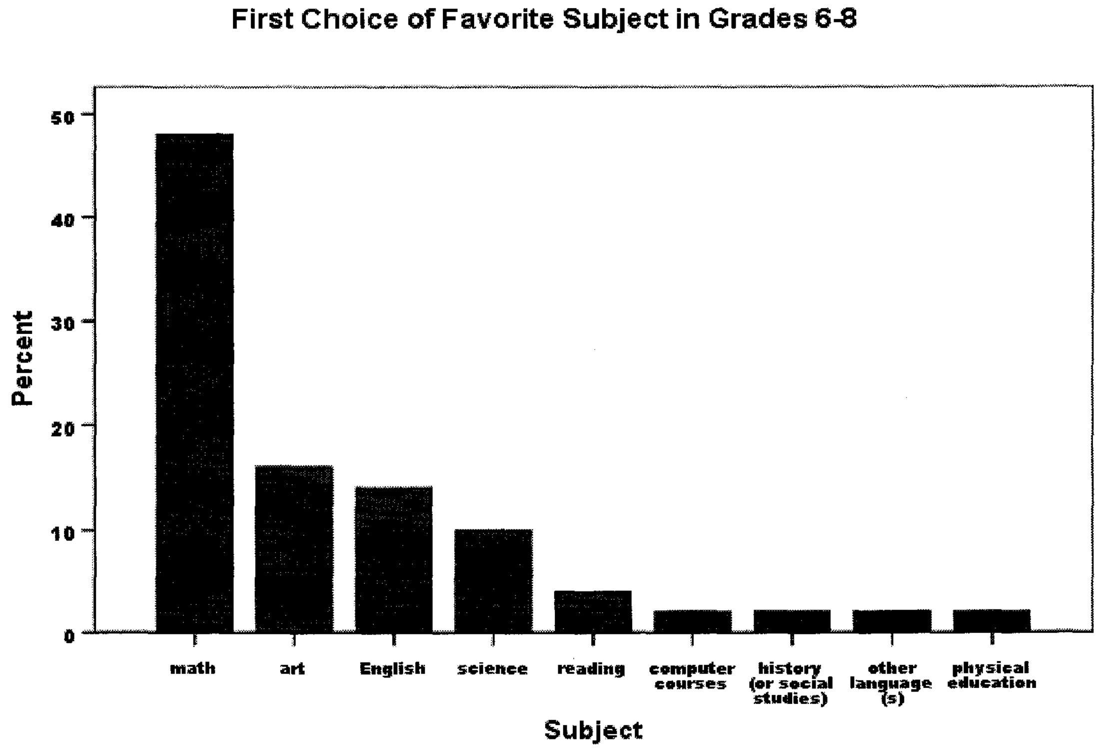

Figure 6. First-choice responses to question 12, "What was your favorite subject in school in grades 6-8?"

High School Years

The next questions inquired about participants' high school experiences. Questions 13 and 14 asked participants for the type of high school each attended and the gender composition of their high schools. Results were that 84%, once again a large majority, attended a regular (not magnet) public school, and that 96% attended a coeducational school. Tables D6 and D7 in Appendix D display all the percentages for these questions.

Table 9.

First-Choice Responses to Question 15, "What Was Your Favorite Subject in Grades 9-12?"

Subject	Percent (n=50)
Math	36
English	16
Science	12
Art	10
Other language(s)	8
Reading	6
Business	4
History (or social studies)	4
Computer courses	2
Music	2

Survey question 15 asked, "What was your favorite subject in grades 9-12?" Respondents' first-choice answers to this question are shown in Table 9 and Figure 7. Once again, math was the most frequent first choice, with 36% of survey participants choosing it as their most favorite high school subject. No participants chose "physical education" as their first choice of favorite subject in grades 9 through 12.

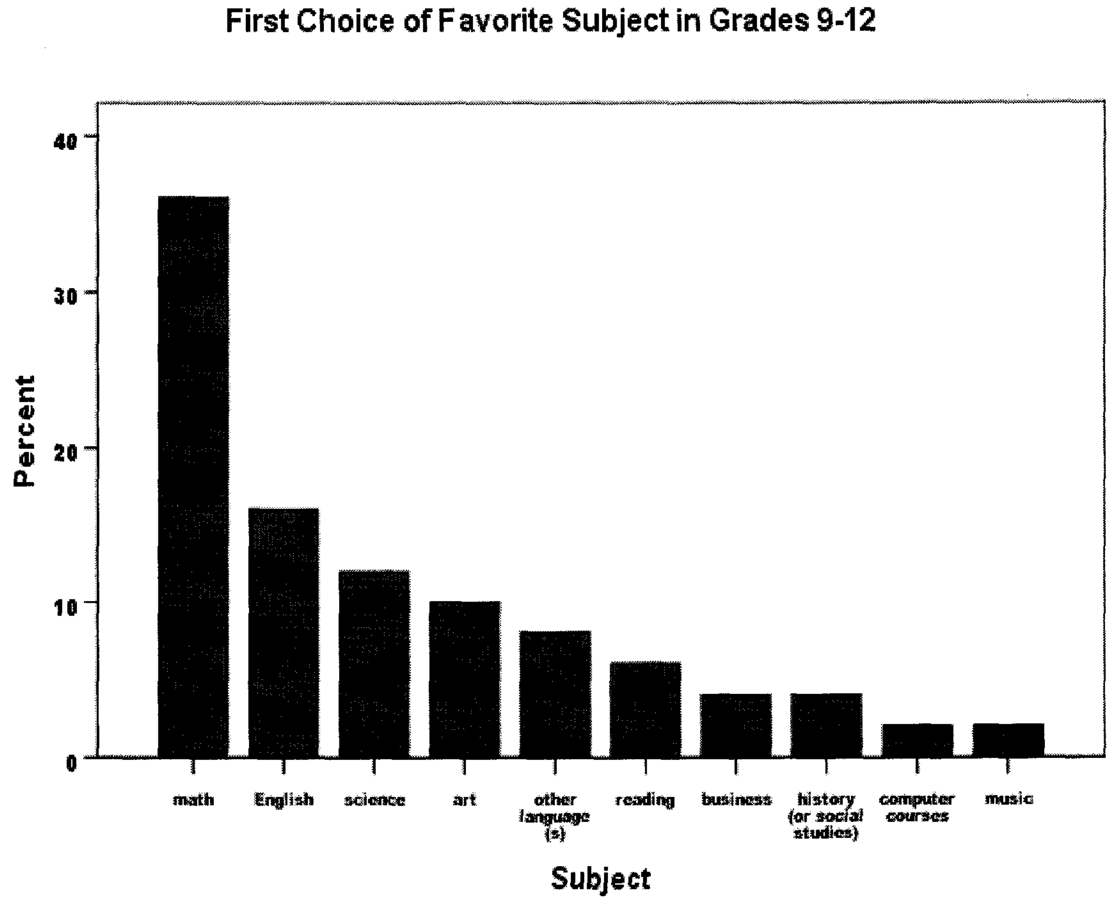

Figure 7. First-choice responses to question 15, "What was your favorite subject in grades 9-12?"

Table 10.

The Number of Years of High School Mathematics Courses Completed by Each Participant

Number of years	Percent (n=50)
2	2
3	12
3.5	2
4	72
More than 4	12

Survey question 16 asked respondents to tell the number of years of high school mathematics each person completed. Results are displayed in Table 10 and Figure 8. A large percentage of participants, 72%, completed 4 years, and 12% completed more than 4 years of high school mathematics. If those two groups are combined, 84% of survey participants completed 4 or more years of high school mathematics courses. No one marked that she had completed 1, 1 ½ , or 2 ½ years of high school mathematics courses.

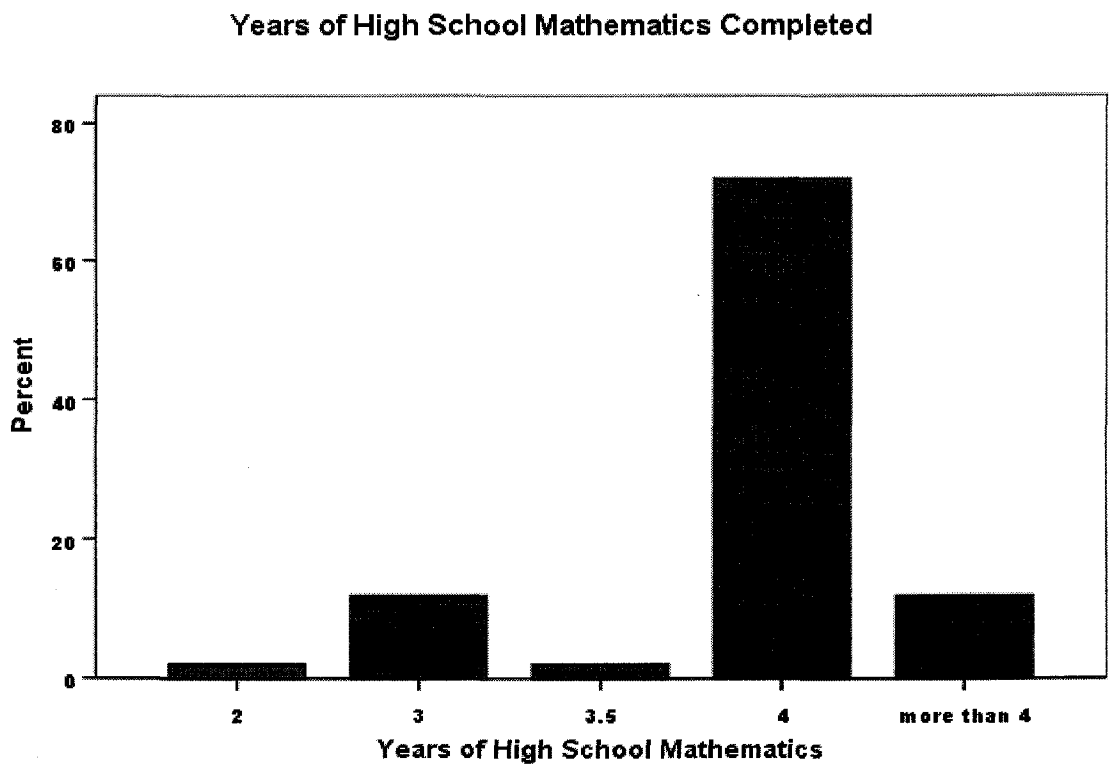

Figure 8. The number of years of mathematics courses completed by each participant in high school.

Table 11.

Responses to Question 17, "In Which Type(s) of Math Did You Do Well in High School?"

Type of math	Percent (n=50)
Every type of math	56
Not very good at math	16
Algebra only	12
Both algebra and geometry (but not every type)	8
Geometry only	2
Statistics/probability only	2
I don't remember.	4

Survey question 17 asked, "In which type(s) of math did you do well in high school?" Responses to this question are displayed in Table 11 and Figure 9. The highest percentage of participants (56%) noted that they were good at all types of mathematics in high school, but 16% said they were not very good in mathematics at all, and 4% did not remember how they did in their high school mathematics courses. A possible reason for the low percentage (2%) for "statistics/probability" may be that few high schools offer it as a separate course.

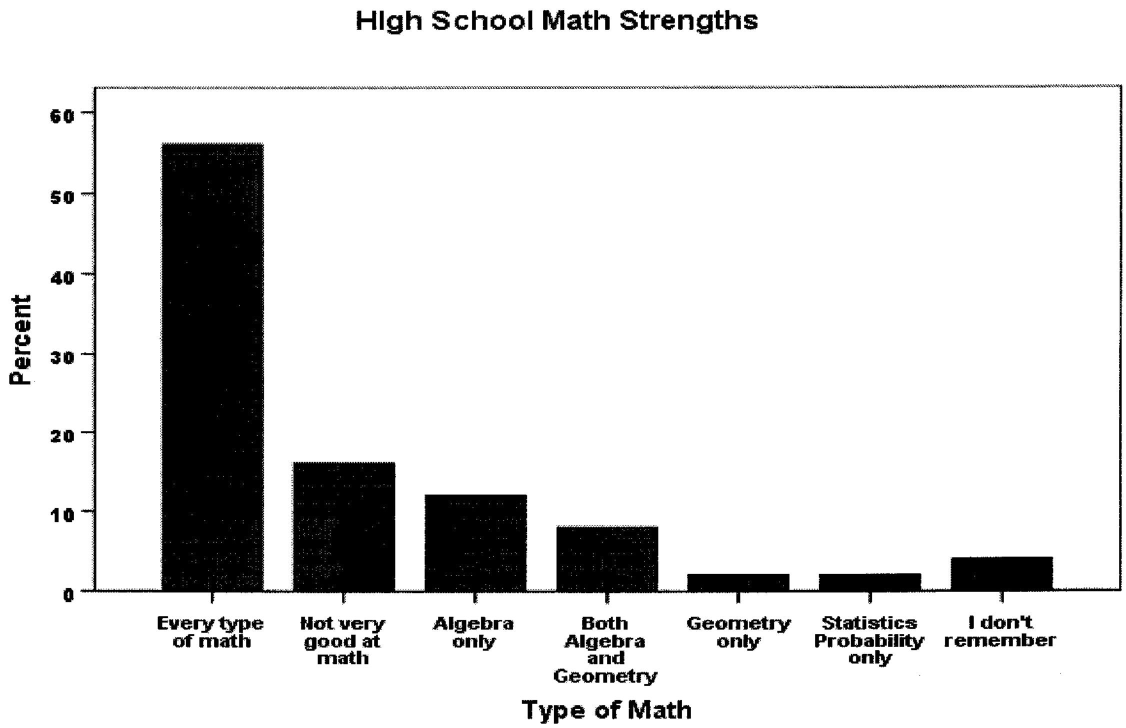

Figure 9. Responses to question 17, “In which type(s) of math did you do well in high school?”

First-choice responses to survey question 18, "What influenced you to take mathematics courses in high school?" are shown in Table 12 and Figure 10. The largest percentage of participants, 34%, chose "I like math" as their first choice, but there were 20% of respondents who chose "I took only what was required."

Table 12.

First-Choice Responses to Question 18, "What Influenced You to Take Mathematics Courses in High School?"

Type of influence	Percent (n=50)
I like math	34
I did well in math	20
I took only what was required	20
I was encouraged to take it	16
It was needed for my career	10

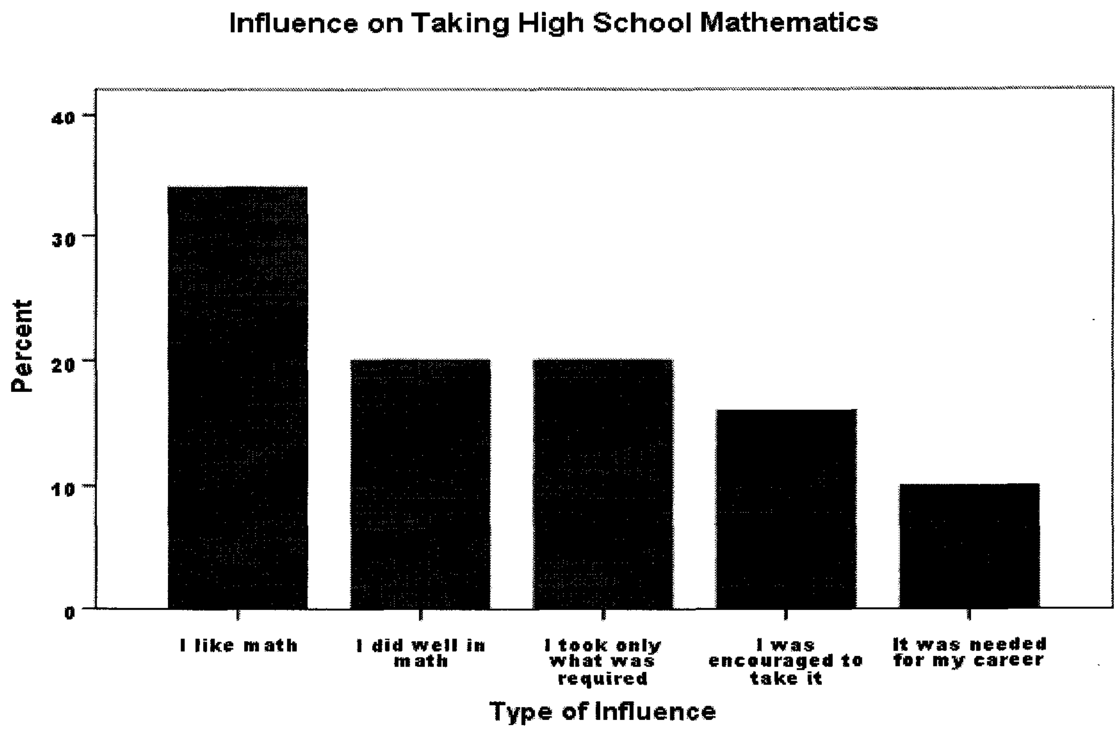

Figure 10. First-choice responses to question 18, "What influenced you to take mathematics courses in high school?"

Table 13.

The Number of Years of High School Science Courses Completed by Each Participant

Number of years	Percent (n=50)
2	12
3	18
4	52
More than 4	18

Question 19 asked participants to pick the number of years of science courses they each completed in high school. Their responses are shown in Table 13 and Figure 11. The majority of participants, 52%, completed 4 years of high school science. By adding that percent to the 18% who completed more than 4 years of high school science, there is a large majority of 70% who completed 4 or more years of high school science. No one marked that she had completed 1, 1 ½ , 2 ½, or 3 ½ years of high school science.

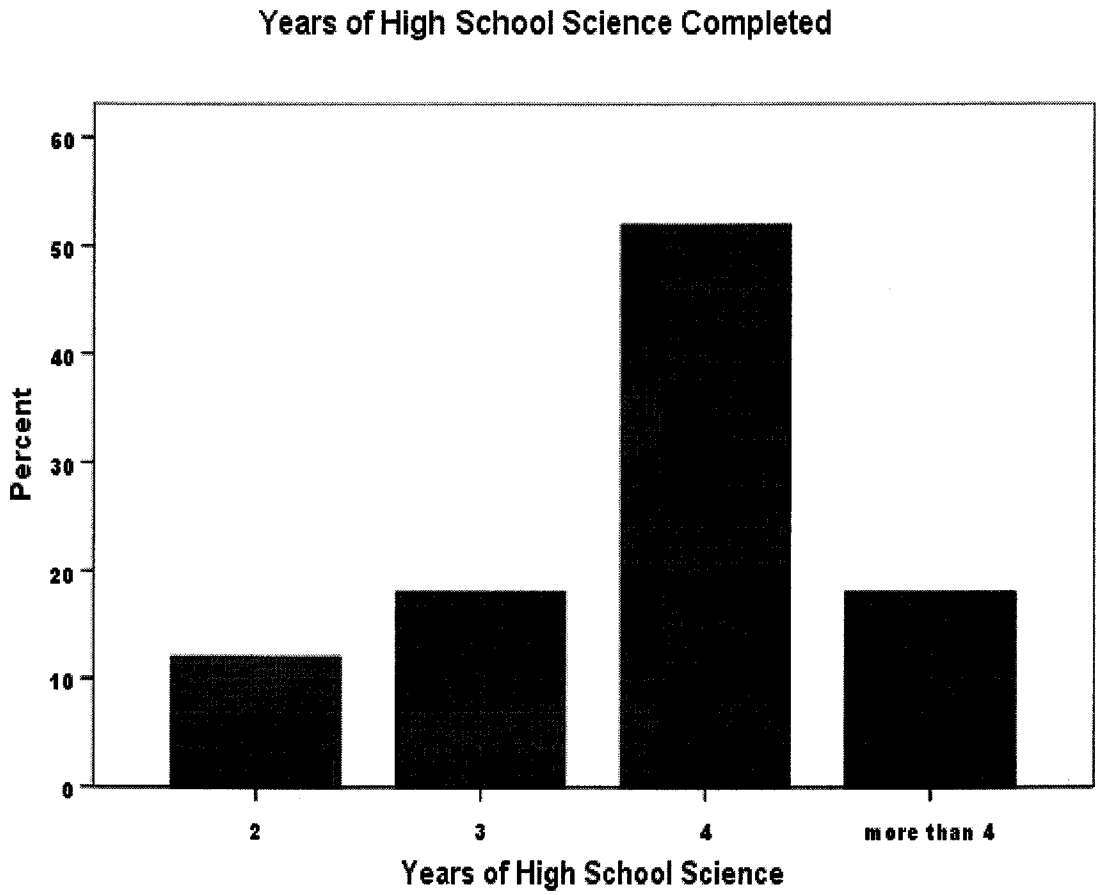

Figure 11. The number of years of high school science courses completed by each participant.

Survey question 20 asked, “In which type(s) of science did you do well in high school?” The participants could choose more than one answer from a list containing five areas of science as well as “every type of science,” “not very good at science,” and “I don’t remember.” Results are displayed in two different ways. Table 14 lists all the possible combinations of answers a participant could have chosen along with the percentages of participants who answered each way. Table 14 does not show a majority percentage for any science subject alone nor for any group of science subjects, and only 12% of respondents marked that they were good in all types of science. Table 15 displays the percentage of participants who marked each science subject as her strength. This table shows that the largest percentage of participants, 62%, reported biology as a strength. But there were also large percentages for chemistry (40%), physics (36%), and geology/environmental science (32%). Because participants can choose more than one response, percentages did not sum to 100% in Table 15. In this table, a possible reason for the low percentage (10%) for “space science” may be that few high schools offer it.

Table 14.

Answers to Question 20, "In Which Type(s) of Science Did You Do Well in High School?"

Type of science	Percent (n=50)
Physics only	4
Chemistry only	2
Space science only	0
Biology only	4
Geology/environmental science only	2
Biology and geology/environmental	8
Physics and biology	8
Chemistry and biology	10
Chemistry and geology/environmental	2
Physics and chemistry	2
Chemistry, biology, and geology/environmental	4
Physics, chemistry, and biology	12
Space science, biology, and geology/environmental	6
Physics, chemistry, biology, and geology/environmental	6
Physics, space science, biology, and geology/environmental	2
Every type of science	12
Not good at science	6
Don't remember	10
Total	100

Table 15.

Types of Individual Science Subjects Reported as Strengths by Participants

Type of science	Percent (n=50)
Biology	62
Chemistry	40
Physics	36
Geology/environmental science	32
Space science	10

In question 21, the participants were asked to report what influenced them to take science courses in high school and rank their answers. Participants' first-choice answers are reported in Table 16 and Figure 12. The largest percentage of participants, 34%, reported that they took only what was required, followed closely by the 30% who reported that their liking science contributed to their taking science courses.

Table 16.

First-Choice Responses to Question 21, "What Influenced You to Take Science Courses in High School?"

Type of influence	Percent (n=50)
I took only what was required	34
I like science	30
I did well in science	18
I was encouraged to take it	12
It was needed for my career	6

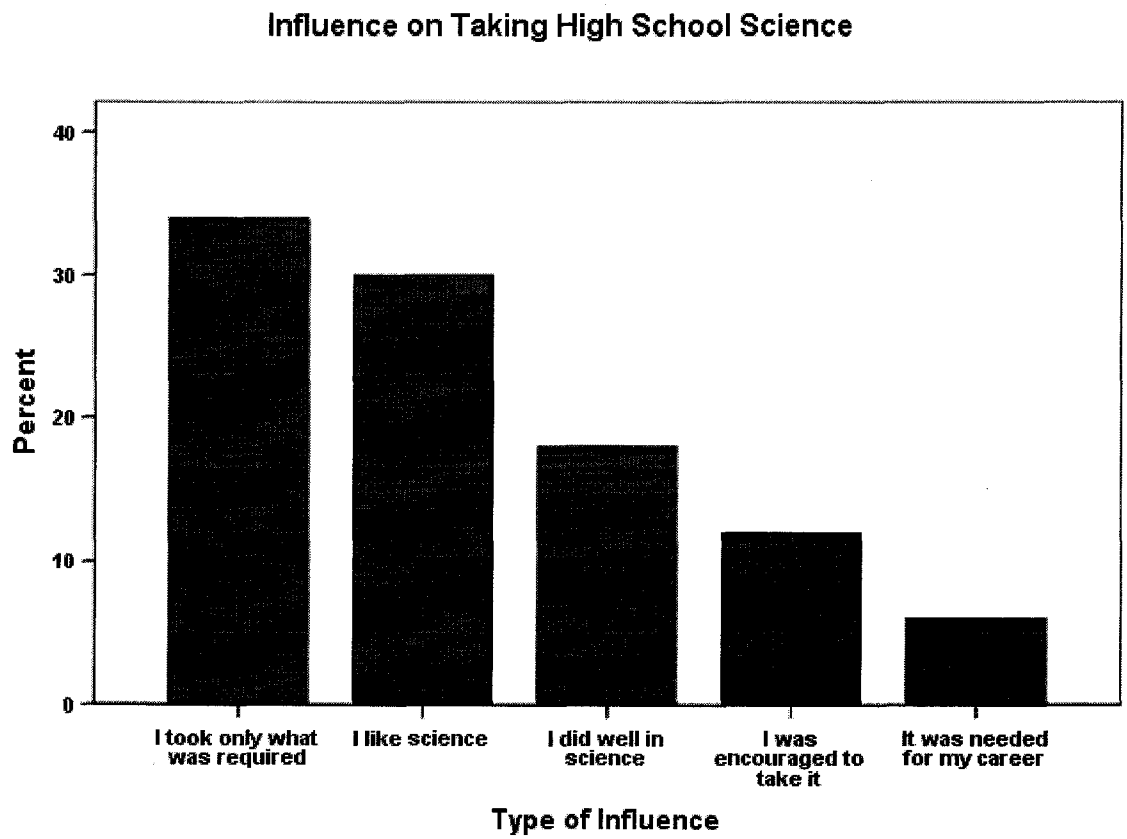

Figure 12. First-choice responses to question 21, "What influenced you to take science courses in high school?"

Question 22 asked the participant for her high school GPA. Overall these computing women did very well in high school, with their GPAs having a mean of 3.57 and a median of 3.75. Table 17 shows a summary of the participants' GPAs by groups. This table shows that 88% of participants had a high school GPA of 3.01 or higher (calculated by adding the 28%, 58%, and 2% for the groups included); 60% of respondents had a GPA of 3.51 or higher (calculated by adding 58% and 2%).

Table 17.

Percentages of High School GPAs in Groups

Grouped GPAs	Percent (n=50)
1.51 - 2.00	2
2.01 - 2.50	2
2.51 - 3.00	8
3.01 - 3.50	28
3.51 - 4.00	58
4.01 - 4.50	2

Table 18.

Types of Software Experienced by Participants by the End of High School

Type of software	Percent who experienced it (n=50)
No experience with any computer software in K-12	50
Word processing	32
Programming language(s)	22
Games	22
Spreadsheets	18
E-mail	8
None of these	8
Internet use	6
Presentation software	4
Databases	2
Authoring/publishing software	2

Survey question 23 asked, "By the end of high school, with which type(s) of software programs did you have substantial experience? Please check all that apply." For this question, participants were asked to consider all their computer experience in grades K-12. Their responses are displayed in Table 18 and graphed in Figure 13. The most frequent response was "no experience with any computer software in K-12," with 50% of participants marking this. The most common experience with any type of computer software was with word processing programs, with 32% of participants noting that experience. Answer categories which were not marked at all by participants were "data acquisition software," "web design," and "I don't remember." The percentages in the table add to more than 100% because participants could check more than one type of software.

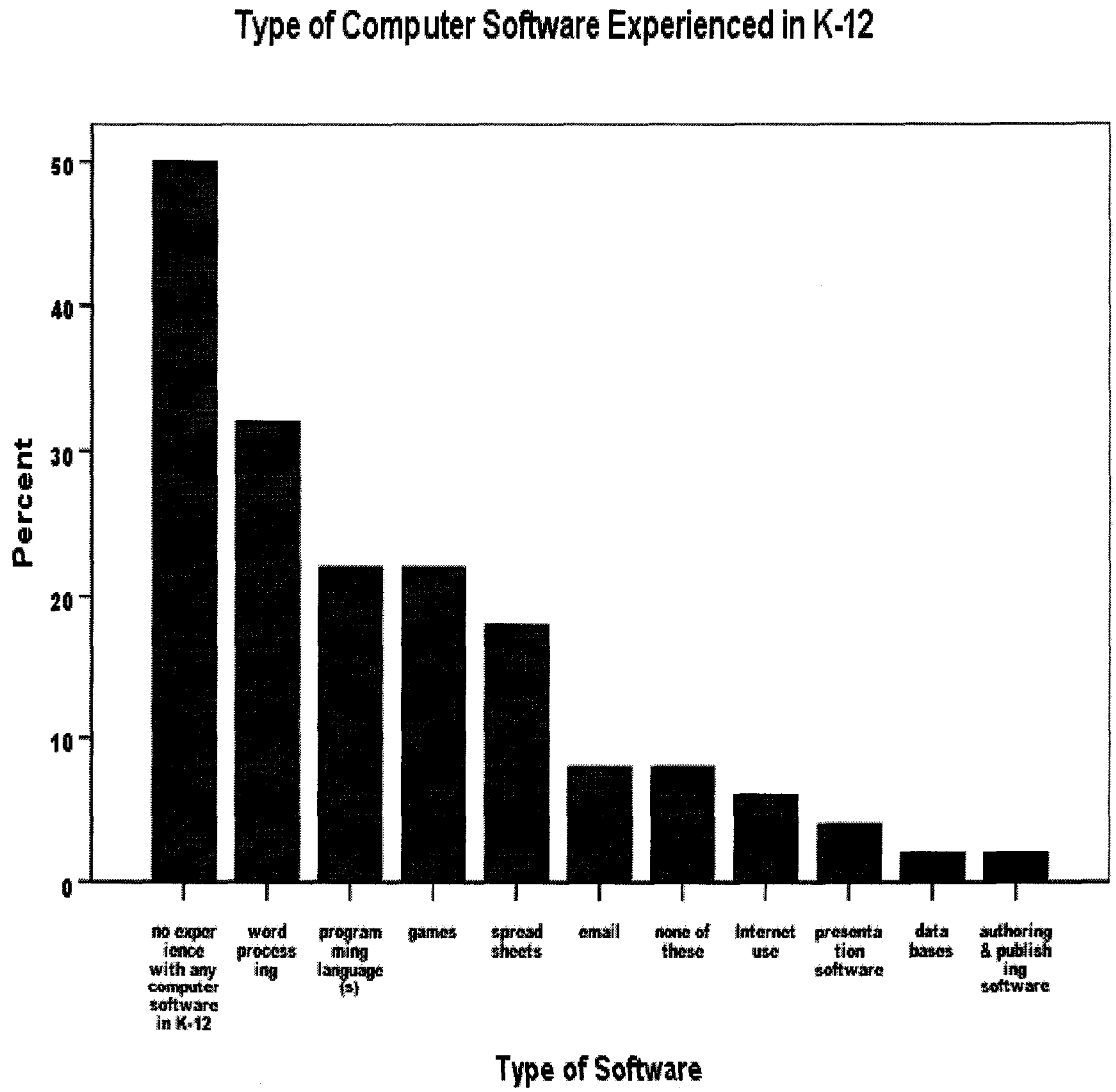

Figure 13. Types of software experienced by participants by the end of high school.

Higher Education

The next group of questions dealt with participants' experiences in undergraduate college and graduate school, if they attended graduate school. In survey question 24, the participant was to report what type of undergraduate college/university she attended by answering: (a) Was it public, private, or a technical/community college? (b) Was it large, small, women's, or religious? Respondents could also name more than one type of college, if she attended more than one. Apparently this question was confusing for many participants because a large percentage of respondents, 30%, left it blank. Because of such a large percentage of nonresponse and apparent confusion, the researcher considers the results inconclusive. However, the largest percentage of those who did answer it, 28%, attended a large public college or university for their undergraduate studies. All the results are shown in Appendix E in Table E1.

Survey question 25 asked participants for their undergraduate college major. Table E2 in Appendix E lists all of these college majors. For discussion here, the college majors have been grouped into categories and listed in Table 19. The category "other majors" is used for majors like art, education, political science, or pre-law which did not fit into the other categories. Some participants earned double majors, which is the reason for majors like "computer science and math" or "mathematics and technology." Even though the majors cluster around computer science and mathematics, participants' education included a variety of college majors.

Table 19.

Undergraduate College Major Grouped by Type

Type of major	Number of participants in this major (n=50)
Computer science (programming)	13
Computer science only (6)	
Computer science & math (4)	
Computer science & other (3)	
Mathematics	8
Mathematics only (5)	
Mathematics & science (1)	
Mathematics & technology (1)	
Mathematics & other (1)	
Management information systems (software)	4
Business	4
Engineering	4
Science	4
Science only (3)	
Science & other (1)	
Education	3
Other technology	1
Other majors	8
Answer missing	1

Question 26 asked, "For the majority of your computing courses, in which college were the courses located? A large percentage, 46%, completed their computing courses in the College of Arts and Sciences, 16% completed them in the College of Engineering, and 14% in the College of Business; 8% did not have any college computing courses. Complete results are shown in Table E3 in Appendix E.

Question 27 asked each survey participant for her undergraduate college GPA. These computing women as a group achieved high grades in college; they had GPAs with a mean of 3.38 and a median of 3.4. Table 20 shows a summary of the participants' GPAs by groups. This table shows that 78% of the women surveyed (adding the 38% in the "3.01 - 3.50" group and 40% in the "3.51 - 4.00") had an undergraduate GPA higher than a 3.00.

Table 20.

Percentages of Undergraduate College GPAs by Groups

Grouped GPAs	Percent (n=50)
2.01- 2.50	4
2.51 - 3.00	18
3.01 - 3.50	38
3.51 - 4.00	40

Survey question 28 asked respondents if they had a master's degree or not. Of the 50 survey participants, 62% did not have a master's degree, 34% had a master's degree, and 4% did not answer the question. Question 29 then asked those with a master's degree to list the field in which the degree was located. Table E4 in Appendix E lists all of these master's degree fields.

Table 21.

Participants' Highest Level of Education Attained

Education level	Percent (n=50)
At least a bachelor's degree	100
At least some graduate work	50
At least a master's degree	34
At least some work beyond master's degree	12
Doctorate	4

Question 30 asked each participants for the highest level of education she attained. Table 21 and Figure 14 display these data. Because this study only surveyed computing women with at least a bachelor's degree, 100% of participants earned at least that degree. But 50% of survey participants completed at least some graduate work and 4% earned a doctorate.

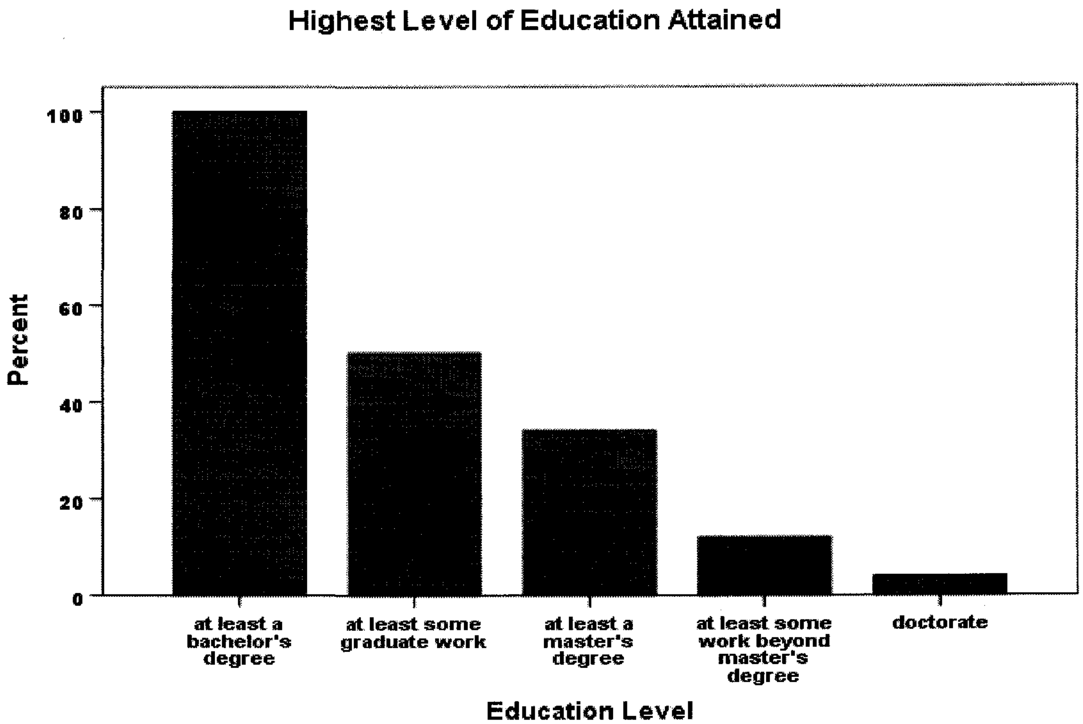

Figure 14. Participants' highest level of education attained.

Question 31 asked, “When did you pursue the majority of your studies in the computing/information technology field?” The participants’ answers to this question are displayed in Table 22 and Figure 15. Of the women who completed the survey, the largest percentage of participants (48%) studied computing in the 1990s. No one marked that she had completed her computing studies in the 1960s.

Table 22.

Decade When Majority of Computing Studies Were Undertaken by Participants

Decade	Percent of participants (n=50)
1990s	48
1980s	32
1970s	18
Answer missing	2

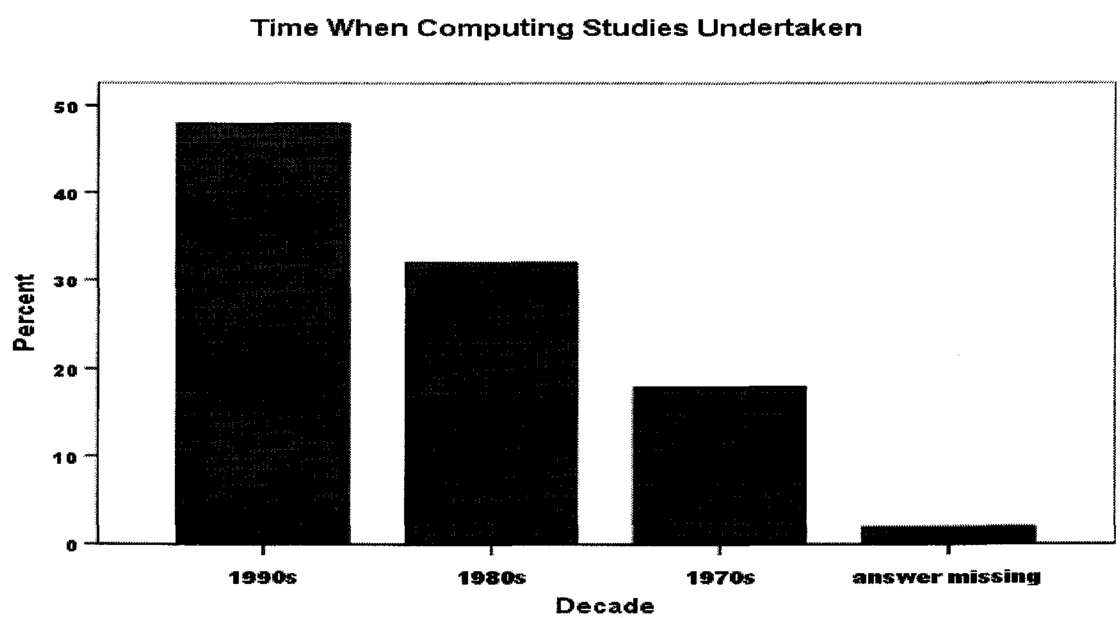

Figure 15. Decade when majority of computing studies were undertaken by participants.

Question 32 asked survey respondents to pick one or more from a list of choices to answer the question, "Which best describes your experience while studying in your computing/IT courses?" Results are not listed here because the majority of respondents, 62%, did not report *any* of the encouraging or opposition experiences listed, and only 10% reported continuing despite any type of opposition. Table E5 in Appendix E displays all responses to this question.

Family Background

The next group of questions asked survey participants about their family backgrounds. Question 33 asked respondents to fill in the blanks in the following statement: "I am ___ of ___ children." Responses used to fill in the first blank, the participant's position in the family, are shown in Table 23. The table shows the percentage of participants occupying each birth order position. A large percentage, 72% (adding 52% for position 1 and 20% for position 2), were either the first or second child in their families. The mean of the participants' birth positions is 2.0 and the median is 1.0. Participants' answers ranged from 1 to 6. Perhaps the large percentage of women in this study who were the first or second child in their families was because of the prevalence of families containing one or two children. The next paragraph discusses childhood family sizes for the women in this study; the issue will be revisited after those results are presented.

Table 23.

Percentages for Each Participant's Position in Her Family

Position	Percent (n=50)
1	52
2	20
3	10
4	6
5	8
6	2
Answer missing	2

A similar analysis was done for the answers used to fill in the second blank in question 33, "I am ___ of ___ children." The numbers filling in this second blank represented the number of children in the participants' childhood families. These numbers have a mean of 3.3 and median of 3; they ranged from 1 to 8. Table 24 shows the percentage of respondents who were in each of the categories for total number of children in their childhood families. A large percentage of participants grew up in families of two or three children, showing percentages of 24% and 30% respectively. Thirty-four percent of the computing women in this study came from families of one or two children, with 10% of the women being the only child in their families, and 24% from families of two children.

Table 24.

Percentage of Participants in Each Size Childhood Family

Number of children	Percent (n=50)
1	10
2	24
3	30
4	16
5	6
6	8
7	2
8	2
Answer missing	2

Combining the data from the computing women's birth position with the number of children in their childhood families reveals additional information about the computing women in this study. Of the survey participants who were first or second in birth order in their families, 10% were only children and 24% came from two-child families. That leaves 26% of the participants who were the firstborn out of families of three, four, or five children, and 12% of the women of this study who were the second child out of families of three, four, or five children. Combining these last two percentages means that 38% of the women in this study were the first or second child in a family of three or more children. This report previously stated that 72% of the computing women in this study were the first or second child in their childhood families. But 34% of those women were from families of one or two children. That means that 38% of the women in this study were first or second children in families of three or more children; this is no longer a majority of the participants in this study.

"Which best describes your sibling group?" was asked by survey question 34. The results are shown in Table 25 and Figure 16. The largest percentage (30%) was for sibling groups that were "approximately half girls and half boys." The order of the groups in the table is from largest to smallest number of girls in the group, then "only child."

Table 25.

Participants' Sibling Groups

Sibling group	Percent (n=50)
All girls	22
Mostly girls, one boy	22
Approximately half girls and half boys	30
Only girl among boys	14
Only child	10
Answer missing	2

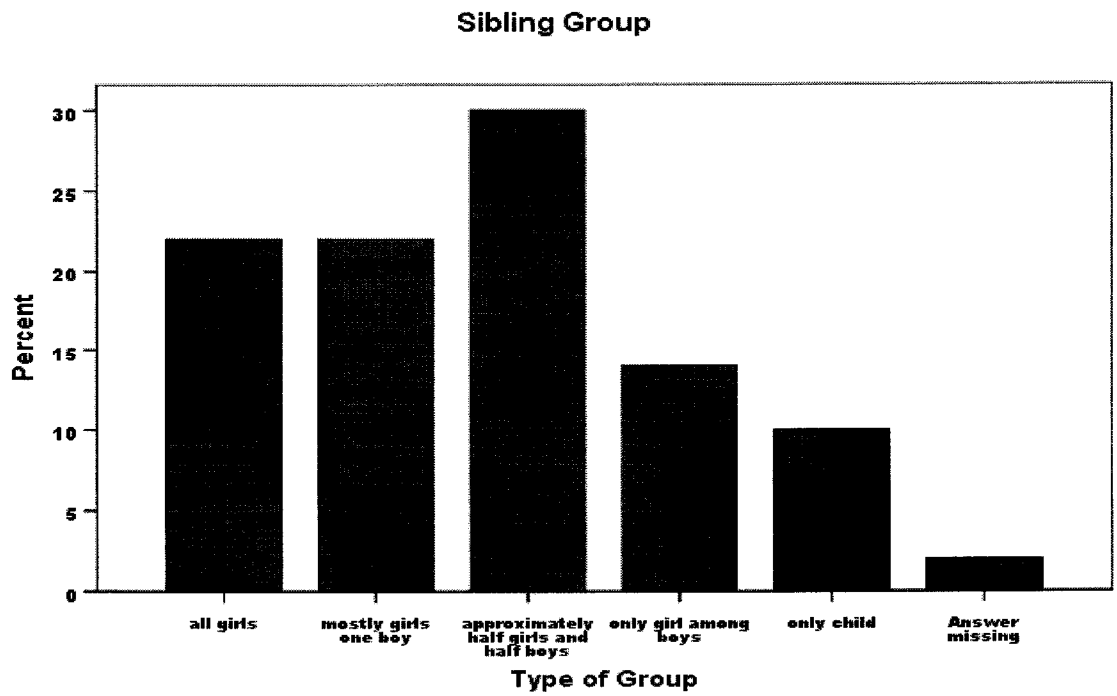

Figure 16. Makeup of participants' sibling groups.

Question 35 asked, "For the majority of your childhood, what was your family makeup?" A large percentage of survey participants, 80%, grew up in a family with a father, a mother, and one or more siblings. A table containing percentages for all categories is in Appendix F.

Question 36 asked, "With which person(s) in your family did (do) you feel closest?" Respondents were instructed to rank their answers if they felt close to more than one person. Participants' first-choice responses are displayed in Table 26. The largest percentage of participants, 40%, were (are) closest to their mothers. After that, participants felt closest to father, sister, and brother, each in equal percentages of 16%. Choices which were not chosen by anyone as her first choice were grandfather, stepmother, and stepbrother.

Table 26.

Family Member to Whom Participant Felt Closest

Family member	Percent (n=50)
Mother	40
Father	16
Sister	16
Brother	16
Grandmother	4
Stepfather	2
Stepsister	2
No one	2
Answer missing	2

Question 37 asked respondents for the highest level of education that their mothers attained. Results are displayed in Table 27 and Figure 17. Ninety percent of participants' mothers had at least a high school diploma; 60% of the mothers had some college, with 40% earning at least a bachelor's degree, 18% with at least a master's degree, and 6% of the mothers earning a doctorate.

Table 27.

Mother's Level of Education

Level of education	Percent (n=50)
No high school diploma	6
At least a high school diploma	90
Some college	60
At least an associate degree	44
At least a bachelor's degree	40
At least some graduate courses	20
At least a master's degree	18
Doctorate	6
No mother figure in my life	2
Answer missing	2

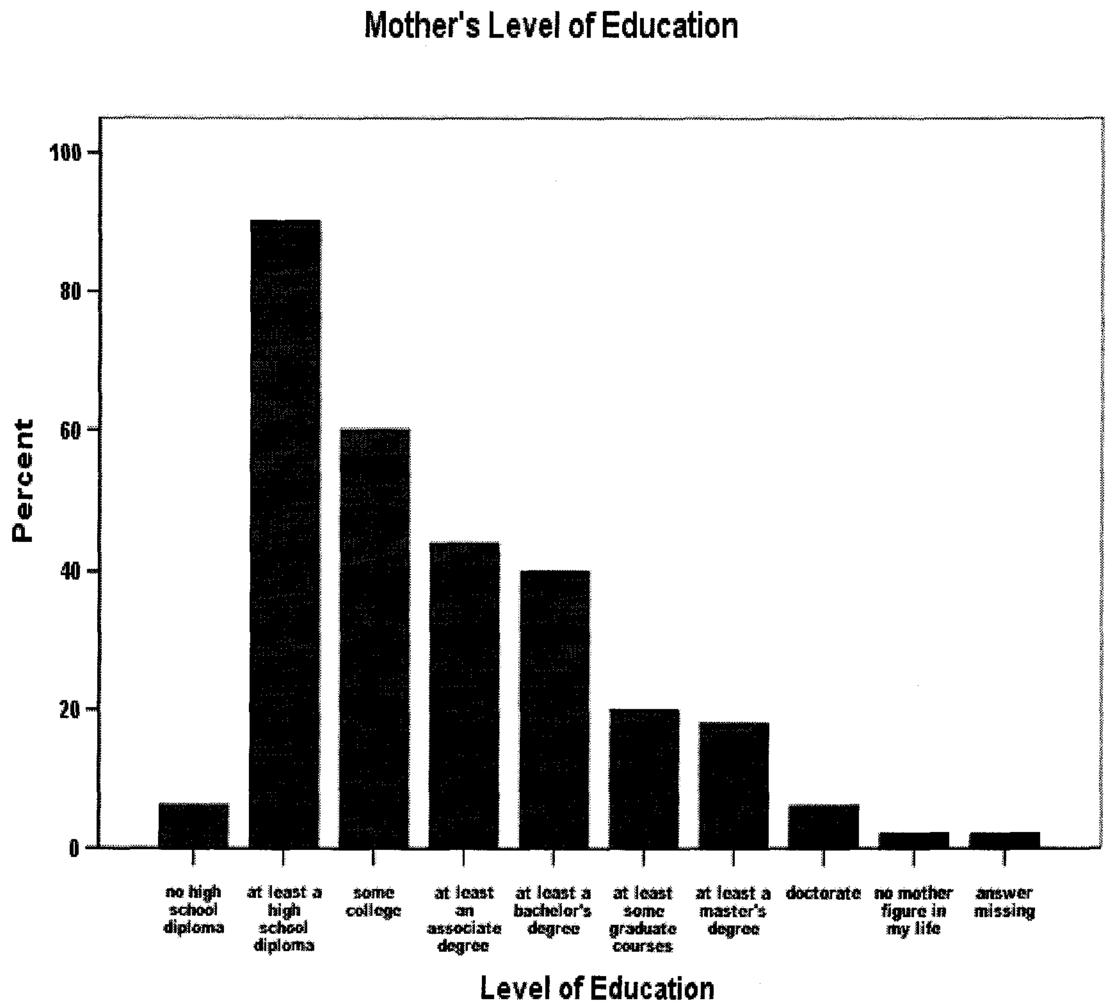

Figure 17. Level of education attained by participants' mothers.

Question 38 asked each participant for the highest level of education that their fathers attained. Table 28 and Figure 18 display the results of this question. Eighty-four percent of participants' fathers attained at least a high school diploma. Sixty percent of the fathers had at least some college, with 40 percent earning at least a bachelor's degree, 28 percent with at least a master's degree, and 14 percent earning a doctorate.

Table 28.

Father's Level of Education

Level of education	Percent (n=50)
No high school diploma	10
At least a high school diploma	84
Some college	60
At least an associate degree	48
At least a bachelor's degree	40
At least some graduate courses	32
At least a master's degree	28
Doctorate	14
No father figure in my life	4
Answer missing	2

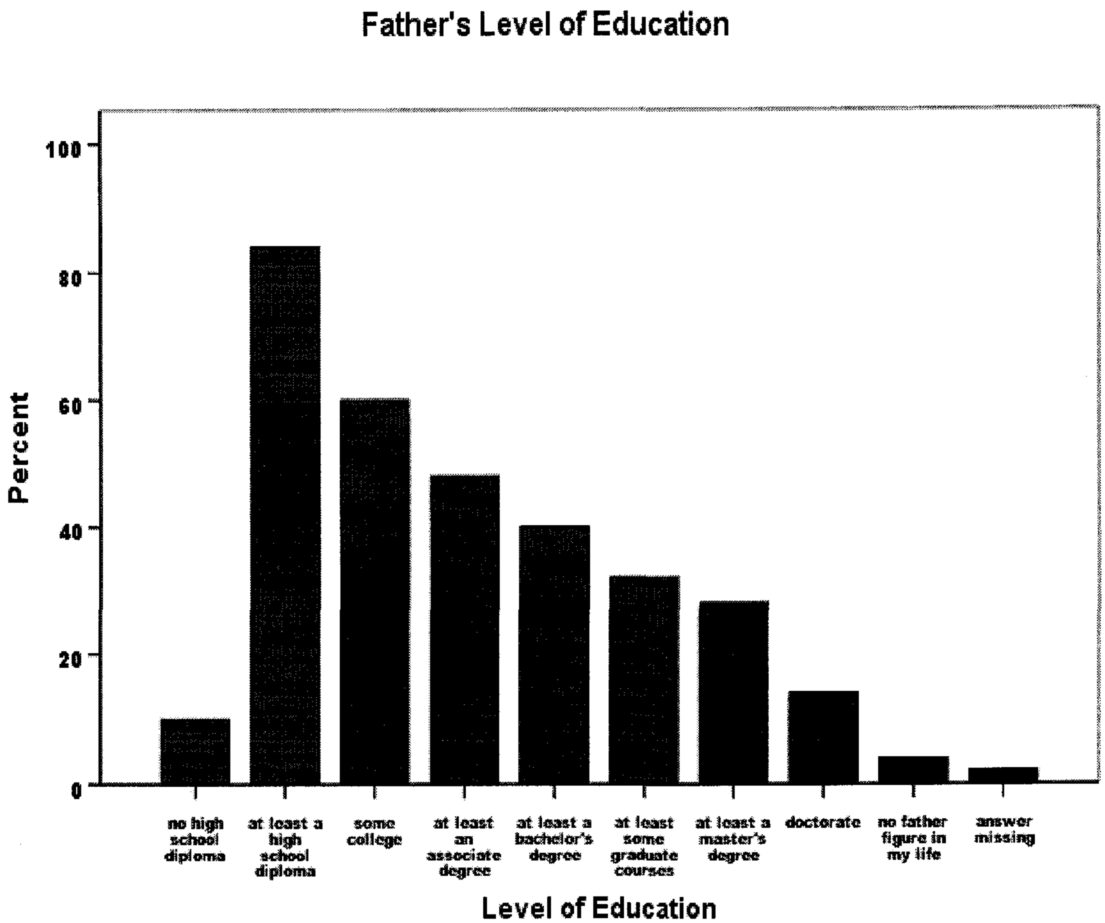

Figure 18. Level of education attained by participants' fathers.

Question 39 asked, "What type of job/career did your mother have during your growing-up years?" Responses are grouped into categories with results shown in Table 29. The largest percentage of mothers, 32%, were full-time homemakers. Sixteen percent of participants' mothers combined homemaking with at least part-time work. The most common other jobs were teacher (10%), office work (8%), and nurse (6%).

Table 29.

Participant's Mother's Job During Participant's Growing-Up Years

Job	Percent (n=50)
Homemaker only	32
Homemaker and at least part-time work	16
Office (4%)	
Retail (4%)	
Student (2%)	
Teacher (4%)	
Other work (2%)	
Teacher	10
Office	8
Manager & secretarial (4%)	
Bookkeeper (4%)	
Nurse	6
Postal worker	4
Retail	4
School, not teacher	4
Banking	2
Beautician	2
Librarian	2
Newspaper production	2
Sewing field	2
Social worker	2
Telephones, technical	2
Answer missing	2

The next two questions, 40 and 41, were only answered by respondents whose mothers worked outside the home. Question 40 asked participants if their mothers worked part time, full time, or some combination over time. Results are displayed in Table 30. For participants' mothers, 32 percent did not work outside the home and 66 percent worked outside the home at least part-time. Categories for differing amounts of time worked outside the home by participants' mothers are shown in the table.

Table 30.

Mother's Amount of Working Outside the Home During Participant's Growing-Up Years

Mother's amount of working	Percent (n=50)
Did not work outside home	32
Worked outside home at least part-time	66
Always part-time (10%)	
Some part-time, some full-time (8%)	
At first part-time, then full-time (14%)	
Always full-time (34%)	
Answer missing	2

Next the survey asked only those respondents whose mothers worked outside the home for their ages when their mothers started to work. Table 31 displays percentages for participants in each age category, as well as a cumulative percentage for participants at that age or younger when their mothers began to work. The largest percentage for any age category in this table is for age 1, with work outside the home beginning for mothers of 42% of participants with working mothers. In the cumulative percentage column, by age 1, a majority of these participants' mothers (54%) were working outside the home. By age 6, 93% of participants whose mothers worked outside the home had started to work. For the ages in the table, the median is 1 and the mean is 2.8. The final cumulative percent is only 99 because of rounding.

Table 31.

Age When Mother Started to Work, Only for Participants With Mothers Who Worked Outside the Home

Age when mother started working outside the home	Percent in that age category (n=33)	Cumulative percent up to that age category (n=33)
0	12	12
1	42	54
2	3	57
3	3	60
5	24	84
6	9	93
8	3	96
9	3	99

Question 42 asked, "What type of job/career did your father have during your growing-up years?" Responses are grouped into categories with results shown in Table 32. The highest percentage was 32% for blue-collar fields, followed by 28% in professional fields. Ten percent were self-employed or owned a business, and 8% were in sales. This table shows a diversity of careers held by fathers of computing women.

Table 32.

Participant's Father's Job During Participant's Growing-Up Years

Job	Percent (n=50)
Blue-collar fields	32
Construction field (4%)	
Manufacturing (18%)	
Supervisor (6%)	
Worker (12%)	
Repairman (6%)	
Skilled tradesman (4%)	
Professional fields	28
Accountant (4%)	
Doctor/dentist (2%)	
Engineer (8%)	
Professor/teacher (8%)	
Psychologist (4%)	
Science professional (2%)	
Self-employed or owns business	10
Sales	8

Job	Percent (n=50)
Salesman (4%)	
Salesman and manager (4%)	
Government	4
Military	4
CEO	2
Clerk or office worker	2
Deliveryman	2
Graduate student	2
Technology	2
No father figure	2
Answer missing	2

Table 33.

Race of Participants

Race	Percent (n=50)
White or Caucasian	88
Asian or Pacific Islander	6
Black or African American	4
Answer missing	2
American Indian or Alaska Native	0
Hispanic	0
Not Hispanic	94
Answer missing for Hispanic category	6

Question 43 asked for the participant's race and whether she is Hispanic or not. The race categories and the inclusion of Hispanic ethnicity are based on census questions used by the U.S. Census Bureau. The researcher chose to include Hispanic ethnicity in this survey because U.S. Census Bureau reports include statistics about people of Hispanic origin as a separate category. Results are shown in Table 33. The majority of participants, 88%, were of white or Caucasian race. There were only 3 participants of Asian or Pacific Islander race (6%), and only 2 of black or African American race (4%). There was no participant of American Indian or Alaska Native race. The table shows that 94% of the participants marked that they are not Hispanic, but 3 participants (6%) did not mark either "Hispanic" or "not Hispanic" categories.

Table 34.

Number of Children Raised by Each Participant

Number of children	Percent of participants (n=50)
0	42
1	20
2	20
3	8
4	6
27	2
Answer missing	2

Question 44 asked, "What is the total number of children that you are raising or that you raised?" Table 34 and Figure 19 display the percentage of participants raising each number of children listed. The woman who marked "27" raised her biological children and is now raising foster children; that is the reason for such a large number. The largest percentage (42%) was marked by participants having no children. A majority of

62% of participants have 0 or 1 child (calculated by adding 42% for "0" and 20% for "1"). The number of children raised by participants in this study have a mean of 1.65 and a median of 1.

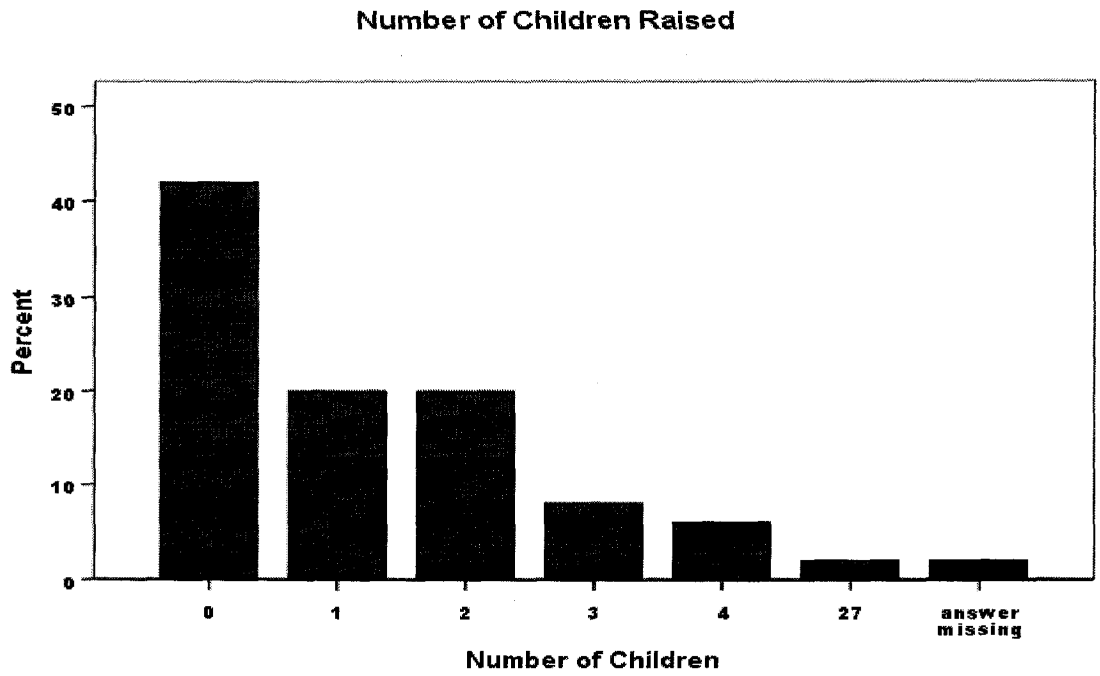

Figure 19. Number of children raised by each participant.

Career Decisions

The next group of questions are related to the respondents' career decisions. Question 45 asked, "Which best describes your first experience with computers?" Results for this question are displayed in Table 35 and Figure 20. There were two response categories added due to respondents' answers in the "other" category: "at work" and "grades K-12, at a local college." The largest percentage of participants, 50%, reported their first experience with computers during their college years. Combining the percentages for the categories of "in college" and "at work" show that a majority (58%) of respondents reported a first computer experience in college or later. For this question, there was 0% response for the categories of "I first used computers at a friend's house," "I first used computers at a relative's house," and "I first used computers at the community library."

Table 35.

Participants' First Computer Experiences

First computer experience	Percent (n=50)
At home	14
Grades K-12	26
At K-12 school (24%)	
At a local college (2%)	
In college	50
At work	8
One I built myself	2

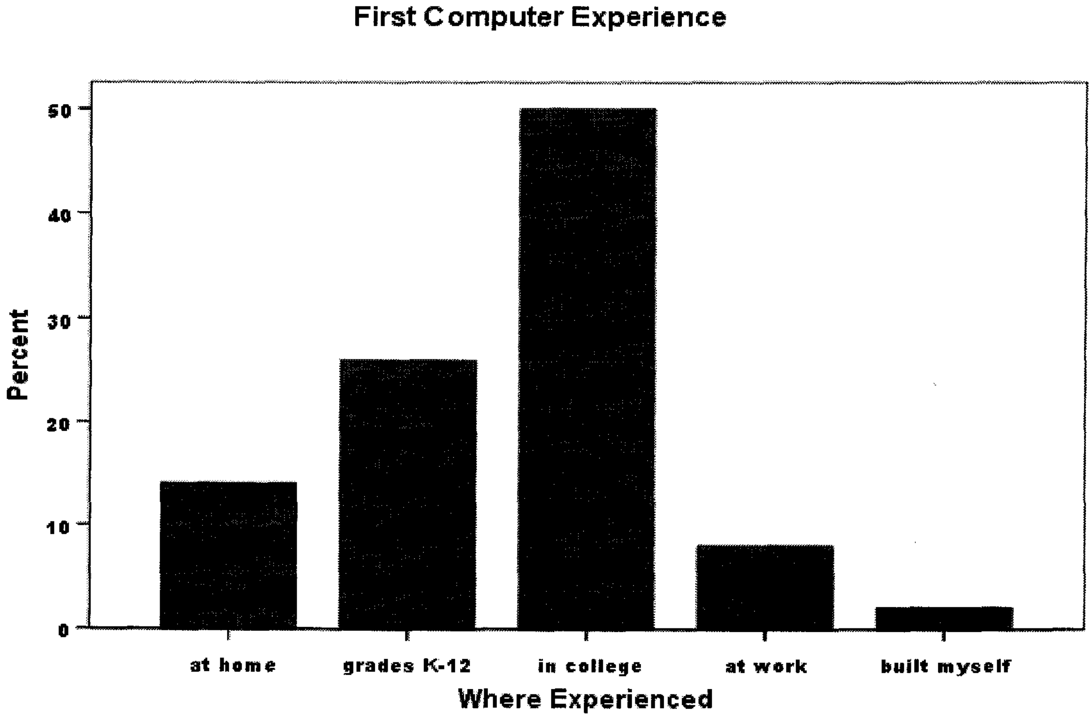

Figure 20. Participants' first computer experiences.

Question 46 asked, “What first interested you in computers?”; the respondents then ranked their choices. Most respondents gave only one choice or supplied their own in the space marked “other.” First-choice responses to this question are shown in Table 36. Due to respondents’ answers under “other,” the categories of “playing games,” “I was encouraged by another person to pursue computing,” “It was my job,” and “no interest” were added to the ones originally listed for this survey question. The largest percentage of participants, 44%, chose the response “the usefulness of the computer as a tool to accomplish other tasks.”

Table 36.

First-Choice Responses to Question 46, “What First Interested You in Computers?”

Type of interest	Percent (n=50)
The usefulness of the computer as a tool to accomplish other tasks	44
The computer’s ability to do complex operations	12
The job possibilities of the computer field	12
The inner workings of the computer	10
I saw someone else using it and wanted to learn about it too.	10
Playing games	4
I was encouraged by another person to pursue computing.	4
It was my job.	2
No interest	2

Question 47 asked, "How do you consider yourself?" It then listed qualities like "confident" and work characteristics like "I prefer others to take the lead." Respondents could check as many as applied to them or check the one labeled "none of these." Responses to this question are displayed in Table 37. Seventy percent or more of participants responded that they considered themselves "likable," "confident," and/or "independent." A majority of 60% responded that they considered themselves "a leader." Only 32% responded that "I like to work on my own." A greater percentage (though not a majority), 44%, responded "I like most to work on a team." The sum of the responses is more than 100% because participants could have chosen more than one answer. No one chose a response of "sociable."

Table 37.

Participants' Answers to the Question, "How Do You Consider Yourself?"

Characteristic	Percent (n=50)
Likable	78
Confident	72
Independent	70
A leader	60
I like most to work on a team.	44
I like to work on my own.	32
I prefer others to lead.	12

Question 48 asked, "Which person do you believe influenced your career choice the most?" Participants' first-choice responses are displayed in Table 38 and Figure 21. The largest percentage of participants, 34%, chose "no person" as their most influential. One person who marked "no person" commented that it was the movie *2001: A Space Odyssey* which influenced her, not a person. The next two highest percentages were 22% for "father" and 18% for "teacher" as the most influential person. The categories of "husband," "boss," and "mentor" were added because of comments written in the "other" category by those who had not marked any other answers for this question. There was a 0% response for the categories of "counselor," "son," and "daughter."

Table 38.

Person Who Influenced Career Choice the Most

Person	Percent (n=50)
No person	34
Father	22
Teacher	18
Mother	8
Other relative	8
Boss	4
Husband	2
Best friend	2
Mentor	2

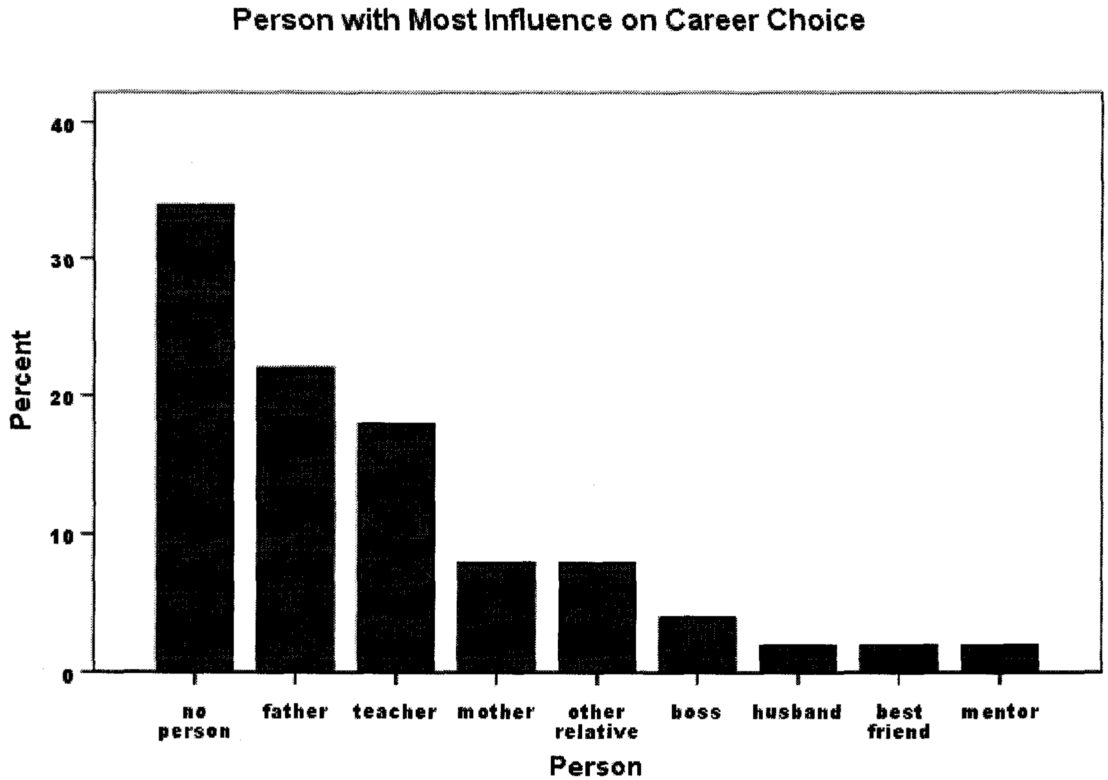

Figure 21. First-choice answers to question 48, "Which person do you believe influenced your career choice the most?"

Question 49 asked, "What do you think is the most important reason for your career choice?" First-choice responses to this question are displayed in Table 39. A majority of respondents, 56%, answered "genuine interest and desire." No respondent chose as her most important reason any of the categories "parental influence," "influence of peers," or "ability to devote time/effort to this career."

Table 39.

Participants' Self-Reported Most Important Reason for Career Choice

Reason	Percent (n=50)
Genuine interest and desire	56
Pay & benefits	18
I'm really good at it	16
Availability of jobs	10

Question 50 asked participants when they decided on a career in the computing/information technology field. Results are displayed in Table 40. The response "as an adult worker, after college" was added due to participants' answers in the "other" category. Fifty percent of participants decided on a computing career as an adult worker, and 40% decided in college.

Table 40.

When Participants Decided on a Career in Computing/Information Technology

When decided	Number of participants	Percent (n=50)
In K-12 school	5	10
Before high school (1 person; 2%)		
During high school (4 people; 8%)		
In college	20	40
As an adult worker	25	50
After college (4 people; 8%)		
During graduate school (1 person; 2%)		
Career change after working at something else (20 people; 40%)		

Question 51 asked, "What is the best description of the person(s) who supported/encouraged your efforts in the computing/information technology field?" First-choice responses to this question are displayed in Table 41. Fifty-two percent named a male encourager as their most important encourager and 28% answered, "no one; did it on my own." "Work colleague or boss" was added as a category because of participants' responses in the "other" box for this question. No respondent chose "female sibling," "female teacher," "son," "daughter," "my children," or "group of mostly female friends."

Table 41.

Person(s) Who Supported/Encouraged Participant's Efforts in the Computing/Information Technology Field

Encouraging person(s)	Percent (n=50)
Male encourager(s)	52
Father or stepfather (18%)	
Husband (14%)	
Male friend (8%)	
Male sibling (6%)	
Male teacher (4%)	
Group of mostly male friends (2%)	
No one; did it on my own	28
Female encourager(s)	10
Mother or stepmother (6%)	
Female friend (4%)	
Group of male and female encouragers	4
Group of male and female friends (4%)	
Encourager not specified as to gender	6
Work colleague or boss (6%)	

Participants were then asked, "What do you like most about your career?" (question 52). First-choice responses to this question are displayed in Table 42. The largest percent of respondents, 40%, answered "challenge," followed by the categories "fulfillment," "I'm good at it," and "pay/benefits," each marked by 14% of the survey respondents. The category "autonomy" was added due to a participant's response in the "other" box.

Table 42.

What Participants Like Most About Their Careers

Characteristic	Percent (n=50)
Challenge	40
Pay/benefits	14
Fulfillment	14
I'm good at it.	14
It's something I always wanted to do.	6
Working hours	4
My co-workers	4
My employer	2
Autonomy	2

Question 53 asked, "What do you think has been most responsible for your staying in the computing/IT field?" First-choice responses are displayed in Table 43. The largest percentage of respondents, 26%, chose "pay/benefits" as their first choice, followed closely by the 20% who chose "challenge." The categories "autonomy" and "close to retirement" were added as a result of participants' responses in the "other" box. No respondent chose "my ability to devote time/effort to this career" as their first-choice response to this question.

Table 43.

Participants' Self-Reported First-Choice Reasons to Stay in Their Careers

Reason	Percent (n=50)
Pay/benefits	26
Challenge	20
I'm good at it	12
Fulfillment	10
My co-workers	8
Working hours	8
My employer	6
It's something I always wanted to do.	6
Autonomy	2
Close to retirement	2

Question 54 asked participants what they liked least about their career. First-choice responses are displayed in Table 44. The first-choice response with the largest percentage, 30%, was "working hours." The next largest percentage, 16%, was for "lack of chance for advancement." The categories "politics of the job," "stress from management," and "too much to do" were added from participants' comments in the "other" box for this question.

Table 44.

What Participants Reported Liking Least About Their Careers

Characteristic	Percent (n=50)
Working hours	30
Lack of chance for advancement	16
Co-workers	8
Doesn't mesh well with family responsibilities	8
Impersonal nature of job	8
Lack of fulfillment	8
My employer	6
Answer missing	4
Lack of challenge	4
Pay/benefits	2
Politics of the job	2
Stress from management	2
Too much to do	2

Question 55 asked, “What is your experience in working for your present employer?” Participants were to mark that they worked for either a large or a small company and then choose among the options: (a) “often the only woman in my project group,” (b) “usually one of many women in my project group,” or (c) “there are only women in my project group.” Results are grouped into the six categories created by the available choices just listed. Categories of “not applicable” and “missing answer” were added. “Not applicable” was used for the two women in unique situations where there are not any project groups; one is a college lecturer and the other is CEO of her own company. The largest percentage, 44%, consisted of women who work for large companies and are usually the only woman in their project group. The next largest percentage, 22%, consisted of the women who work for a large company and have many women in their project groups. This question may have been confusing for several respondents because 20% submitted answers that were incomplete or missing. Results are displayed in Table 45. Categories with a response of 0% are included so that comparisons among all possibilities can be made.

Table 45.

Size of Company and Type of Work Group for Participants

Size of company and work group type	Percent (n=50)
Large company; often the only woman in project group	44
Large company; usually one of many women in project group	22
Large company; there are only women in project group	0
Small company; often the only woman in project group	8
Small company; usually one of many women in project group	0
Small company; there are only women in project group	2
Not applicable	4
Answer missing	20

Question 56 gave participants choices similar to the last question, but participants were to answer it about their previous employers, if any. The question stated, "What was your experience in working for the employer for whom you worked longest in the computing/IT field (if it is different from your present employer)?" Besides the choices from the last question, respondents could have also marked "have had only one employer" or "already gave the information for this employer in previous question." A large percentage, 52%, marked either that they already gave the information or only had one employer. Because of this, the percentages for the other categories are rather low. Results are displayed in Table 46.

Table 46.

Size of Company and Type of Work Group for Previous Company for Whom Participant Worked Longest

Size of company and work group type	Percent (n=50)
Large company; often the only woman in project group	16
Large company; usually one of many women in project group	8
Large company; there are only women in project group	0
Small company; often the only woman in project group	6
Small company; usually one of many women in project group	2
Small company; there are only women in project group	0
Already gave the information for this employer in previous question	16
Have had only one employer	36
Not applicable	2
Answer missing	14

Table 47.

Women's First-Choice Reasons for Leaving the Computing/IT Field as Reported by Participants Who Knew Them

Reason for leaving field	Percent (n=22)
Did not like the subject or work	32
Career was not compatible with child-raising responsibilities.	27
Uncomfortable work or school atmosphere	9
Academic problems	9
Forced job cut	9
Discouraged by teachers or supervisors	5
Higher pay and more responsibility elsewhere	5
Career was not compatible with marriage or other family responsibilities (other than child-raising)	5

Question 57 asked, "Do you know any women who started in the computing/IT field (in college or in a career) and dropped out or changed to another career?" A majority of participants, 56%, answered that they did *not* know any women in this situation. On the other hand, 44% answered yes, and were then asked question 58, "When thinking of the women from the previous question, why do you think they dropped out of the computing/IT field or changed to another career?" The first-choice responses marked by participants who knew a woman who left the field are displayed in Table 47. The highest percentage, 32%, was for the category "did not like the subject or work," followed closely by the 27% for the category "career was not compatible with child-raising responsibilities." If the categories "career was not compatible with child-raising responsibilities" and "career was not compatible with marriage or other family responsibilities (other than child-raising)" are combined, the percentage is 32%. The categories with smaller percentages in the table are interesting but must be considered with caution because of the small number of respondents (22). The categories "forced job cut" and "higher pay and more responsibility elsewhere" were added due to responses marked in the "other" box by participants. The percentages in the table total to more than 100% because of rounding.

From a presentation of the results of the survey questions, this paper moves to a discussion of the results of a statistical test performed on pairs of survey results.

Other Analysis of Survey Results

The statistical test chi-square is used to find significant relationships between pairs of categorical data (Minium, King, & Bear, 1993; Kerlinger, 1986). For the purposes of this study, paired categorical data will be accepted as related to each other, and not occurring merely due to chance, if the chi-square test is significant at the 95% confidence level. For this to occur, the measure of significance would be equal to .05 or less. This means that there is only a 5% or less chance that the relationship between the variables occurred by chance.

Chi-square analysis was conducted on selected pairs of survey question results to look for relationships between them. It is important to analyze these results to determine if common factors among the surveyed women were related to each other or could have occurred by chance. A table containing results for all the pairs which were analyzed in this way is located in Appendix G. An abbreviated form of this table is shown as Table 48.

Table 48.

Chi-Square Significance for Selected Pairs of Survey Data

Pairs of data	Significance
Favorite subject 9-12; number of math courses	.964
Number of math courses; influence on taking math courses	.380
Number of science courses; influence on taking science courses	.003 *
Mother's education; highest education attained by participant	.771
Father's education; highest education attained by participant	.524
Decade of year pursued; first computer experience	.036 *
Decade of year pursued; like most about career	.381
Years in computing (grouped); decade of year pursued	<.001*
When decided on career; number of children raised	.263
Like most about career; reason to stay in career	.036 *

*significant at .05 level, using 95% confidence level

Most of the pairs that were analyzed produced no significance at the .05 level, except for (a) "number of science courses; influence on taking science courses," (b) "decade of year pursued; first computer experience," (c) "years in computing (grouped); decade of year pursued," and (d) "like most about career; reason to stay in career." In the pair "number of science courses; influence on taking science courses," "influence on taking science courses" included choices like "I did well," "I like it," "encouraged to take it," "only took required," and "needed for my career." The finding that the chi-square test showed significance at the 95% confidence level for this data pair shows that the number of high school science courses the surveyed women completed was related to their reason for taking those courses. It could be expected that young women who like science, who are good at science, or who are required to take a certain number of science courses would then take those courses; the chi-square test for this data pair shows such a connection for the computing women in this survey. In the case of the data pair "decade of year pursued; first computer experience," "first computer experience" offered responses like "at home," "one I built myself," "in grades K-12," "in college," and "at work." The relationship shown by the chi-square test between this data pair shows that the decade when the women took their computing courses is related to their first computing experience. This is understandable because in more recent years there were first computer experiences, such as personal computers at home and computers in the lower grades in schools, more available than in the earlier days of computing. In the case of the data pair "years in computing (grouped); decade of year pursued," it is understandable that the chi-square test showed a relationship because a woman with more years of experience would have pursued her computing courses in an earlier decade. The fact that the chi-square test showed a relationship in the case of "like most about career; reason to stay in career" is understandable because the same things that the computing women like most about their careers could contribute to their reasons for remaining in their careers.

The chi-square statistical test did not show a relationship between any other pairs of data that were analyzed other than the ones mentioned in the previous paragraph. The fact that most of these tests did not show significance is not surprising because the structure of the questions, with an invitation to survey participants to insert their own answers if they were not included in the list, was meant to allow each participant to give an answer precisely right for her. This semi-structured, open-ended questioning format helped to generate many types of answers but resulted in a large number of answer categories which made it more difficult to find relationships between categories. Those previously mentioned cases where data pairs were found to be related has provided information about women in computing. If additional relationships were found among the common factors it would have provided even more information about women in computing careers which could be used to increase female participation in these career fields.

The previous section presented, discussed, and analyzed the survey results for this study. Next this paper will present the interview results.

Interview Results

The researcher interviewed 44% of the 50 women who completed the survey in order to clarify and further study ideas that surfaced in the survey. Topics in the interview included (a) the interviewee's career decisions, including when, why, and under what circumstances she chose her career; (b) when she first experienced computers and her reaction to that experience; (c) whether and under what circumstances she encountered any discrimination; (d) her likes and dislikes about her career; (e) the people, if any, who helped encourage her in her career; (f) why she continues in her computing/IT career; (g) advice to a young woman contemplating a computing career; (h) description of the interviewee's specific job situation; (i) her personal characteristics which make her good at her job; and (j) demographic questions. The interview results will be presented next.

Data Collection

Over a six-week period, the researcher interviewed 22 computing women. They had volunteered by marking a positive response to survey question 60 and supplying an e-mail address. There were actually 33 volunteers; Table 49 displays how the initial 33 volunteers resulted in 22 phone interviews being conducted and transcribed. In the second group in the table, an invitational e-mail was sent out three times, at least a week apart, with no response. In the table, the third group consisted of computing women who, although they answered the initial or second e-mail, did not have time in their schedules to participate in a phone interview. The last person described in the table was the one woman who initially scheduled an interview, was not available when called, then scheduled another interview, was again unavailable, and did not answer the subsequent e-mail sent to her.

Table 49.

Telephone Interview Participants

Description	Number
Interview was scheduled, conducted, and transcribed.	22
E-mail contacts were made 3 times with no response.	6
Person was unavailable during the interviewing time frame.	4
Interviews were scheduled, phone calls made, but person unavailable then and subsequent e-mails were not answered.	1

In order to interview women with a variety of backgrounds, an effort was made to include women with children and women without children in the interviews. The interview results show that eight interviewed women (36%) did not have any children and 14 interviewees (64%) had one or more children at the time of the interview. This information was taken from each interviewee's survey answers because there was no question in the interview guide about it.

An effort was also made to include women of different racial backgrounds in the interviews. Of the 22 women in the interviews, 20 are white/Caucasian, one is African American, and one is Asian American.

The researcher interviewed the 22 computing women via telephone, and the conversations were audiotaped with the participant's permission. The interview guide used for these phone interviews is in Appendix C. Before each interview, the researcher reviewed each interviewee's survey answers to recall her background. After interviewing, the researcher summarized her impressions and important points about the interview. The audiotapes were then transcribed and the printed transcripts were coded and analyzed for patterns.

Participants

A pseudonym of the interviewee's choosing will be used throughout this document to refer to each of the 22 computing women who were interviewed. Interview question 10 included asking each interviewee for her preferred pseudonym. The women interviewed show a variety of backgrounds. Bee lives in Colorado and is a project manager at a private (non-government) company. Leah is a computer engineer working for the federal government in Ohio. Priscilla is a producer for a games company in Massachusetts. Ruthie is an associate director of application systems at an Ohio college. Lynette is an applied analyst at a private company in Ohio. Lolamay is a database administrator for a private company in Florida. Megan is a solution architect for a private company in Ohio. Sloan works in software support at a college-based research institute in

Ohio. Susan is a systems analyst for a college in Ohio. Vicki lives in Ohio and works as an applications developer for a database system for a California-based private company. Marie is the director of technology for a college in Ohio. Marlea lives in Hawaii and works as a software engineer for a California-based private company. Beth is a games systems programmer for a private games company in Texas. Barbara is an advanced system administrator for a private company in Ohio. Toni is an information analyst for a private company in Ohio. Elizabeth is a computer engineer working for the federal government in Ohio. Belinda is a lecturer for an Ohio college and previously worked for many years for governmental and private companies in the computing/IT field. Bella is a systems coordinator for a college library in Ohio. Phyllis is a programmer/analyst for an Ohio college. Isabelle is an information analyst for a private company in Ohio. Ruth (different person than Ruthie mentioned earlier) is a lead programmer for a private company in California. Heather is an environmental artist (three-dimensional artist) for a private games company in California. Table 50 displays interviewees' types of employers and states of residence. The percentages in the table do not add up to 100% because of rounding.

Table 50.

Interviewees' States of Residence and Types of Employer

State of residence	Type of employer	Number of participants	Percent (n=22)
Ohio (68%)			
	College	7	32
	Private company	6	27
	Government	2	9
California	Private company	2	9
Massachusetts	Private company	1	4.5
Florida	Private company	1	4.5
Texas	Private company	1	4.5
Hawaii	Private company	1	4.5
Colorado	Private company	1	4.5

Career Decisions

Interview question 1A asked, "When did you decide on a career in computing?" The decade during which each woman decided is displayed in Table 51. A large majority (81.5%) of the women interviewed decided on a computing career in the 1980s (36%) or 1990s (45.5%). The decade of the 2000s was not included in the table because the target population for this study consisted of women with at least five years of experience, the interviews were conducted in 2006, and women from the 2000s would not have had five years in the workforce by that time.

Table 51.

Decade When Interviewee Decided on a Computing Career

Decade	Number of participants	Percent (n=22)
1960s	1	4.5
1970s	3	14
1980s	8	36
1990s	10	45.5

The researcher asked each women interviewed for her approximate age when she decided on a computing career (first part of question 1B), and to describe the circumstances surrounding her decision to pursue a computing career. The results are shown in Table 52. The two main life circumstances during which the interviewees decided on their careers were in college (41%) and as an adult worker (45%). For those who decided as adult workers, 9% decided immediately after college (but not in college), 27% made use of an opportunity at work, and 9% chose it as a career change after working at something else.

Table 52.

Life Circumstances and Age Category When Interviewee Decided on a Computing Career

Life circumstances	Age category	Number of participants	Percent (n=22)
In high school	15-17	3	14
In college		9	41
Early (4 people; 18%)	18-19		
Later (5 people; 23%)	20-21		
As an adult worker		10	45
After college (2 people; 9%)	23-24		
At work			
(4 people; 18%)	23-24		
(2 people; 9%)	27-28		
Career change after working at something else (2 people; 9%)	31-33		

The interviewees' ages when they decided on a computing career ranged from a minimum of 15 to a maximum of 33 years old. The mean for these ages is 22.1, and the median is 21.

The interviewees were also asked for their approximate present age (second part of question 1B). They ranged in age from 28 to 62, with a median age of 40 and a mean age of 40.8.

Table 53.

Interviewees' Responses to the Question, "Why Did You Choose Computing as a Career?"

Reason	Percent (n=22)
Liked combining subject or interest with computing	36
Liked some specific aspect of how the computer worked	23
Mentioned liking the fun or game aspect of computing	23
Make good money	23
Enjoyed problem solving	18
Liked computers	18
Liked the challenge	18
Was good at it	18
Constantly changing field	14

Interview question 2 asked, "Why did you choose computing as a career?" The answers clustered around certain types of responses. Table 53 displays the most common types of responses to this question from the computing women interviewed. The percentages add up to more than 100% because most interviewees gave more than one reason for choosing a computing career.

Of the 22 women interviewed, eight (36%) mentioned that what drew them to the computing field was the way in which it combined computing with another field that they loved or knew well. In fact, several of them mentioned that the reason they were working in the computing field was because of their knowledge or interest in another field (like libraries, museums, art, mathematics, or games), not that they were especially drawn to computing in itself. Leah said, "I thought it would be really neat to work on computers, . . . and I had a strong interest in NASA growing up, and I thought that there might be applications for that at NASA." As Heather (a three-dimensional artist) expressed it, "This seemed a good way to do everything I enjoyed doing."

Interviewees responded in other ways, too. Elizabeth remarked, "I guess I'm a computer geek!" Belinda stated, "A lot of programming tasks felt like playing games to me. And every time I got the computer to do what I want, I won!" Ruth emphasized, "I get a lot of satisfaction from . . . creating something that didn't exist before." Toni mentioned, "You're never going to be bored. It changes under your feet." Ruthie answered, "I always enjoyed a challenge . . . and there were really tremendous opportunities career-wise." Sloan remarked, "It just came natural to me."

There was an interesting initial response from several women that is *not* shown in the table. There were four women interviewed (18%) whose first response to question 1A ("When did you decide on a career in computing?") or question 2 ("Why did you choose computing as a career?") was that they had *not* really decided on it or chosen it. As Vicki expressed it, "I did not actually decide on it consciously; I kind of side-stepped into it."

Megan remarked, “It was an opportunity that kind of came up and I ended up pursuing it. It kind of fell in my lap and then I pursued it and enjoyed it.” Barbara expressed it, “I just kind of fell into it.” Their use of these opportunities to work in the computing/IT field will be echoed later in these results.

Table 54.

Interviewees' Responses to the Question, "Was There a Person Who Gave You the Most Encouragement to Pursue a Computing Career or Did You Mostly Do It on Your Own?"

Response	Number of participants	Percent (n=22)
I did it on my own.	9	41
Male encourager	9	41
Male relative (5 people; 23%)		
Male person in field (4 people; 18%)		
Female encourager or role model	2	9
Encourager not specified as to sex	3	14
Home environment	1	4.5
Parents	1	4.5

Interview question 3 asked, “Was there a person who gave you the most encouragement to pursue a computing career or did you mostly do it on your own?” Responses are displayed in Table 54. Nine interviewees (41%) answered that they did it on their own as part or all of their answer. There were nine other respondents (41%) who named an encouraging person who is male. Of these nine, five (23%) named a male relative (brother, father, husband) as an encourager; the other four (18%) of these nine named a male boss, supervisor, mentor, or other person in the field as her encouraging person. Two interviewees (9%) mentioned either being encouraged by a female friend or being influenced by her mother as a role model. Three respondents (14%) answered that a person encouraged them but did not mention if the person was male or female. One respondent (4.5%) named a computer-rich home environment as an encouraging factor for her, and one interviewee(4.5%) named both her parents as encouraging her. Percentages in the table add up to more than 100% because some interviewees mentioned more than one encourager.

Likes/Dislikes About Working in Computing

Question 4A in the interview guide asked, "What do you like about working in computing?" Types of responses are shown in Table 55. The largest percentage (68%) of interviewees answered with a remark about how "challenging and interesting" the job is. This was followed by the 50% of interviewees who mentioned liking the variety on the job. There were 32% of interviewees who mentioned liking the aspect of computing in which they worked with people or helped people. Because many interviewed women gave more than one reason, the percentages add up to more than 100%.

Table 55.

Most Common Types of Interviewee Responses to the Question, "What Do You Like About Working in Computing?"

Type of reason	Percent (n=22)
Challenging and interesting	68
Challenge (45%)	
Interesting (14%)	
Not boring (9%)	
Variety on the job	50
Constantly changing (41%)	
The variety of the projects (9%)	
Enjoyed solving problems	41
Satisfaction of solving a problem or creating something new (27%)	
Enjoyed helping solve people's problems (14%)	
Working with people or helping others	32
Helping users or working with people (18%)	
Working on a team or the collaboration (14%)	
Like a game or puzzle	23
Enjoyed programming or learning code	9
Instant gratification in seeing things work	9

There were some notable responses to this question made by those interviewed. Susan commented, "It's a mystery. . . . It's like you're a little detective. . . from behind the scenes." Toni said, "If we're having a problem. . . I can tackle it and figure out what's causing it and how to prevent it in the future and fix it, and there's a lot of satisfaction in that." Priscilla answered with, "It's interesting, engaging; you have smart creative people working together to come up with a fun goal." Ruth, who writes educational software, expressed it, "But I really enjoy the fact that what I'm actually creating is something to help kids learn." Heather, who is a three-dimensional artist, commented, "With the art on the computer you can do all sorts of things; the possibilities are endless." Belinda remarked, "With computer skills you can walk into anywhere and be immediately useful and valuable."

Table 56.

Most Common Types of Interviewee Responses to the Question, "Why Do You Continue to Work in Computing?"

Type of reason	Percent (n=22)
Well-paid field and/or good benefits	27
I still like it.	27
Challenging	27
Constantly changing	18
Interesting or engaging	18
The flexibility	14

Question 4B asked, "Why do you continue to work in computing?" The most frequent types of responses are displayed in Table 56. Many interviewees answered in a way similar to their responses to question 4A. This is shown in the 27% who answered "challenging" and 18% who answered "constantly changing." But some chose to emphasize other aspects of working in computing, like the 27% who mentioned that it is a well-paid field that has good benefits. The14% who mentioned the flexibility of computing brought up how working in computing fits many women's needs by allowing for telecommuting or part-time work. Once again in this table, because most interviewed women gave more than one response, the percentages add up to more than 100%.

Some women made interesting comments to question 4A. Toni responded, "I still enjoy the challenge." Bee said, "It has proven out to be everything that I imagined it would be in the way a challenge is and change." Beth expressed it, "I love chasing solutions to problems. . . . I make computer games for a living and that's fun too." Megan stated, "It's changing all the time and I learn something new every day, every project." Heather commented, "I'm still happy with what I do. . . I like everything about it, so I'll stick with it." Ruth answered, "I hadn't really considered doing anything different."

Table 57.

Types of Interviewee Responses to the Question, "What Do You Dislike About Working in Computing?"

Type of reason	Percent (n=22)
Difficulty in coping with constant change	36
Long hours	23
Other people's lack of understanding of what computing people do (coworkers or public)	23
Unrealistic workload/managerial expectations	14
Nothing disliked about the work	14
Lack of social interaction	9

Interview question 5A asked, "What do you dislike about working in computing?" The most common types of responses are displayed in Table 57. The largest percentage of interviewees, 36%, mentioned they disliked having to cope with the constant change in the computing field. There were also 23% of interviewees who mentioned the long hours as something they disliked, as well as 23% who mentioned they disliked how others failed to understand what people in computing actually do. Fourteen percent mentioned they disliked unrealistic expectations about their jobs. There also were 14% of interviewees who answered that there was nothing they disliked about their work Only 9% mentioned that they disliked the lack of social interaction in their jobs. Because most interviewed women gave more than one reason, the percentages in the table add up to more than 100%.

Several interviewees gave interesting responses to question 5A. Phyllis answered, "I don't know if I dislike anything." Heather expressed it, "It's really a lot of work, but I can't imagine doing anything else." Belinda stated, "I really wish that . . . our public school system would teach people something about how computers work.. . . . If people had a better understanding of . . . how procedurally oriented computers are, . . . better decisions would be made."

Discrimination?

Interview question 5B asked, "Did you encounter discrimination or obstacles in school or at work because you're a woman in computing?" Of the 22 computing women who were interviewed, nine (41%) responded "no." There were 13 interviewed women (58.5%) who answered that they were aware of some type of discrimination toward themselves or other women in the computing/IT field. Of these thirteen, eight women (36%) answered "yes" to question 5B. Four women (18%) of the thirteen answered that they were not discriminated against personally, but that they were aware of discrimination against women in the computing/IT field. These four women's answers were classified as a "qualified no." And there was one additional interviewee (4.5%) who mentioned one case of discrimination early in her career, and then emphasized that there was no other discrimination at any other time in her career. This person's response was classified as a "limited yes." Both the Asian American and African American interviewees did not believe they were discriminated against because of their race, but the African American woman did mention discrimination in her job, and the Asian American woman did not. Table 58 displays the results. The percentages do not sum to 100% because of rounding.

Table 58.

Interviewees' Responses to the Question, "Did You Encounter Discrimination or Obstacles in School or at Work Because You're a Woman in Computing?"

Answer	Number of participants	Percent (n=22)
No	9	41
Awareness of discrimination	13	58.5
Yes (8 people, 36%)		
*Qualified no (4 people, 18%)		
*Limited yes (1 person, 4.5%)		

*Look in the narrative for the meaning of these.

Table 59.

Types of Discrimination Mentioned by Interviewees Who Reported Discrimination

Type of discrimination	Number of interviewees reporting it	Percent (n=13)
Pay	4	31
Lack of respect for her ability	4	31
Culture	3	23
Sexual	3	23
Age	2	15
In school	2	15

The thirteen women who mentioned some awareness of discrimination were asked to describe the circumstances under which the discrimination occurred. These descriptions were then categorized into six main types: pay, lack of respect for her ability, culture, sexual, age, and in school. Pay discrimination refers to the interviewee mentioning that she was paid less than her male counterparts or was aware of situations where women in her field were paid less than men. Discrimination as "lack of respect for her ability" refers to the attitude of some people in the computing/IT field that women are not very capable in computing. Discrimination identified as "culture" refers to situations identified by the interviewee where she was made to feel uncomfortable because of expectations of the predominantly male environment or where she was made to feel that she did not "fit in." Sexual discrimination includes sexual harassment, comments, or situations. Age discrimination refers to situations that happened to two women early in their careers when they were younger than their employer or other employees. In these situations their employers or supervisors either held them back because of their youth or did not believe they were capable of tackling a task because of their young ages. Age discrimination does not refer to discrimination as the women got older because no interviewee mentioned such discrimination. Because there was so little discrimination in school settings mentioned by the interviewed women, there is a separate category ("in school") for discrimination which occurred in a high school or college setting. Table 59 displays these results. The types of discrimination with the highest percentages reported by the interviewed women were "pay" (31%) and "lack of respect for her ability" (31%). Because some women mentioned more than one type of discrimination, the percentages sum to more than 100%.

Interviewed women's comments about this discrimination follow. Ruthie remarked,

> I did feel discriminated against at that time. . . . In my very first job. . . I don't think I was treated the same as my male counterparts. . . . [I was even told] 'your increase isn't as high as so-and-so's because you know you're a woman and you know your husband also works and so we're giving the other males higher increases.'

Lynette expressed it,

> I had a manager that marked me lower on one of my performance reviews . . . because I didn't go to lunch with the team. The reason I didn't go to lunch is because it was all men; . . . all they talked about [was] boats and sports. . . . People had all these assumptions about me that I should try to fit in better with the team,

> like I should fit in like everybody else.

Marlea noted, “In my professional career, I’ve had certain situations here and there, derogatory comments, sexual comments, things like that. . . . I’ve only gotten an HR department involved one time.” Barbara mentioned,

> I had a big confrontation one time . . . because I was not being chosen for a particular project, although I was clearly more qualified than the person who was chosen. . . . That was just that one time, and I think it was probably just that one particular guy.

Toni stated,

> in my first position . . . [there was] a sales manager that was obviously sexist and he was annoying, but it didn’t affect me professionally because I didn’t report to him. . . . As far as my work was concerned and the person I reported to, I never felt any discrimination.

Belinda described,

> I was told by my supervisor at that time not to let anybody know that I could type. . . . My boss was very concerned that if anybody ever saw me typing on my keyboard in the office . . . they wouldn’t be able to distinguish me from the data entry staff or the secretaries.

Bella remarked, “I’m currently in my fourth year of not getting a [pay] raise . . . and I feel discriminated against. . . . I don’t feel as though it’s because I’m a woman. I . . . feel as though it’s because they don’t understand what I do.”

Several women spoke of the subtleties of the discrimination they experienced.

Lolamay stated, "Not so much discrimination as . . . having to prove yourself . . . maybe more so than the male. And probably I have worked extra hard because of that." Marie stated,

> It's hard for me to point to anything blatantly as an obstacle. . . . In some cases, you know if you look around the room and you don't see anybody that looks like you that can be an uncomfortable feeling. And there are instances where things are done, developed in a way that is very comfortable for the males who are programming but it isn't really the way a female might do it.

Others mentioned more traditional discrimination they had seen. Megan answered, "I do think within the industry women are still paid less and compensated a little differently." Vicki expressed it, "I know for a fact that the males in the same position that I have make more than I do, at the company I work for. . . . But I gain the flexibility so I don't really care." (Vicki telecommutes from home to do her job.)

There were some strong reactions and comments from interviewees who said they had *not* been discriminated against. Leah replied, "I don't feel like I have ever been told I couldn't do something for any reason." Susan stated, "I've had male and female bosses. . . . No, I don't see discrimination." Phyllis expressed this, "No, I don't think I encountered any discrimination. You have some men that don't like to work for a woman, but you . . . learn over the years how to handle that. . . . It's a personality thing I think sometimes." Priscilla emphasized, "Not at all; if anything I think it was an advantage. I feel like I was not like all the others. . . . You never blend in." Heather responded,

> Not at all. It was almost like they were more receptive because they wanted to

make me feel more comfortable because . . . on my team . . . at one point there were . . . 130 people, and there were only three of us that [*sic*] were female. So they're . . . very inclusive. It's kind of nice."

To investigate the incidence of discrimination noted by interviewed women in different age groups, the researcher divided the 22 interviewees into age groups and whether they spoke of any type of discrimination (even if it was "other people" or long ago) or not. Results are displayed in Table 60. In the age groups 60s, 50s, 40s, and 30s, a majority of women noted some discrimination, with 100%, 50%, 67% and 62.5% respectively in the column "Percent in age group who noted discrimination." This column shows 0% for women in their 20s, with 100% of them answering that they were not discriminated against, but there were only 2 interviewees in this group.

Table 60.

Interviewees' Age Groups and Awareness of Discrimination in the Computing/IT Field

Age group	Number who noted discrimination	Percent in age group who noted discrimination	Number who were not discriminated against	Percent in age group who were not discriminated against
60s	1	100	0	0
50s	1	50	1	50
40s	6	67	3	33
30s	5	62.5	3	37.5
20s	0	0	2	100

Computing Women's Personal Characteristics

Interview question 6 asked, "What personal characteristics do you have that make you good at your career?" The researcher grouped the women's responses into categories. Results are shown in Table 61. The category with the highest percentage, with 32% answering that they had this type of characteristic was "logic/analytical skills," followed by the 23% who answered "good people skills/like helping people." The researcher did not combine the category "math skills" with the category "logic/analytical skills" because some of the interviewed women mentioned that they were not good at math, but were good at the logical and analytical skills that working with computers required. The researcher respected the distinction between "math skills" and "logic/analytical skills" that some interviewed women made and listed them separately. Because most women mentioned several characteristics, percentages in the table sum to more than 100%.

Table 61.

Categories of Interviewees' Answers to the Question, "What Personal Characteristics Do You Have That Make You Good at Your Career?"

Type of characteristic	Percent (n=22)
Logic/analytical skills	32
Good people skills/like helping people	23
Well-organized	14
Math skills	14
Persistent	14
Good with details	14
Good problem solver	14

First Experiences

Interview question 7A asked, "How old were you when you had your first experience with computers?" The interviewees' responses ranged from a minimum of 7 to a maximum of 28 years old. The mean was 14.67 and the median was 15.00. The 22 interviewed women showed a considerable variation in the age at which they first experienced computers.

Interviewees were then asked to describe their first computer experience. These responses were categorized by type and the results are shown in Table 62. There is an almost even division, at about 30%, among the categories of "as a child at home," "in K-12 school," and "at a college." Fourteen percent of the interviewed women did not experience computers until they were in the workplace.

Table 62.

Types of Interviewees' First Experiences With Computers

Type of first experience	Percent (n=22)
As a child at home or with parent(s)	32
In K-12 school	27
In elementary school (14%)	
In middle school (4%)	
In high school (9%)	
At a college that participant attended	27
At work	14

The researcher then asked question 7B, "Were you drawn to computers then?" Sixteen women (73%) replied "Yes" to this question, although one of these women was really drawn to it during her second college course, not at first. Leah answered, "When I took my first programming course, it was just like a light went off; it was a puzzle, a challenge." Bee stated, "It made sense to me that they work by instructions and . . . they did exactly what you tell them to do. . . . That just made perfectly good sense to me." Toni responded, "I was fascinated. I loved the fact they could do your work for you." Ruthie stated, "I found it to be very intriguing because I never had an experience like that before." Marie answered, "Once that computer was part of the office I was fascinated by it and wanted to find out what I could make it do and . . . how it worked but more what we could do with it." Beth expressed, "I played the games a lot. I was very voracious and wanted more games. . . . I was typing in the source [code] from the magazines, and that's what got me interested in learning how the code works." Elizabeth mentioned, "It came with . . . BASIC. After a while . . . I needed to know what it was and I looked at the manual and I started doing a little bit with it. And the more I did it, the more I was hooked." Heather answered, "It seemed like high-tech and kinda cool, and my dad was always very into those . . . things and was all excited about it as well and he showed me how to do things." Sloan expressed it, "Part of that [attraction to computers] probably could have been because my dad and my older brother were on it and I wanted to do what they did."

Six women (27%) answered "no" to this question. A few of them not only mentioned that they were *not* drawn to computers, but actually had an aversion to them at their first computer experience. Vicki answered, "Hated them. They were loud and they were noisy, and why would anybody want to sit in a room with a big loud noisy thing that went 'THRRRRRRRRRR' for eight hours a day?" (She was referring to the days when computers were mainframes and took up a whole room.)

Advice to Women Interested in the Field

Interview question 8 asked, "What would you say to a young woman interested in a computing career right now?" Again there were a wide variety of answers, but many of them clustered around certain ideas or categories of answers. Table 63 displays the most common answer categories and the percent of interviewees who responded with that type of answer. Most interviewees responded with some type of encouragement, like the 23% who answered, "Go for it," or the 18% who said, "I would encourage her." But 14% talked about how it's a difficult field right now. Percentages in the table add up to more than100% because most women gave responses in more than one category.

Table 63.

Categories of Interviewees' Answers to the Question, "What Would You Say to a Young Woman Interested in a Computing Career Right Now?"

Type of response	Percent (n=22)
"Go for it." or "Go into it."	23
"I would encourage her."	18
Lots of opportunities	18
Field has changed and your goal of type of job must change too	18
"Stick with it."	14
It's a difficult field right now.	14
Must know yourself and if your abilities match intended field	14

There were several noteworthy responses to this question. Some expressed well a topic shown in the table. Priscilla answered, "The possibilities right now are pretty huge. So I would say, 'Go for it!'" Megan added, "I just think that there is a lot of opportunity out there, and you could focus it in any direction you want, absolutely any direction." Barbara replied, "There's [*sic*] just so many different facets of which way to go. . . . Do they relate more to people? Or do they want to sit in an office and program by themselves?" Leah stated, "It's a great field to get into. . . . It's not only about the technical work, it's also about communication with other people and working on teams." Marie mentioned, "Stick with it because we need more women." Marlea responded, "Stick with it and . . . concentrate not only on computers but on really excelling in your other areas of studies. . . . [Don't] concentrate too much on being a woman in engineering; concentrate on being an engineer." Beth expressed it, "Totally go into it. . . . There are a lot of companies right now that are looking for females and would love to hire them if they could. Female game programmers are just not out there."

Others had a negative response or pointed out challenges and difficulties in the field right now. Lolamay remarked, "Think about something else. . . . I have too many friends that have a lot of experience that are doing something completely different right now." Lynette answered, "A lot of jobs in the U.S. are outsourcing our positions. . . . She might want to consider choosing something that can't be outsourced, something that she has to do hands-on or work for a major company that is creating the technology." Bee remarked, "Competition is more fierce now than when I started. . . . People are having to really be educated to stay in the field, . . . to keep their skills . . . updated." Susan expressed it,

> She'd have to really look at what she can handle and what she can't. . . . The biggest thing . . . is constant change. . . . If you're a person who gets stressed out [when] things are going too fast . . . this isn't the field for you.

Vicki remarked, "Everything's going to change every 25 minutes, so make sure you have something to fall back on. . . . If you suddenly decide you don't like it, or your skill set becomes outdated, you'll have to be able to do something else."

Still others gave a positive side of being a woman in computing while being aware of the challenges of the field. Bella remarked,

> I think the area of computing is going to be dynamic, and it's going to be changing, and it's going to exist for years to come. . . . I don't think that because they're a woman [*sic*] should detain them from doing that. But . . . they should be well aware that they're gonna have to struggle in that world, especially when you go outside of academia..

Toni stated,

> I really think there are opportunities even with outsourcing going on. . . . I don't get the sense that there's discrimination nearly as much as there may have been even 10 years ago, and certainly less than there was 20 years ago.

Ruth mentioned,

> Don't be afraid to try it. And if you like it, stick with it. . . . If you're talking about problems with different genders in the field, I think there are less than what some people and the media at large would like to think, in terms of it being hostile.

Heather remarked, "Don't let the number of guys intimidate you; there's definitely a place for females in the industry, and it's a lot of fun." Phyllis stated, "I think it's still a great career for women. I think women have . . . an ability to get to the details sometimes. . . . I think women are good at multi-tasking and that helps too." Belinda emphasized, "If you feel like you're so talented that you could do almost anything, get into computer science because computer science will open every door for you."

Women and the Computing Field

During the interview, the women had an opportunity to add to their previous responses when they were asked interview question 9, "Is there anything else you would like to say on the topic of women in computing?" Two women had nothing else to say. The other 20 women made comments on a wide variety of topics.

Several women had positive comments about their choice of a computing career or how good the computing field is for women. Bee remarked, "I absolutely love the choice that I made. . . . I think that any woman that wants a challenging, exciting, constantly changing career should pursue a career in computing and she'll get all of that and more probably." Leah mentioned, "It's a great field for women to get into. There's some flexibility with it because of things like telecommuting, where you can work from home." Toni stated, "I think it's a good field for women who have an interest in solving technical problems."

Some made comments about the talents of women in the computing/IT field. Ruthie expressed it,

> I do believe that . . . women are very good. I think that they have tremendous attention to detail; I think their analytical skills are very good; their management

> skills are very good. . . . I feel that they have a tremendous amount to offer in the field.

Lolamay emphasized, "I can say from my experience that women do very well in computing. . . . Women have the aptitude certainly for [a] computing career and maybe more so than men." Beth added, "The very, very first computer programmers were women. . . . Women are perfectly capable of it. In some cases, I think they might even exceed males in it." Bella answered, "I think that there are a lot of talented women out there in computing . . . but . . . they're more low-key. And I don't know if that's the choice of the woman or just the choice of the career."

Some interviewees talked about the need or desire for more women in the computing field or the unique abilities of women in the field. Megan expressed it, "I think there are a lot of nuances and intricacies about computer systems. . . . I think that women can have a different perspective on it, and find different applications for it [than men can]." Priscilla remarked,

> Specifically in the games field, one of the big complaints people have about games is that they are primarily targeted at boys and young men, and I think . . . there is a real opportunity to change that if we got more women in the field, and I would personally love to see that happen.

A few interviewees mentioned challenges which still exist in the field or problems in attracting more women to the field. Susan responded, "It's a high stress job." Marie remarked,

> We still have some barriers because we still . . . have a male-dominated culture

related to technology. . . . I think we can have a big impact [with] . . . guidance counselors and their misperceptions of these careers . . . [when] they're looking at young . . . women that are people-oriented and . . . helping move them away from a technology career. . . . So that would be an area that I think we need to do some work in, . . . helping them to understand what the jobs really are."

Belinda expressed it,

> We really need women in computer science! The entire population uses computers and we can't meet that requirement only using half the brain power. We have to have a diversity of thinking styles in order to meet a diversity of user styles.

One interviewee spoke about her experiences with older women in the field. Marlea remarked,

> One thing that surprises me is that other women that I've run into professionally have done more to make me feel worse about being a woman sometimes than some men have. Some of them I feel . . . have really been burned in the past. I used to get really upset that they're so focused on being women and so angry at men.

Jobs of Computing Women

Interview question 10 consisted of a series of mostly demographic questions that also gave the interviewee an opportunity to talk about her job. Included in question 10 were questions about the state where she lives, how long she's been working in computing, her job title, the company for which she works, and what name she would like to use as her pseudonym in this study. The interviewee's pseudonym, type of job, state of residence, and type of employer have been discussed previously in this chapter. Refer to Table 50 for interviewees' states of residence and type of employer. Most interviewees were also asked to describe their present jobs, some also described previous jobs as well as the male/female makeup of their working groups.

Table 64.

Types of Jobs Interviewees Presently Hold

Job classification	Percent (n=22)
Software applications	50
Manager of computing team	18
Programmer (write programs)	14
Design programs	14
College lecturer	4.5

From the job descriptions the interviewees gave, the researcher classified their jobs. Table 64 displays these job classifications and the percent of interviewees in each category. The largest percentage (50%) have jobs in software applications, which means that they set up computer software to accomplish specific tasks for their clients or customers. The other categories in the table include "manager of computing team", "programmer", "design programs," and "college lecturer." The manager of a computing team is the person on the team who directs the team's effort and is ultimately responsible for the successful accomplishment of the team task. The designation "programmer" refers a person who actually writes (or "codes") the software programs. A person who designs programs is often a computer engineer and actually designs how the computer program will work to accomplish a specific task. The percentages in the table sum to more than

100% because of rounding.

Many of the interviewed women were asked about the gender composition of their working groups. Of the 22 women who were interviewed, six women (27%) did not have reportable answers because the interview did not include the question or it did not apply to the one woman who is now a college lecturer. The results for the 16 women who spoke of their working groups are in Table 65. The majority of these women (62.5%) were in groups composed mostly of men at the time of the interview, although other group configurations were reported.

Table 65.

Gender Composition of Interviewees' Working Groups for Interviewees Reporting Groups

Working group composition	Percent (n=16)
Mostly men	62.5
Varies widely from mostly men to 50-50 to mostly women	19
Approximately 50% women	12.5
Over half women	6

Additional Comments

The interviewer asked question 11, "Is there anything else you'd like to say or any questions that you have?" This question was included to allow the interviewee to add anything or to ask the researcher about her project. Where applicable, these responses have already been reported in previous sections. But there are a few notable comments not included elsewhere. Lynette stated,

> When people think about what is computing, they don't think that there is interaction with humans. . . . There is an aspect of computers where they can interact with the customer and help them define requirements; that will be encouraging for them [girls] to go in it because there is that human side of it, and they can work with users to solve problems.

Leah mentioned,

> When I started out in school back in the late 70s . . . there weren't many women in my computer classes. And getting into the work field, there really [weren't] . . . a lot either. I've seen a big change in the group I work in, at work right now. I think we're probably over half women and I do see a lot more women in the field these days. And I just think it's a great field for women to get into, there's some flexibility with it because of things like telecommuting.

This section has elucidated computing women's paths to their careers and their experiences in their careers by using their own words. Next will be an explanation of another researcher's findings about the interviews.

Other Researcher's Opinion

To strengthen the validity and reliability of the interview results, this researcher randomly chose two interviews and sent the recordings, transcripts, and a spreadsheet containing the coding of the answers to another researcher. This second researcher recently received her Ph.D. and has experience in qualitative research and women's issues. The other researcher listened to the recordings and checked for the interviewer-researcher's tone of voice, phrasing of the questions, wait time, and other issues which could bias the results. The second researcher found that the interviewer-researcher used a neutral tone of voice, that she allowed plenty of wait time for interviewees' responses, that she was respectful of the interviewees, that there was no coaching of answers, and that she allowed for open-ended responses. The second researcher also mentioned that the interviewees became more comfortable with the interview as the interview progressed, and that the interviewer-researcher clarified interviewees' answers by asking additional questions as needed. When the second researcher checked the transcripts, she found that the transcripts matched the audio recordings. When the second researcher looked at the assignment of categories and coding of responses for the interviews, she agreed 100% with the interviewer-researcher's categories and the way the interviewees' responses were coded.

Summary

This chapter presented the study's results in two parts, the first one dealing with the survey results and the second with the interviews. The survey part of this chapter first presented the results of the survey questions, then discussed a chi-square analysis of data pairs from the survey results. The interview part of this chapter first explained the results of each interview question, then presented a second researcher's opinion on how the interviews were conducted and coded. The next chapter will discuss and summarize conclusions drawn from the study's results, beginning with answers to the research subquestions.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Introduction

There is an underrepresentation of women earning computing degrees, and the situation has worsened over the last 25 years. Women were awarded about 33% of the bachelor's degrees in computer and information sciences in 1980-1981, but only 22% in 2004-2005 (U.S. Department of Education, 2001, 2007). In the latest government statistic, the percentage of women in most computing careers was 20% to 30% (U.S. Department of Labor, 2006). This compares to women's percentage of about 46% of the employed population and women's percentage of about 56% in all professional occupations (U.S. Department of Labor, 2006).

Women are underrepresented in computing majors and careers. Instead of comparing men and women using a deficit model, this study examined women who had chosen a career in computing/information technology and continue in the field. Investigating the characteristics which distinguish successful computing women from the majority of women who have not chosen computing provides a perspective from which to understand the underrepresented group. This increase in knowledge about women in computing can be used to make recommendations for ways to recruit and retain women in computing/IT in order to increase the percentage of women in the field.

This study investigated factors which influenced computing women having at least a bachelor's degree and at least five years of experience in their careers to choose and to continue to work in computing. This investigation asked these experienced computing women questions about (a) their family, school, and college backgrounds; (b) their individual preferences and personal characteristics; (c) when and why they chose a computing career; (d) their likes and dislikes about their careers; (e) why they remain in computing; and (f) who and what has influenced them to choose and to persist in a computing career.

The research question and its parts which guided the investigation of this study are: What factors or combination of factors influence women to choose and to continue in a computing career? This investigation included the following subquestions:

1. What factors, if any, in their family backgrounds influenced computing women to choose this field?
2. What were the common childhood play and leisure preferences, if any, of women who chose computing careers?
3. What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?
4. What college experiences, if any, influenced women in computing careers to choose and to continue in the field?
5. What factors, if any, in computing women's career situations influenced them to continue in their careers?
6. Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?

Summary of Methodology and Procedures

This study investigated factors that influence women to choose a computing career and to persist in it; women who have remained in the computing/IT field for at least five years and have earned at least a bachelor's degree were studied. This investigation concentrated on experienced computing women because of the belief that the lives of women who chose the career, persist in it, and are successful in their career paths contain important information that can help inform the study of women's choices in this field and can help make recommendations for the recruitment of more women into the computing/information technology field.

By concentrating this investigation on experienced computing women, this dissertation investigated women who not only initially chose a computing career, as other studies (Lips & Temple, 1990; Pearl et al.,1990) have done, but also chose to continue in the computing/IT field. By looking for commonalities among experienced women in computing careers, this study approached the question from a different perspective than the studies (Howell, 1996; Rasmussen & Hapnes, 1991) which compared characteristics of men and women in the field.

Data for this study were collected in two ways. First, an online survey was conducted using the questions shown in Appendix B. Second, 44% of the 50 women completing the online survey were interviewed via telephone using the questions in Appendix C. The survey data was analyzed for commonalities; the interview data was coded and analyzed for patterns. Survey data were triangulated with interview data and findings of research studies from the literature. Research studies in the similarly male-dominated disciplines of mathematics, science, and engineering, as well as studies involving girls and women in computing, were used to compare with this study's survey and interview results. A discussion of the findings follow.

Discussion of Findings

This study's research question is, "What factors or combination of factors influence women to choose and to continue in a computing career?" To investigate this question, it was divided into six subquestions which will be discussed next using this study's results. To make it easier to follow references to different sources in this document, results from the survey will be tagged as (S), interview results will be tagged as (I), and findings from the literature will include the article's reference citation.

Research Subquestion One

Subquestion 1 asks, "What factors, if any, in their family backgrounds influenced computing women to choose this field?" One common trait was that 72% of the women (S) in this study were the first or second child in their family's birth order (Table 23). However, 34% of the women (S) came from one-child or two-child families (Table 24). That leaves 38% of the computing women in this study who were the first or second child in families of three, four, or five children. This finding tends to support Lemkau's finding (1983) that women in predominantly male professions were more likely to be firstborn than women in predominantly female professions; however, Lemkau's study compared women with at least a master's degree in these professions.

Another common trait found among the women in this study was that a majority were from sibling groups that were 50% or more female. Referring to Table 25 and

Figure 16, 74% of the computing women (S) were from sibling groups that were either "all girls," "mostly girls, one boy," or "approximately half girls and half boys." If the percentage of women who were only children (10%) is added to the percentages for the previous groups, then 84% of the computing women (S) grew up in sibling groups that were 50% or more female. This disagrees with Lemkau's finding (1983) that women in male-dominated professions were *not* less likely to have brothers.

This study also found that a majority (80%) of the computing women (S) grew up in a family with a father, a mother, and one or more siblings (Appendix F). Adding to the previous percentage the 4% of participants (S) who grew up in a family with a father, a mother, and no siblings, shows that 84% of the computing women (S) lived with their father and mother during their growing-up years. Lemkau (1983) reported that women in predominantly male careers mentioned more support and encouragement from their fathers than women in predominantly female careers did; this level of encouragement would be achieved more easily with father and daughter living in the same home.

Mothers' Backgrounds

When considering the background of the computing women's (S) mothers, 66% had mothers who worked outside the home at least on a part-time basis (Table 30). Of those mothers who worked outside the home, 34% always worked full-time (Table 30). This supports Lemkau's finding (1983) that women in male-dominated professions were more likely to have mothers who were employed after marriage. It also supports Jagacinski's finding (1987), in the similarly predominantly male field of engineering, that mothers of female engineers were less likely to be homemakers than were the mothers of male engineers. Of the computing women (S) whose mothers worked outside the home, a majority of the mothers (56%) were working by the time the computing woman was 2 years old (Table 31). In fact, the median age of the computing women (S) when their mothers began to work outside the home was 1 year old. This is a new finding. With respect to the careers of the computing women's (S) mothers, no career field stands out as most common, although 10% were teachers, 8% did office work, and 6% were nurses (Table 29).

Regarding the level of education of the computing women's (S) mothers, 6% did not have a high school diploma, 60% had at least some college, with 40% earning at least a bachelor's degree, 18% earning at least a master's degree, and 6% earning a doctorate (Table 27). This shows a higher level of education than the general population. Referring to U.S. Census Bureau information (2006) for the educational attainment of women 25 years of age and older, 14% did not earn a high school diploma (compared to 6% of the computing women's mothers), and 53% reported at least some college (compared to 60% of this study's mothers). The U.S. Census Bureau (2006) also reported that, among women 25 years of age and older, 26% earned at least a bachelor's degree (compared to 40% of this study's mothers), 8% achieved at least a master's degree (compared to 18% of this study's mothers), and 0.8% earned a doctorate (compared to 6% of this study's mothers). The computing women's (S) mothers in this investigation attained a higher level of education than the general population has achieved. Comparing these findings with findings in the literature will be discussed later, after a discussion of the computing women's fathers' backgrounds.

Fathers' Backgrounds

When considering the level of education of the computing women's (S) fathers, 10% did not have a high school diploma, but 60% reported at least some college, with 40% earning at least a bachelor's degree, 28% earning at least a master's degree, and 14% earning a doctorate (Table 28). These fathers, like the computing women's (S) mothers, attained a higher level of education than the general population has achieved. Referring to the U.S. Census Bureau (2006) statistics on the educational attainment of males 25 years of age and older, 15% did not have a high school diploma (compared to 10% of this study's fathers), and 51% reported at least some college (compared to 60% of this study's fathers). The U.S. Census Bureau (2006) also reported that, among men 25 years of age and older, 27% earned at least a bachelor's degree (compared to 40% of this study's fathers), 9% achieved at least a master's degree (compared to 28% of this study's fathers), and 1.8% earned a doctorate (compared to 14% of this study's fathers). When comparing the fathers' level of education with the mothers' education, there were more fathers without a high school diploma (10% compared to 6% of the mothers), an equal percentage of mothers and fathers went to college, and an equal percentage of each group earned a bachelor's degree. But a larger percentage of fathers earned higher degrees, with 28% earning a master's degree or higher (compared to 18% of the mothers), and 14% of the fathers earning doctorates (compared to 6% of the mothers). Both mothers and fathers of these computing women (S) have attained a higher level of education than the general population has achieved.

The careers of the fathers during the computing women's growing-up years (S) do not show a preponderance in one type of field, with 32% in blue-collar fields, 28% in professional fields, and 10% self-employed or owning their own business (Table 32). The rest were scattered throughout other types of jobs and fields. No commonality was evident among the fathers' careers.

The research literature in the similarly male-dominated fields of engineering and mathematics show similar findings about parents' education. Jagacinski (1987) found that the parents of female engineers were more likely to have earned a college degree than were the parents of male engineers. Gavin's study (1998) about students' continuing to study mathematics found that parents with higher education projected higher goals for their child's education than did parents with lesser education.

On the other hand, this study's finding that the fathers' and mothers' careers were not largely in professional fields or concentrated in certain careers disagrees with Jagacinski's finding (1987), from studying the similar field of engineering, that the parents of female engineers more often held professional positions than did the parents of male engineers.

Research Subquestion Two

Subquestion 2 asks, "What were the common childhood play and leisure preferences, if any, of women who chose computing careers?" This study only discovered common traits among participants' favorite TV programs and favorite play activity in elementary school. In the preference for TV programs, 36% of the computing women (S) liked watching cartoons and animated TV programs best (Table 6). This may not be unusual because Cherney and London (2006) reported that girls cited cartoons as one of their three favorite types of TV shows in Cherney and London's study of girls and boys aged 5 to 13 in Omaha, Nebraska. But the Cherney and London study investigated 60 boys and 60 girls in one school in one city. The lack of studies on such childhood preferences, as well as the lack of studies on the relationship between TV show preferences in childhood and later career choices, make it uncertain whether computing women's interest in cartoons in childhood could be an early indication of interest in a computing career.

The favorite play activity among the participants (S) in elementary school was writing/reading, which was chosen by 42% of the computing women (S) (Table 5). It is unclear whether this leisure preference is linked to their later choice of a career. Perhaps this preference for writing/reading was a result of a home environment provided by highly educated parents. That writing/reading is not a common leisure preference among children is supported by Nippold, Duthie, and Larsen (2005), who surveyed 50 sixth-grade girls in Oregon and found that 70% of them liked reading as a leisure activity and 52% liked writing, but other activities (listening to music, riding a bicycle, shopping, and watching TV) were preferred over reading and writing. However, it is unclear whether this preference for writing/reading is linked to the later choice of a computing career; there is need for further study to determine if and how they are linked.

Research Subquestion Three

Subquestion 3 asks, "What factors, if any, in their elementary, middle school, and/or high school experiences influenced women to choose and to persist in a computing career?" The type of school attended by the computing women does not show anything remarkable because a large majority (86%, 84%, and 84%) of the women (S) attended regular public schools in their K-5, 6-8, and 9-12 school years, respectively. An even greater majority (96%, 94%, and 96%) of the computing women (S) in this study attended a coeducational school in their K-5, 6-8, and 9-12 school years, respectively. These findings do not support the findings of some research studies that single-sex schools or single-sex classrooms lead to greater interest in computers for women. Crombie et al. (2002) found that girls in same-gender high school computer courses reported more positive future academic and occupational intentions than did girls in mixed-gender classes; Jones and Clarke (1995) reported that girls from single-sex high school settings in Australia had more positive attitudes toward computers than did girls from coeducational high schools in their study.

Strong Mathematics and Science Backgrounds

A common trait among the computing women (S) in their school years was their early and continuing choice of mathematics as their favorite subject. Thirty-eight percent of the computing women (S) marked that mathematics was their favorite subject in their K-5 school years; 48% noted it as their favorite subject during grades 6-8; and 36% marked that mathematics was their favorite subject in grades 9-12. Although these percentages do not show majorities, the percentages are still higher than for any other subject.

The computing women (S), as a group, earned high GPAs in high school, with a mean of 3.57 on a 4.00 scale, and with 60% of respondents (S) earning a high school GPA of 3.5 or higher. Their high school backgrounds also included a large amount of science and mathematics courses. Seventy percent of participants (S) completed four or more years of science (Table 13), and 84% (S) completed four or more years of high school mathematics courses (Table 10). A majority of these computing women (S), 56%, responded that they did well in every type of mathematics (Table 11). These computing women had strong high school science and mathematics backgrounds and showed strong academic performance in high school.

This study's finding of strong high school mathematics and science backgrounds for these computing women (S) agrees with several studies in the literature. Clarke and Chambers (1989), in their study of first-year college students, reported that women's mathematics experience was related to their intention to pursue further computing studies. In Teague's (2002) interviews of computing women, 5 of the 15 women she interviewed mentioned ability in mathematics as a factor in choosing a computing career. The computing women interviewed by Clarke and Teague (1996) mentioned the importance of high school students keeping their career options open by completing as many mathematics courses as possible. In the related areas of mathematics, science, and engineering, Maple and Stage (1991) discovered that the amount of high school mathematics and science courses completed by the senior year of high school was a strong predictor of both black and white and both males' and females' choice of a mathematics or science major in college. In the area of science careers, a similar finding that women and men in science careers completed more elective high school science courses by personal choice than did those in other careers was reported by Farmer et al. (1999).

Computing Courses

In this study, experience with K-12 computing courses apparently did not have a large influence on most of the computing women's choice of a career because 50% of the women (S) reported that they had no experience with computer software by the end of K-12 school (Table 18). Of those participants (S) who did report computer software experience in K-12, the largest percentage reported experience with word processing, but that was only marked by 32% of respondents (S).

There were other research studies which did not support this study's finding about software experience. One disagreement is cited in Jones and Clarke's article (1995), in which they related that experience with many different types of software in high school was strongly related to a positive attitude toward computers in high school girls. Another disagreement was found in Lips and Temple's article (1990) that reported that previous (high school) experience in computer science played a strong role in undergraduate women's intent to major in computer science. This study also differs with Taylor and Mounfield's finding (1994) that precollege computing experience has a positive effect on women's success in an introductory college computing course.

On the other hand, this investigation's finding that the computing women (S) are successful at computing despite the fact that 50% of them did not have any K-12 computing classes supports Fisher et al.'s discovery (1997) that women in college computing understood computing concepts and earned good grades despite their lack of computing experience prior to college. Another agreement with this study's finding is in Pope-Davis and Vispoel's report (1993), which stated that college women became more confident in their computing ability after they received computer training in college.

First Computing Experiences

Considering the first computer experiences of this study's computing women (I), 59% reported one or more precollege computer experiences at home (32%), or at school (27%) (Table 62). Of these computing women (I), 73% said they felt drawn to computers at that time. This tends to support Fisher et al.'s finding (1997) that women and men majoring in computer science were often first introduced to computers by a parent who worked with computers and/or brought one home. This study also tends to support Levin and Gordon's discovery (1989) that exposure to computers before grades 8-10, especially having a computer at home, had a stronger positive effect on attitude toward computers than being a boy or a girl. Apparently some exposure to computers, but not necessarily a large or varied amount of software experience in school, helped lead to computing careers among the women in this study.

Research Subquestion Four

Research subquestion 4 asks, "What college experiences, if any, influenced women in computing careers to choose and to continue in the field?" This study found their college experiences as critical to many of the computing women's careers. Fifty percent of the women (S) experienced computers for the first time in college (Table 35). For these women, college was the place where they experienced what computing is about and where many of them made decisions concerning their future in the field.

Not only did many women first experience computing in college, the women (S) were very good college students, as evidenced by their GPAs. The mean of the participants' (S) college GPAs is 3.38, and 78% of the computing women (S) earned GPAs higher than 3.00 (Table 20). These women were good students in undergraduate college, as well as in high school, as reported in the last section.

The researcher also investigated which college in the university offered the computing courses taken by these computing women. This study found that 46% of the computing women (S) completed the majority of their computing courses in the college of arts and sciences, 16% in the college of engineering, and 14% in the college of business (Table E3 in Appendix E). This tends to support Camp's finding (1997) that if the computer science department was located in the college of arts and sciences, there were significantly more women graduating with bachelor's degrees than if the department was located in the college of engineering. However, comparing courses/departments located in arts and sciences with those in engineering does not tell the whole story because of the increase in the number of computing degrees involving computer applications and systems, like those in CIS (Computer Information Systems) or MIS (Management Information Systems). The courses for these degrees are often located in the college of business administration. Randall et al. (2003), in their study of the enrollment of women in computer science, information technology, and information systems within the University System of Georgia, found a greater female enrollment in information technology and information systems than in computer science. For present degree programs, it would be more insightful to compare degrees awarded and computing courses completed in the colleges of arts and sciences, engineering, and business administration.

Career Decisions

College was also important to the this study's computing women as the place where many of them chose their careers. About forty percent of the women (S and I) decided on a computing career during their college years (Tables 40 and 52). This finding agrees with Jagacinski's study (1987) of engineers, another predominantly male field, which reported that more than half of the female engineers in the study chose their career in college, as compared to the majority of the male engineers in the study who chose their career in high school. This study's finding of the importance of college experiences to computing women agrees with Teague's report (2002) that 3 of the 15 computing women she interviewed mentioned their university experiences as instrumental to choosing their careers. Because of the importance of the college experience to the career choice of many computing women, the recruitment programs which increased women's enrollment in computing programs at Stanford University (Roberts et al., 2002), Carnegie Mellon University (Fisher & Margolis, 2002), and Central Queensland University in Australia (Clayton & Lynch, 2002) provide a rich source of information about which programs have been successful at increasing women's participation in computing majors.

Discrimination?

Of the 58.5% of computing women (I) who mentioned an awareness of some type of discrimination (Table 58), only 2 women, 15%, mentioned any type of discrimination at school (Table 59). Although any discrimination is unacceptable, this small percentage shows a lower degree of discrimination in schools and colleges than in the women's other experiences. In fact, some women (I) specifically noted the encouragement they received during their college computer experiences, even though they were in the minority. A few even felt it was an advantage to be in the minority in college. As Priscilla stated it, "If anything, I think it was an advantage. . . . You never blend in."

Even though it was mentioned, discrimination was not a main reason for leaving the field noted by those participants (S) who knew a woman who left the computing/IT field. An "uncomfortable work or school atmosphere" was marked as the most important reason for leaving the field by only 9% of the 22 women (S) who marked that question (Table 47). This finding of very little discrimination in schools and colleges was supported in other research studies. Fisher et al. (1997), in their interviews of computer science women at Carnegie Mellon University, reported that some of the women considered gender a non-issue, a few felt disrespected by their male peers because of their gender, but only one female student in the study mentioned faculty members who were nonsupportive.

But sometimes a person may or may not be aware of the subtle biases or discrimination that occur around her. Howell (1996), while studying the experiences of first-year computer science majors in college, reported the presence of subtle gender discrimination even though no one in the study mentioned it overtly. Teague (2002) also cited the subtle and sometimes unintentional discrimination that occurs at some colleges and which could make a female student doubt her abilities and possibly drop out of the field.

Rasmussen and Hapnes (1991) reported that, at the university where they conducted their study, the female computing students felt themselves marginalized and discriminated against because of the dominance of a group of male students there. The results of this study do not agree with this finding from Rasmusen and Hapnes' study.

Research Subquestion Five

Subquestion 5 asks, "What factors, if any, in computing women's career situations influenced them to continue in their careers?" Situations at work were instrumental in many computing women's careers because many of these women either had their first computing experience at work or chose the computing/IT field because of a work opportunity. Many of these women did not major in a computing field in college (refer to Table E2 in Appendix E). Instead, some computing women "fell into it," as interviewee Barbara declared, or "sidestepped into it," as interviewee Vicki expressed it. These computing women either pursued computing as a career change after working at something else or decided on it early in their working life because of an opportunity that presented itself at work. For many women, the opportunity was either to learn computing or to combine their knowledge of another subject with computer skills in order to work with computers in fields like art, libraries, nursing, or museums. This work opportunity often translated into a lifetime career.

Career Decisions

Eight percent of the computing women (S) experienced computing for the first time at work (Table 35). Work experiences were even more decisive for the 50% of the computing women (S) who decided to pursue a career in computing/IT as an adult worker (Table 40). This 50% included 8% who decided shortly after college, 2% who decided in graduate school, and the 40% who pursued computing as a career change after working at something else (Table 40). Verifying this information in the interviews showed similar results.

Two research studies are of particular importance for comparison with the interviews of this study. Because of their importance, it is helpful to consider how these studies were alike or different from this research study in order to make proper comparisons with them. Both Clarke and Teague (1996) and Teague (2002) interviewed professional women in computer-related careers, as this study did. What is unclear are the years of experience of the women in the Clarke and Teague (1996) and Teague (2002) studies. Clarke and Teague (1996) do not mention ages or years of experience for the women computing professionals whom they interviewed; however, some of the job titles, such as database administrator and developer of computer assisted instruction packages, as well as a few comments, such as the women's comments on how much continuing education is part of the job, allude to some of the women having a fair amount of experience in computing/IT. Teague (2002) reported that the interviewees' ages ranged from 21 to 52, with most of them in their 30s; she did not specifically mention their years of experience but did allude to many of the women making their career choice several years ago. The information about these two studies (Clark & Teague, 1996; Teague, 2002) can be kept in mind whenever this paper refers to them.

This study's finding that many computing women (both S and I) chose or found a computing/IT career while they were in their work situation supports findings from other research studies in the literature. Clarke and Teague (1996), in their interviews of 19 computing women, reported that most of the women entered computing after working in another career. Very few of the women interviewed by Clarke and Teague had started out in the field by majoring in computer science. Teague (2002) also stated that 4 of the 15 computing women she interviewed chose computing after graduating in another discipline. A similar situation occurred for some of this study's computing women and will be discussed next. Table E2 in Appendix E contains a list of all their college majors.

Among this study's computing women (S), computing majors included computer science majors, 26%, and management information systems majors, 8% (Table 19). Those participants who majored in business (8%) and engineering (8%) could have a computing component in their majors. When all of the previously mentioned majors are factored out, the most common non-computer science major among the women of this study was mathematics, at 16%. The rest of the computing women (30%) showed a variety of other majors including (a) music education, (b) pre-law, (c) nursing, (d) psychology, (e) statistical genetics, (f) political science and pre-law, (g) elementary education, (h) fine arts, (i) physics, (j) liberal arts, (k) English and creative writing, (l) geology, (m) English literature and secondary education, (n) analytical chemistry and art history, and (o) engineering physics. This variety of majors is consistent with 36% of the computing women (I) mentioning that the reason they chose computing as a career was because they liked combining a subject or interest with computing. It also agrees with Clarke and Teague's interviews (1996), in which many of the women computing professionals noted the advantage of combining computing with some other field.

Job Classification

The classification of jobs for the computing women (I) can shed light on the types of jobs held by women in the computing/IT field. Of the computing women (I), 50% are working in jobs involving software applications, which means that they set up computer software to accomplish specific tasks for their clients or customers, 18% manage a computing team, 14% write programs, and 14% design programs (Table 64). This finding that half of the computing women (I) have jobs involving computer applications supports Randall et al.'s suggestion (2003) that women may be more successfully recruited into the computing/IT field by placing a greater emphasis on computer applications. Randall et al.'s research was conducted at the University System of Georgia where they found more women in computing majors involving applications than in computer science.

How Career Chosen

As a result of the interviews in this study, the researcher classified the interviewees' choice of a computing career into two categories, "actively chose career" or "used an opportunity ('fell into' it)." The researcher used these classifications based on whether it appeared to her that the interviewee had actively chosen her career, or if the interviewee found herself in a computing career because she had taken advantage of an opportunity that presented itself. The classification of "actively chose career" was applied to a computing woman who chose to major in computing or a related field during college and either actively pursued it with part-time jobs in college and/or actively sought a job in the computing/IT field immediately after completing a degree. The classification of "used an opportunity ('fell into' it)" was applied to a computing woman who did not major in a computing field or started her working life in another field, but is presently in the computing/IT field because an opportunity presented itself to move into a computing career. This opportunity may have occurred during a career-choosing time in college, right after college, or while working in another field. The computing women (I) are evenly divided between these two groups, with 50% in each.

The finding that half the computing women (I) used an opportunity after college or at work to start a computing career agrees with Clarke and Teague's finding (1996) that most of the 19 computing women they interviewed had moved into computing as a second career or from some related field. In order to accomplish this, they already had the necessary background in computer courses and/or took more advanced courses in the computing/IT field in order to qualify them for the career change. This study's finding that 50% of the computing women (I) "fell into" their careers supports what Teague (2002) was told by 1 of the 15 working computing women she interviewed, "I didn't choose computing. I fell into it as a way to pay the grocery bills" (Teague, 2002, p. 151).

The discovery that half the computing women in this study found their computing careers as an adult worker has implications for schools, companies, and individuals. Even though these computing women found their field after completing most of their schooling, they still were able to succeed in the field because of their logical ability and their strong mathematics and science backgrounds. As mentioned in the discussion of research subquestion 3, 84% of the computing women (S) completed four or more years of high school mathematics courses, and 70% (S) completed four or more years of high school science. These successful computing women had strong high school mathematics and science backgrounds. This finding points to the necessity of recommending four or more years of high school mathematics and science courses even to young women who have not yet chosen a career field. That way, they will be prepared for any career field that needs such a background, even though they may not have computing/IT in mind as a career when they are in high school. Several studies in the literature (Clarke & Teague, 1996; Farmer et al., 1999; Maple & Stage; 1991) found connections between strong high school mathematics and/or science backgrounds and careers in computing or careers in other predominantly male fields of mathematics, science, and engineering.

Reason for Choosing Career

After the interviews, the researcher also categorized each interviewee's reason for choosing and continuing in computing. Categories were assigned based on comments the interviewee made, her voice inflections, and topics independently mentioned by the interviewee. A majority, 64%, of the computing women (I) appeared to sincerely love the field and their work in it. The category "present job situation meets her needs" was used for those women (I), 27%, who like the advantages of their present position, like telecommuting or pay, but would change to another career in the future if the opportunity presented itself. The final 9% of the computing women (I) mentioned that they liked computing/IT as a well-paid field.

Job Likes

The finding that most computing women (I) like their jobs is not surprising considering the results of interview question 4A, "What do you like about working in computing?" In the survey, when the computing women (S) were asked what they liked best about their jobs, 40% marked that they liked the challenge of their jobs the most, with responses of "pay/benefits," "fulfillment," and "I'm good at it," tied for 14% each

(Table 42). During the interviews, when the computing women (I) could speak at greater length about their jobs, 68% mentioned that they liked how challenging and interesting their jobs are, and 50% stated that they liked their jobs' variety (Table 55).

When the participants (S) were asked about their reasons for staying in their careers, 26% marked "pay/benefits" as their first-choice reason, followed by "challenge" marked by 20% (Table 43). When the computing women (I) were able to explain at greater length in the interviews about why they continue in their careers, "well-paid field and/or good benefits," "I still like it," and "challenging" tied for the most common responses, with 27% of the women (I) mentioning each of those (Table 56). It is notable that many of these experienced computing women answered that they still liked their jobs and continued to find computing challenging.

These results support findings from Clarke and Teague's study (1996) in which the women computing professionals that were interviewed described their work as challenging, not boring; the computing women in Clarke and Teague's study mentioned most frequently that they liked working with people in their jobs and the variety and challenge of a computing career. There is also agreement between this study and Teague's study (2002) in which she asked women computing professionals what they liked about working in computing. Their responses included (a) "change, challenge, and diversity;" (b) "solving a problem and developing a solution;" (c) "the career opportunities, money, and travel;" (d) "the interaction with . . . others;" and (e) "their working environment and flexibility of hours and work location" (Teague, 2002, p. 153). These responses are very similar to those expressed by the computing women (I) in this study and shown in Table 55.

Job Dislikes

As with most any job, the computing women also expressed some dislikes about their jobs. Of the computing women (S), 30% marked “working hours” as what they liked least about their careers, followed by 16% who mentioned “lack of chance for advancement” (Table 44). In the interviews, when the computing women were given more of an opportunity to verbalize what they disliked about working in computing, 36% of the respondents (I) replied that it was the “difficulty in coping with constant change,” followed by a tie between “long hours” and “other people’s lack of understanding of what computing people do,” at 23% each (Table 57). But 14% of the computing women (I) mentioned that they did not dislike anything about their work. The computing women in this study tended to dislike the long working hours associated with their careers, the sometimes difficult task of coping with so much change, and the lack of understanding from others as to what they and the technology itself were capable of accomplishing.

This study’s results were mixed when compared to Teague’s findings (2002). This study and Teague’s study agree that the computing women do not like the long hours that the job often requires, the problems caused by constant change, and problems caused by misunderstanding of computing work by management and users. Teague also reported that the computing women she interviewed mentioned more likes than dislikes about their jobs, which agrees with the results of this study. On the other hand, Teague’s study noted that 5 of the 15 women she interviewed disliked being in a minority and that a majority of the dislikes expressed by the interviewed women, such as the attitude of some men in the field, occurred as a result of being a female in a predominantly male environment. It is unclear how many years of experience the five women who disliked being in a minority had; perhaps a comparison with the women in this study cannot be fairly made because a woman with less than five years' experience who does not like the predominantly male environment could have dropped out of the field before reaching the five years of experience required by this study. In any event, the women in this study (S and I) did not express that they disliked being in a predominantly male environment.

Discrimination?

Most of the computing women in this study who mentioned an awareness of discrimination reported that it had occurred at work. Of the participants (I), a majority, about 59%, mentioned an awareness of some type of discrimination (Table 58). Of the 13 women who reported some type of discrimination, 12 of them reported discrimination at work. Not all of these women experienced discrimination personally. Included in the women (I) who noted an awareness of discrimination were 36% who answered that they had experienced it personally, 18% who remarked that they knew it occurred in the place where they worked but did not experience it personally, and one person, 4.5%, who noted that she had experienced discrimination one time very early in her career, but that was years ago with no other incidents (Table 58). The type of discrimination which occurred is also important to consider. Of the 13 women (I) who noted awareness of discrimination, the largest percentage, 31%, was for each of the classifications of pay discrimination and "lack of respect for her ability" (Table 59). There also were 3 women

(I), 23% of those noting discrimination, who indicated discrimination because of the type of computing culture at their place of work. This type of discrimination, which is identified as due to the computing culture, refers to situations in which a computing woman is made to feel uncomfortable because of expectations in the predominantly male environment or she is made to feel that she does not "fit in." Finally, 3 women (I) (23%) reported discrimination of a sexual nature (Table 59). Because several women mentioned more than one type of discrimination, these percentages total to more than 100%.

In order to discover whether this discrimination is increasing or decreasing, the researcher compared the ages of those women who noted and did not note discrimination. Table 60 shows that the percent of women (I) who noted discrimination decreased, but not steadily, with percentages of 100%, 50%, 67%, 62.5%, and 0% for computing women (I) with ages in their 60s, 50s, 40s, 30s, and 20s respectively. It is disappointing and unacceptable that any discrimination has been occurring, but the fact that none of the computing women (I) in their 20s noted any discrimination may be a sign that discrimination is decreasing. This is mentioned cautiously because the interviewees only included two computing women (I) in their 20s; these two women could have unique career situations, or they possibly did not have enough years of job experience to notice or experience the discrimination noted by the older women. On the other hand, 41% of the computing women (I) answered that they had not been discriminated against, and some of these women were vehement in stressing that they had never felt any type of discrimination. In addition to the 41% (I) who did not feel any discrimination, there were two women (I) who spoke of discrimination in their experience, but who remarked that the situation has been improving and they expect it to continue to improve. One of the two women, with almost 20 years' experience in the field, observed that gender discrimination has lessened in the last 10 years, and that it has certainly lessened during the last 20 years. The other of the two women, even though she noted gender discrimination in her eight years of working in the computing/IT field, commented that there is a lot less discrimination than "what some people and the media at large would like you to think." She also observed that the situation for women in the computing/IT field has improved in the last 10 years and should be improving further in the near future as the field contains fewer of the "old-school guys" who are being replaced by younger workers coming into the field.

This study's finding of some gender discrimination at work agrees with research studies that also noted such discrimination. Jagacinski (1987) reported that in the similarly male-dominated field of engineering, there were pay differences and differences in supervisory responsibilities between the male and female engineers, with the gap widening as the engineers' years of experience increased. Teague (2002) found that 2 of the 15 computing women she interviewed mentioned differential pay rates for men and women. Teague also reported that 2 of the 15 computing women she interviewed remarked about being considered as inferior workers by some men until they proved themselves. This agrees with this dissertation's finding that 31% of the women who noted discrimination mentioned a type that would be classified as a "lack of respect for her ability" (Table 59). Another area of agreement, at least between some of the computing women (I) in this study and some of the women Teague interviewed, is that the younger computing women tended to mention that they liked and got along well with their coworkers, presumably male. This agrees with the two youngest women in this study, who were in their 20s and did not note any discrimination.

Research Subquestion Six

Encouraging People

Subquestion 6 asks, "Who were the people (i.e. parent, mentor, teacher, friend), if any, who influenced women in computing careers to choose and to continue in the field?" There were some mixed findings in answer to this question. When asked who encouraged them the most in their careers, 52% of the participants(S) noted a male encourager (father/stepfather, husband, male sibling, friend, teacher, or group of mostly male friends), 28% answered that they did it on their own, and 10% mentioned a female encourager (mother/stepmother, or female friend) (Table 41). When the computing women (I) were questioned further during the interviews, 41% said they did it on their own, 41% mentioned a male encourager (relative or person in the field), and 9% indicated a female encourager or role model (Table 54). Consequently, this study found that a majority of computing women mentioned that another person encouraged their work in the computing/IT field. For these computing women who cited such encouragement, the encourager was most often male.

This study's finding that a majority of the computing women mentioned a person who encouraged them in their work in the computing field supports the results of research studies in the similar fields of engineering, science, and mathematics. Dick and Rallis (1991) reported that parents and teachers were more influential on the career choices of high school seniors choosing careers in engineering and science than for those choosing other careers, and that teachers' encouragement was especially influential for some women who chose engineering or science. Frazier-Kouassi et al. (1992) reported that the graduate women in her study considered encouragement from other people (whether parents, faculty member, or friend) essential to their success in their undergraduate programs in mathematics or physics.

This study's finding of a major male career influence for those computing women (both S and I) who reported encouragement in their careers supports Lemkau's finding (1983) that women in male-dominated professions often had a positive male influence on their career development. It also supports Teague's interview results (2002) for 7 of the 15 computing women she interviewed who named a male person as contributing to their interest in computing.

But this study also found a considerable percentage of computing women (28% S) who indicated that they accomplished their careers on their own. If this is compared to the personality traits that the participants (S) noted (Table 37), a majority of 70% considered themselves "independent, " and 72% marked "confident." For some computing women, this independence and confidence could have translated into studying and pursuing their careers on their own, without any overt encouragement from others. Although there is a lack of research studies which address this issue in the same way, the results of two studies can be used to help explain the results of this study. Jagacinski et al. (1988) hypothesized that one reason for lower persistence rates for women than for men in college computer science could be attributed to college women having a hard time with the first or second computing class, then giving up because of low self-esteem or feeling that they could not succeed at it. Lemkau (1983) also reported that women in predominantly male professions were more assertive than women in predominantly female professions. Consequently, this study's finding that a number of computing women felt they accomplished their career goals "on their own" and also considered themselves "independent" and "confident" could be a good explanation as to why this study's computing women succeeded when others, who may have been less confident, less independent, or less assertive, dropped out.

Other Issues Uncovered in the Study

Because this study was generative in nature, it uncovered issues not directly addressed by the research subquestions. Three of these issues were: (a) most computing women have few, if any, children; (b) the public image of the computing professional is flawed; and (c) computing women enjoy the aspect of helping people in their careers. These three issues will be discussed next.

Few Children

The first issue not addressed by the research subquestions is the finding that most computing women in this study have few (one or two) or no children. Of the computing women (S), 42% marked that they had no children, 20% reported raising one child, and 20% noted that they had two children (Table 34). This shows a majority of 62% of the computing women (S) had raised or are raising no children or one child. It is unclear whether this finding differs from the number of children raised by working women in other fields. The latest government statistic shows that among working women of ages 15 to 44 years, 44.5% have no children (Dye, 2005); this percent is close to the 42% of women in this study who have no children. However, comparisons to the percent of working women having one child or raising two children could not be made because of the lack of statistics for those cases. The ages in the government statistic also were not a perfect match with the ages of the women in this study.

The finding of computing women having few children agrees with a comment by one of the computing women interviewed by Teague (2002), that not a single one of the computing engineers whom she knew, male or female, was the major caretaker of children. On the other hand, 14% of the computing women (I) mentioned that they continued to work in computing because of the flexibility of their jobs, such as being able to telecommute or to work part-time for a period of time (Table 56). Such flexibility could meet the needs of women to care for children or for other family members. It is unclear from this study whether such flexibility is a recent development which would not appear in the older computing women's comments, or if these flexible opportunities are limited to certain employers. In any event, the flexibility of telecommuting from home and ability to switch to part-time work if needed are hopeful developments in the computing/IT field that may help it better accommodate computing women's caring for family members in the future.

Flawed Image of the Computing Professional

Because the popular image of the computing professional affects who chooses computing as a career, it is important to address whether there is truth to this image, as the computing women in this study see it. This is another issue that was not addressed by any of the research subquestions.

The computing women (S) were asked the question, "How do you consider yourself?" (survey question 47). The participants could mark as many or as few of the choices as they chose to mark. Of the computing women (S), 44% marked "I like most to work on a team," compared to the 32% who marked "I like to work on my own" (Table 37). This shows that most of the computing women in this study preferred to work with people and were not isolated like the popular image of the computing professional portrays. In answer to the same question, 78% of participants (S) marked "likable," and 60% marked "a leader," compared to the very small percentage of 12% who marked "I prefer others to lead" (Table 37). These results show that most of the computing women (S) in this study consider themselves leaders who are likable, not the antisocial and unlikable person in the negative stereotypical image of a computing professional that many young people hold (Clarke & Teague, 1996; Durndell & Thomson, 1997; Schott & Selwyn, 2000).

When the computing women (S) were asked what they liked least about their careers, only 8% marked "impersonal nature of the job" as their first-choice response (Table 44). When the computing women (I) were asked what they disliked about working in computing, only 9% noted the lack of social interaction (Table 57). In fact, 23% of the computing women (I) noted that their people skills or ability to work well with people contributed to their success in computing (Table 61). This shows that most computing women in the study did not feel the isolation or lack of working with people assumed by the popular stereotype of a computing professional.

The responses from this study's computing women (both S and I) that their experience of a computing/IT career is not at all like the stereotype supports research studies in the literature. Fisher et al. (1997) found that the female computing students they interviewed at Carnegie Mellon University emphasized that they did not fit the antisocial stereotype of a computing professional, and the women stressed that they had varied interests, not just computing. Clarke and Teague (1996) emphasized that when the 19 computing professionals they interviewed were asked what they disliked about their jobs, they did not mention the experiences of isolation or loneliness that the stereotypical image portrays.

Helping People as Part of Computing

A third issue which was uncovered in this study but was not addressed in any of the research subquestions is that many computing women sincerely enjoy helping people in their jobs; this is one factor which influences them to continue in the field. This issue will be discussed next.

When the computing women (I) in this study were asked what they liked about working in computing, 32% mentioned that they liked the aspect of their jobs in which they were working with people or helping others, and 14% noted that they enjoyed helping solve people's problems in their jobs (Table 55). Of these same computing women (I), 23% answered that they had good people skills or liked helping people at their jobs, when the interviewer asked them interview question 6, "What personal characteristics do you have that make you good at your career?" One interviewee, who is in a position to hire computing professionals at her job, even remarked that she is only looking for computing professionals who have good people skills because they must work with the public. These computing women (I) also recognized other people's (either coworkers' or the public's) lack of understanding about what their job entails. This lack of understanding by others was cited by 23% of the computing women (I) when they were asked about what they disliked about their jobs.

This study's finding that many computing women like to work with people as part of their jobs is supported in other studies. Clarke and Teague (1996), in their interviews of women computing professionals, reported that most of these women spent a large part of their jobs helping people solve problems with computers and working with people both within their own company and with people from other companies. The women in Clarke and Teague's study mentioned that they particularly liked the part of their jobs spent helping solve users' problems. Fisher et al. (1997) reported that the college computer science women they interviewed referred to using computers as a tool to help investigations in other fields like education, medicine, communication, art, or music; these women were interested in how computing could help people. In the related field of science, Simonis (1982) mentioned how women tend to choose careers that have social benefits, and that includes women in science careers who tend to work on projects which benefit society as a whole or are helpful to future generations.

This issue of how much computing women enjoy helping people at their jobs and the previous issue of how flawed is the public image of what a computing professional does are related issues. But the real problem is not just that the public does not understand what a computing professional's work life is like, because that happens with other professions too; the real problem is that this flawed stereotypical image of a computing professional detrimentally affects the career decisions made by (often young) people and the kind of guidance given to these people by counselors, family members, teachers, and friends. And the effects of these incorrect images influence girls and women disproportionately because of women's already low participation in computing careers. Research studies support the detrimental effects of a flawed stereotypical image. Durndell and Thomson (1997) cited the antisocial image of the computing professional as the main reason given by high school students for not choosing to study computing. In the related field of science, Kelly (1987b) postulates that the seemingly "masculine" image of science may be part of the reason that fewer women than men pursue careers in the field. In the related field of engineering, Tietjen (2004) highlights that it is the public image of engineering that convinces women not to choose engineering, and that people in the field should work to change that image. Montano (2002) reported on how Virtual Development Centers, a project of The Institute for Women and Technology, work to change the stereotypical image of computing, as the sponsored centers aid local communities throughout the country; in the process, students are helped to see the benefits and social uses of computing.

Conclusions and Implications

Computing Woman Profile

As a result of the prior discussion of each research subquestion as well as other issues uncovered in this study, a profile of a typical successful computing woman, as shown in this study, emerges. It is important to be cautious in applying this to an individual computing woman because there may be considerable individual differences from this profile of a "typical" computing woman.

A typical computing woman is equipped with strong high school mathematics and science backgrounds. She was a good student in both high school and college. She either chose the computing field in college or immediately after, or chose or "fell into" it in the workplace after first working at something else. She was probably influenced by a male to try computing as an interest and/or as a career.

This typical computing woman is highly skilled to meet the requirements of the computing/information technology field, including logical skills, a sophisticated understanding of the workings of computers and/or computer software, as well as the people skills needed to successfully interact both on workplace teams and with clients she is helping. She generally likes her work and the computing/IT field, especially the challenge and the constant change in the field. She also likes some of the perks offered through some employers, like telecommuting or working part-time. But the typical computing woman does not like the long hours her job requires and is aware that the constant change can be stressful. She is also very much aware of the stereotypical image of the isolation and lack of social skills of a typical computing professional, and she tends to talk against this stereotype. A computing woman is generally able to handle a male-dominated workplace. She is likely aware of or has personally experienced some discrimination in her workplace, but this is not true of every computing woman, and workplace discrimination appears to be lessening for women in this field. She also is very supportive of attracting more women to the field and recommends it as a good career for other women interested in computing.

A typical computing woman in this study has a family background where she was most likely the first or second child in her family's birth order. Her mother and father achieved a higher level of education than the general population. Her mother worked outside the home and often began such work by the time the typical computing woman was 2 years old. As a child, it is likely that she enjoyed writing and reading. She also tends to come from a sibling group whose members are 50% or more female, or she is an only child; she grew up with a mother and a father at home. On the other hand, in her own personal life, the typical computing woman is likely to have one or no children.

About Successful Computing Women

But it is not enough to describe from this research the profile of a typical computing woman. The underlying reason for this research is to let the lives of successful computing women inform efforts to recruit more women into the field. To help address that issue, this researcher will inspect the lives of successful computing women through another lens.

Illumination for this lens will be provided by using the writings and thoughts of a group of researchers experienced in trying to improve gender equity in mathematics education. Ambrose, Levi, and Fennema (1997) described how their ideal mathematics classroom for girls had evolved. They mentioned how other avenues were tried along the way, but that they now were writing from the belief that every teacher needs to provide gender-fair practices within his/her own classroom. In their own words:

When we try to envision a gender-equitable classroom, our vision is

> blurred—blurred because we are torn between an idealistic stance and a pragmatic stance. Our idealist stance grows out of a conviction that the world should value women's ways of knowing and doing as much as men's and that feminine approaches to knowledge and social interactions should be nurtured in schools. Our pragmatic stance grows out of a realization that the world today values masculine approaches to knowledge and social interaction and that if a female is to succeed in a traditionally male-dominated field, her school experience should give her access to masculine approaches to knowledge and social interactions. (p. 237)

This researcher proposes that the idealistic/pragmatic stance Ambrose et al. (1997) describe for a gender-fair mathematics classroom can be used as a lens in the computing/IT field. This lens of the idealistic/pragmatic continuum can be used both to understand why the computing women of this study are successful in the field and to make recommendations for ways to encourage more women to choose the computing/information technology field as a career.

Idealistic	**Pragmatic**
Make schools/workplaces more conducive to females' ways.	Females learn/develop skills needed in a male-dominated environment.

Figure 22. The Idealistic/Pragmatic Continuum for Computing Women.

The idealistic/pragmatic continuum as applied to women in computing classrooms and careers is shown in Figure 22. On the left side is the idealistic stance that homes, classrooms, work environments, and computing environments should change to make them more comfortable, inviting places for girls and women. On the right side is the pragmatic stance that women and girls should change by acquiring the skills needed to succeed in the often male-dominated environment of computing/IT.

From the results of this study, this researcher observes that successful, experienced computing women have been and presently are successfully navigating the "idealistic/pragmatic" blend of this continuum. Successful women in the computing/IT field have blended the idealistic and pragmatic ends of the continuum to achieve a balance of the two, although this balance is probably never quite the same from one day to the next.

To consider how the idealistic end of the continuum affects computing women, many women in this study have taken advantage of the sometimes required equality of opportunities in college to the point where only two women (I) in this study mentioned any type of discrimination at school or college. In fact, a few of the women (I), mostly the younger ones, spoke of no discrimination and no awareness of any biases; a few instead spoke of encouragement in this field during their college years. Part of the reason why the computing women in this study are successful is the result of some of the changes that occurred in college, school, or workplace environments over the last 25 years in order to make the environment more conducive to women. In the cases of the experienced women who have been in the field for a long time, there may have been a more egalitarian environment early in the history of using computers; the experienced women in this study who began in the computing field at that time may have found an environment conducive to females' ways of thinking because of this initial egalitarianism. The idealistic end of the continuum is also evidenced in some workplaces, such as the ones where two of the computing women (I) spoke of employers who made an effort to check on their comfort levels and see if they were having any problems in the predominantly male environment.

To consider how the pragmatic end of the continuum is shown in the experiences of computing women, most of the computing women in this study, with the experience and kind of success that they have acquired in the computing/IT field, have learned how to navigate and sometimes even thrive in a predominantly male workplace or school environment. A small number of the computing women (I) in this study mentioned being comfortable in a male environment because of being a tomboy or following around an older brother or father and wanting to emulate him. One woman (I) spoke of having a personality in which she is not overly sensitive to slights or teasing which may occur in a predominantly male environment. Many women (I) spoke of successfully participating in or leading work teams with a majority of male members. These are skills which the computing women in this study have learned or developed in order to be successful in their careers in a field that is predominantly male.

However, these computing women are not at one end or the other of the continuum. Each woman's work life shows a blend of the idealistic/pragmatic continuum. For example, the same computing woman who profited from an egalitarian attitude to women in college also learned skills to succeed in a male-dominated environment in those same college courses or from her growing-up years. A computing woman who benefitted from her boss's encouragement to learn computing on the job also acquired the skills needed to be successful in such a predominantly male environment. In these ways, computing women have successfully blended the idealistic end of the continuum, which says that classroom and workplace should become more conducive to women, with the pragmatic stance that women should acquire the skills needed to succeed in the male-dominated environment of computing/IT.

It is with this idealistic/pragmatic continuum in mind that the following implications and recommendations are proposed. But there is a caution. It is the belief of this researcher that success in encouraging more women to choose computing careers is dependent on a successful blending of both ends of the continuum. In our present-day society, it would be as impossible to completely revert to the idealistic end by changing the entire computing/IT field to women's ways of knowing and working, as it would be to totally operate at the pragmatic end in which all computing women change in order to think and work like the men in the field. Successfully attracting more women to the computing/IT field can be achieved by a combination of the idealistic and pragmatic stances along the continuum.

Implications for Stakeholders

A variety of stakeholder groups are involved in recommendations to increase the percentage of women in computing careers. Consequently, implications of this study's research will be described for each of these groups.

K-12 Educators

For K-12 educators (especially in middle and high schools) and policymakers for those schools:

From the idealistic end of the continuum, it is important to promote practices that are conducive to girls learning computing. Put into place practices which are more compatible with females' learning styles, such as collaboration and cooperative groups, allowing for female-only groups when students pair up to use computers, and allowing females to sit beside each other and talk about the work when singly using computers. These measures build on what the Cooper and Stone study (1996) reported, that girls and boys react differently to similar computing situations, and that boys' and girls' learning are impacted differently by similar computing environments. Even if the school has a large number of computers that are available to both girls and boys, it is important to check who is actually using the available computers and to make sure that the girls feel comfortable. Consider having computer time available, possibly after school or at some particular day or time, just for girls. This builds on what Huff (2002) proposes about considering the social context of computer use as well as what several other researchers (Barbieri & Light, 1992; Corston & Colman, 1996; Kiesler et al., 1985) have noted, that in mixed-gender groups the boys often take over the computer and do not allow the girls to have computer time.

From the pragmatic end of the spectrum, schools should help girls acquire skills needed to work among boys and men. Encourage girls' participation in programming classes; require both boys and girls to use technology for projects like making PowerPoint presentations; don't have lower expectations for girls. Other research (Jones & Clarke, 1995; Lips & Temple, 1990; Taylor & Mounfield, 1994) reported that high school computing experience plays a positive role either in attitude toward computers or success in college computing courses.

From the middle of the continuum, where the idealistic and pragmatic stances are blended, comes the recommendation that it is also important for young women to complete as many mathematics and science courses in high school as possible. Achieving this will, hopefully, both prepare young women for the actual world and help transform these classrooms, like the upper-level mathematics courses like calculus and upper-level science courses like physics, into classrooms that are more comfortable for young women just from the presence of more young women there. Because young women may eventually choose computing or another career which they did not anticipate in high school, it is important for all young women to take three or four years of high school mathematics and science to be prepared for many types of careers. Because of this situation, it is recommended for a school or state to require three, or preferably four, years of high school mathematics and science for high school graduates.

Special message for high school teachers and guidance counselors:

Please do *not* dissuade competent and interested young women from a career in computing/information technology because they have a desire to work with and to help people in their careers. This study shows that many women have many opportunities to help people in their computing careers and they relish opportunities to do so. Most computing professionals do not sit in a room and write code all day. Instead, encourage talented and interested young women to pursue a career in computing/information technology as a way to use their abilities and help people. She will have the opportunity to work with other people on teams and in helping clients and will be able to use her special technology and people skills in such a career. As interviewee Belinda wrote in her survey comments, "Computing is one of those rare fields of study that can literally open every door. A girl could go into any industry in any country and get a job at any level with computer skills."

Encourage competent and interested young women to consider a computing career. Clarke and Chambers (1989) reported that women were less likely than men to pursue further studies in computing, even when the women's achievement was comparable to the men's. But Frazier-Kouassi et al. (1992) discovered that encouragement was the key ingredient to women's success in mathematics or physics studies. It may also be a key factor in many women's success in the computing/IT field. In this study, about 70% of the computing women (S and I) noted an encouraging person (Tables 41 and 54). The encouragement of a high school teacher or counselor could be the decisive factor in a young woman's choice of a computing career.

Colleges

For college teachers and decision-makers:

From the idealistic end of the continuum, it is important to promote practices that are conducive to women's mastery of computing skills. From the pragmatic end of the spectrum, it is also important to include in women's college experiences the opportunity to acquire the skills needed to be successfully employed in such a predominantly male field. The next paragraphs will give more details about these concepts.

To help women succeed in college computing courses, possibly change the way computing courses are taught or the sequence of courses to make them more compatible with women's learning styles. For example, build on results from the research on recruitment programs including ones from related disciplines like engineering. Make the college computing experience more interesting to women and more like the experiences they will have on the job, as Zastavker et al. (2006) recommends for the engineering field. Use results from recruitment programs tried at colleges like Stanford University in California (Roberts et al., 2002), Carnegie Mellon University in Pennsylvania (Fisher & Margolis, 2002), and Central Queensland University in Australia (Clayton & Lynch, 2002) to improve the recruitment of women at your own college. Consider instituting recruitment programs which use the research on how women tend to prefer applications of technology and college majors which emphasize such applications (Randall et al., 2003) to recruit more women into computing. Inform the undergraduate computing students about the advantages of combining computing with another discipline and using this to open up career possibilities as Clarke and Teague (1996) mentioned.

Make the college computing experience comfortable for women who choose computing later in their lives than right after high school. Make it easy for women who choose computing at a later point in their lives, possibly after majoring in or starting to work in another field, to enter and complete the college computing curriculum. Of the computing women (S) in this study, 50% chose their computing career as an adult worker. Consider using research from programs like the one described by Humphreys and Spertus (2002) to allow different entry points into the computer science curriculum.

Within the computer classroom and computing programs, try to make the college computing experience as interesting and inviting to women as possible. Allow for female lab groups and female study groups. Promote collaboration and cooperative projects. But also help college computing women acquire skills needed in a traditionally male-dominated field. Help young women to see how applications of computing can be used on the job. Assist them in seeing how computing can be used to help people. Inform women how computing skills can be combined with abilities in other disciplines toward a career using both, as Clarke and Teague's interviews (1996) reported. Guide women computing students to connect to larger organizations of computing women on campus, on the Internet, or nationally. Fight any harassment and discrimination in colleges.

Employers

For employers who hire computing/IT professionals:

In this study, 50% of the computing women (S) chose or found a computing career as an adult worker (Table 40). As a blend of the idealistic and pragmatic ends of the continuum, an employer can recognize abilities and channel potential among women employees by encouraging them to pick up additional education for needed positions. Encourage both male and female employees to add classes or take advanced courses for further accreditation. If you have a job requirement which combines computing skills with knowledge in a particular field, like museums or libraries, consider the skills and abilities of your current employees to see if someone there can pick up additional education to do the job. Two computing women (I) mentioned using this combination of skills, and Clarke and Teague (1996) noted that the women computing professionals they interviewed emphasized the importance of such a combination. Also do your part for the computing field as a whole by giving your employees, especially women, released time so they can make presentations to schools and get involved in career days for schools and colleges.

Among the computing women (I) in this study, 55% reported awareness of some type of discrimination in their job environment. From the idealistic end of the spectrum, it is very important to fight harassment and discrimination on the job, as a matter of fairness as well as to be able to attract the best women computing professionals. A good goal for an employer would be to emulate the employers mentioned by two of the women (I) in this study; these employers periodically check to see if the computing woman is comfortable in her environment and not suffering any type of discrimination, despite her presence in a predominantly male environment on a daily basis.

Parents

For parents, especially parents of girls:

In this study, 40-50% of the participants(S and I) mentioned a male encourager, and about 10% mentioned a female encourager (Tables 41 and 54). From a blend of the idealistic and pragmatic ends of the continuum, encourage your daughters as much as your sons to explore interests and test their ideas in mathematics, science, and technology fields. Encourage your daughters to learn about computers and technology. Have as high expectations for your daughters as you do for your sons. Encourage your daughters to take courses and to be successful in mathematics, science, and technology fields, and praise them for their efforts. Klawe (2002) wrote that most people, including parents, think of computers as a "boy-thing." Parental attitudes, especially fathers' attitudes, can go a long way toward fighting this. Fathers are especially important in encouraging their daughters in computing fields.

Computing Professsionals

For computing/IT professionals:

There is such a flawed, negative image about the work and personalities of computing professionals in the public's mind, that computing professionals themselves can work to change such an image. The women in this study do not reflect the stereotypical public image of a computing professional; 32% of the computing women (I) indicated that they liked working with people or helping others (Table 55), and 23% of the participants (I) mentioned that their good people skills or helping of people contributed to their success at their jobs. This is very different from the public's image of an antisocial, isolated individual working in computing. Based on the idealistic end of the continuum, computing professionals themselves can stress to others how much they work with and help people in their jobs. This can help to attract more girls and women to computing careers. It is also recommended for computing professionals to talk to groups of young people or participate in special programs to help educate the public about what the work of a computing professional is really like, as Tietjen (2004) recommends in the field of engineering.

Software Manufacturers

For software manufacturers, especially of games and educational software:

Girls and boys do not use software for the same purposes. Predominantly, girls' software interests are different from boys' software interests. Girls tend to be interested in software which is used as a tool for their other areas of interest (Wu et al., 2006). Lynn et al. (2003) recommended changing content design to fit girls' interests and preferences. From the idealistic end of the continuum, software and games manufacturers could increase profit by researching and producing educational software and games which appeal to girls. In the process, they can also interest more girls in computing/IT.

Limitations of the Study and Recommendations for Further Research

Limitations

As with any investigation, there were some limitations to this study. One limitation is the size of the survey sample (50 women) and the size of the interview sample (22 women). A larger number of computing women in the sample is needed in order to further analyze the significance of each variable. The questions in this study provided a large number of answers from which to choose so that respondents could find their precise answers. By using the most frequent responses found in this study, limiting the number of categories in each question would facilitate analysis of correlations and other relationships among the variables; such analysis could not be done in this study because of the large number of categories in each question. This study's survey included participation from computing women from at least eight states, and the computing women interviewed came from seven states. However, a survey and interviews involving more women from a greater variety of states, or one that included women from other countries, would show if this study's findings are replicated in a larger group.

Another limitation is the fact that the women self-selected to take the survey. One survey participant commented that she hates surveys of this type, but most others who hate such surveys would just choose not to participate. Therefore, the survey and interview results are colored by the fact that the women who chose to participate may have a different view of working in their computing/IT field than others who possibly chose not to participate. This is a limitation of many surveys. Another limitation of this study is the lack of questions on marital status and income. As a result of the voluntary nature of the study, the researcher chose to exclude such questions because of their sensitive nature and out of concern that potential respondents could consider the questions too intrusive and not participate.

Another limitation of this study is that certain conditions could be experienced by participants who are unaware of them, and consequently the conditions go unreported by the participants. For example, the predominantly male nature of computer software that most people experience as children could be sending such a subtle message about the male nature of computing that no participant mentioned it because none of the participants were aware of it. Huff (1996) wrote that the design of software is affected by the social expectations of the designer, and wrote at a later time (2002) that the social context of computer use should be considered. This subtle message of the male nature of computing could continue throughout a girl's schooling without her awareness of it. Wu et al. (2006) wrote that the way teachers use educational software could appeal more to boys than to girls, which could ultimately lead to more men than women choosing computing and technology careers.

Another limitation is that there could be gender discrimination or gender biases of which women are not even aware and consequently do not mention. Howell (1996) noted subtle gender discrimination in his study, but no one mentioned it. Teague (2002) wrote that there could be subtle or even unintentional gender discrimination in the computing field; this subtle discrimination could cause fewer women to choose it as a career or to continue to major in it in college.

Another limitation is that both the survey and interview results were mostly from women of the white/Caucasian race (88% of women (S); 91% of women (I)).

Recommendations for Further Research

All the findings of this dissertation should be researched further, possibly by using a larger sample size and/or investigating computing women from additional states, a greater variety of states, and/or other countries in order to see if the findings are replicated with larger or more varied groups of computing women. Other recommendations for further research include:

1. Research focusing on computing women of color should be conducted to investigate if computing women of color have different or additional needs from the ones found for the women of this study. Such studies could concentrate on their school and career experiences to find additional needs, if any, which should be addressed to improve women of color's participation in computing careers.
2. Study whether an emphasis on computer applications and/or how computers and information technology are used to benefit people will interest more women to pursue a computing career.
3. Colleges should study and build on other colleges' results from recruitment studies they tried, such as the recruitment programs at Carnegie Mellon and

Stanford. Colleges could investigate which methods and programs worked to recruit more women into computing programs at other colleges, then adjust and adapt them to fit one's own college.

4. Study if there are policies and cultures at certain employers that better provide family-friendly benefits, such as the greater flexibility of telecommuting, flextime, and part-time hours. Publicize these findings throughout the computing/IT field and among employers.
5. Study which types of software and computing games girls and women find appealing. Making games and software which appeal to women and girls could be highly profitable for software and games companies.
6. Study whether certain subareas of the computing/IT field are more favorable for women than other subareas, or if certain types of jobs are friendlier to women and why. For example, are there more women in production areas in computing than in technical areas and why?
7. Study why women who choose computing careers are influenced more by males than by females. Is this influence related to the computing woman's perception of her father's role as being able to deal with worldly issues outside of the home? Lemkau (1983) reported that women in careers that are female-dominated likely had females influence their career choices, and women in male-dominated careers likely had males influence their career choices. Is this male influence on a computing woman's career related to her mother's and father's backgrounds, or is it related to computing being a male-dominated

career?

Concluding Remarks

This researcher began this study with no preconceived ideas about what factors influence computing women to choose the field. The researcher cast a very wide net, with survey questions covering every possible area, in order to find areas of commonality among the women who were surveyed and among the women who were interviewed. This researcher finds personal fulfillment in the fact that this study found common traits among these computing women, and knowledge was gained to provide recommendations on ways to help increase women's participation in computing careers.

Despite the declining percentage of women in computing careers, there are reasons for hope of attracting more women to the field. This hope is based in three areas. First, it appears that historic discrimination is diminishing, at least with some employers and some colleges. However, it is unknown as to how a more competitive job market will affect this decrease of discrimination. Second, most computing women sincerely enjoy their jobs. With some changes in workplace procedures and attitudes, the computing/IT field can become a more satisfying and fulfilling place for women to work. Third, the success of recruitment and retention programs at certain colleges signal a way to interest more women into choosing a computing career; these programs can be applied and adapted to other colleges. This researcher would like to close with a message of hope to women considering a computing career, by using interviewee Belinda's words, "If you feel like you're so talented that you could do almost anything, get into computer science because computer science will open every door for you."

APPENDIXES

APPENDIX A

KENT STATE UNIVERSITY

Dear Computing Professional,

I am a doctoral candidate at Kent State University working on my dissertation. My dissertation project is "Women in Computing Careers". The purpose of my dissertation is to study the factors that influence women to choose computing/information technology careers, from the viewpoint of women who have established careers in the field. During my 15 years of teaching computer programming to high school students, I became frustrated by the small number of women in class. Even when they were good at programming, the young women often chose not to take the advanced classes despite encouragement on my part. I became interested in what influences a woman to choose computing as a career and to continue in the field.

My study consists of a survey to be completed by women professionals in the computing/information technology field. A small subset of this group will be contacted for a follow-up telephone interview to study certain aspects of the survey in greater depth.

If you complete this survey, you will help us learn why certain women choose and continue to work in the computing/information technology field. The more we learn about this topic, the more we can understand how to recruit and retain women in this career. Ultimately, you can help increase the number of women in computing/information technology by completing this survey.

Taking part in this survey is entirely up to you, and you are free to discontinue your participation at any time. Your responses to all questions and your participation in this project will remain confidential. Your name will not appear in any part of the dissertation. Participants in the telephone interviews will have pseudonyms.

Due to the nature of the study, the survey specifically targets women who have a four-year college degree and whose occupation title is one of the following: computer information scientist, computer programmer, computer software engineer, computer hardware engineer, computer systems analyst, database administrator, network and computer systems administrator, network systems and data communications analyst, operations research analyst, or other similar job title. The participant must have been actively working in the field for at least 5 years. If this applies to you, I would appreciate your completion of my survey located at http://newmedia.kent.edu/computing/ . If you know of another woman who has been working at one of these positions for at least 5 years, please invite her also to respond.

If you want to know more about this research project, please call me at xxx.xxx.xxxx or email me at Vkolacz@aol.com or my advisor Dr. Trish Koontz at 330.672.0640 or email her at tkoontz@kent.edu. This project has been approved by Kent State University. If you have questions about Kent State University's rules for research, please call Dr. John West, Vice President for Research and Dean of Graduate Studies at 330.672.3012.

Thank you for your willingness to complete this survey. You have made a valuable contribution to the study of women in computing and technology.

Sincerely,
Vilma Kolacz-Belanger

APPENDIX B

Women in Computing Survey

Please select one:

- I am starting a new survey.
- I am returning to continue an existing survey.

Please fill these in to help identify your survey:

Your Initials [ ] (Use First, Middle, Last) and Birthday (Month/Day): [ ] / [ ]

Continue

Women in Computing Survey

Please answer the following questions to the best of your ability. If your answer is not listed, add it using the space below the question or the place for comments (#59) at the end of the survey.

1. I am a woman in the computing and/or information technology field.

True ○ False ○

2. I have been in the computing and/or information technology field for ____ years. (Please give approximate number of years in the field; it should be 5 or more years for participation in this survey.)

3. My job title is: (Add short description if necessary.)

Continue >>

Save & Exit

Women in Computing Survey

Early Years

4. Which type of play activities did you engage in most as a child in elementary school? Please number your top 5 choices from this list from greatest engagement (1) to least engagement (5).

- computer/technology games
- building things
- organized team sports
- taking apart things to see how they work
- individual sports
- informal neighborhood sports
- nature activities
- art & music activities
- group play activities
- writing/reading
- playing with paper dolls
- playing with dolls/stuffed toys

Other/comment

5. Which type of playmates did you typically have as a preschool/elementary school child? (If more than one applies, rank the top 3 as most often (1), second most often (2), to least often (3).)

- played alone
- several girls
- one girl playmate
- several boys
- one boy playmate
- mostly sibling(s)
- group of boys & girls
- I don't remember

Other/comment

6. Which type of TV programs did you like to watch most as a child? (If more than one applies, rank the top 3 as most often (1), second most often (2), to least often (3).)

- I watched very little or no TV
- sitcoms
- nature/science programs
- cartoons/animated
- dramas
- action programs
- variety/music
- talk shows
- programs about how things work
- science fiction

Other/comment

7. Which type of school did you attend in grades K-5? (For predominant number of years in K-5).

- public
- public magnet school
- private, with religious mission
- private, no religious mission

8. Who were your classmates in grades K-5? (For predominant number of years in K-5.)
   - ○ boys and girls
   - ○ all girls
   - ○ mostly girls (only a few boys)
   - ○ coed with some classes single sex

9. What was your favorite subject in elementary school (K-5)? If more than one applies, rank the top 3 as (1) liked the most, (2) liked second most, through (3).
   - [ ] math
   - [ ] science
   - [ ] English
   - [ ] other language(s)
   - [ ] history (or social studies)
   - [ ] art
   - [ ] music
   - [ ] reading
   - [ ] physical education

   Other/comment ________

10. Which type of school did you attend in grades 6-8? (For predominant time in grades 6-8.)
    - ○ public
    - ○ public magnet school
    - ○ private, with religious mission
    - ○ private, no religious mission

11. Who were your classmates in grades 6-8? (For predominant time in grades 6-8.)
    - ○ boys and girls
    - ○ all girls
    - ○ mostly girls (only a few boys)
    - ○ coed with some classes single sex

12. What was your favorite subject in school in grades 6-8? If more than one applies, rank the top 3 as (1) liked the most, (2) liked second most, through (3).
    - [ ] math
    - [ ] science
    - [ ] English
    - [ ] other language(s)
    - [ ] history (or social studies)
    - [ ] art
    - [ ] music
    - [ ] reading
    - [ ] computer courses
    - [ ] physical education

    Other/comment ________

Continue >>

Save & Exit

Women in Computing Survey

High School Years

13. Which type of school did you attend in grades 9-12? (For predominant time in grades 9-12.)

- ○ public
- ○ public magnet school
- ○ private, with religious mission
- ○ private, no religious mission

14. Who were your classmates in grades 9-12? (For predominant time in grades 9-12.)

- ○ boys and girls
- ○ all girls
- ○ mostly girls (only a few boys)
- ○ coed with some classes single sex

15. What was your favorite subject in grades 9-12? If more than one applies, rank the top 3 as (1) liked the most, (2) liked second most, through (3).

- [ ] math
- [ ] science
- [ ] English
- [ ] other language(s)
- [ ] history (or social studies)
- [ ] art
- [ ] music
- [ ] reading
- [ ] computer courses
- [ ] physical education
- [ ] business

Other/comment ____________

16. The number of years of mathematics courses you completed in high school:

○ 1 ○ 1 ½ ○ 2 ○ 2 ½ ○ 3 ○ 3 ½ ○ 4 ○ more than 4

17. In which type(s) of math did you do well in high school?

- ☐ Geometry
- ☐ Algebra
- ☐ Statistics/Probability
- ☐ Every type of math
- ☐ Not very good at math
- ☐ I don't remember

18. What influenced you to take mathematics courses in high school? If more than one applies, order from greatest (1) to least (5).

- [ ] I did well in math
- [ ] It was needed for my career
- [ ] I like math
- [ ] I was encouraged to take it
- [ ] I took only what was required

Other/comment ____________

19. The number of years of science courses you completed in high school:

○ 1 ○ 1 ½ ○ 2 ○ 2 ½ ○ 3 ○ 3 ½ ○ 4 ○ more than 4

20. In which type(s) of science did you do well in high school?

- ☐ Physics
- ☐ Biology
- ☐ Chemistry
- ☐ Geology/Environmental Science
- ☐ Space Science
- ☐ Every type of science
- ☐ Not very good at science
- ☐ I don't remember

21. What influenced you to take science courses in high school? If more than one applies, order from greatest (1) to least (5).

- [▾] I did well in science
- [▾] It was needed for my career
- [▾] I like science
- [▾] I was encouraged to take it
- [▾] I took only what was required

Other/comment [ ]

22. What was your approximate high school GPA (using 4.00 as highest)?

[ ]

23. By the end of high school, with which type(s) of software programs did you have substantial experience? Please check all that apply. (Consider all of your computing experiences in grades K-12.)

- ☐ word processing
- ☐ spreadsheets
- ☐ programming language(s)
- ☐ web design
- ☐ presentation software
- ☐ authoring/publishing software
- ☐ databases
- ☐ games
- ☐ email
- ☐ Internet use
- ☐ data acquisition software
- ☐ I don't remember
- ☐ None of these
- ☐ did not experience any computer software in K-12

Other/comment [ ]

[Continue >>]

[Save & Exit]

Women in Computing Survey

Higher Education

24. For your undergraduate work, which type of college/university did you attend? Check all that apply. If you attended more than one type of college/university, rank your answers as 1(most time there), 2 (next most time there), etc.

private college	public college/university	technical or community college
small	small	small
large	large	large
women's		
religious		

Other:

25. What was your undergraduate college major(s)?

26. For the majority of your computing courses, in which college were the courses located?

- Arts and Sciences
- Engineering
- Business
- Education

Other:

27. What was your approximate undergraduate GPA? (With 4.00 being highest)

28. Do you have a masters' degree?

Yes (go on to the next question) No (skip the next question)

29. In which field is your master's degree? Include degree and major.

30. What is your highest level of education attained?

bachelor's degree some work beyond master's degree

- some graduate work
- doctorate
- master's degree

31. When did you pursue the majority of your studies in the computing/information technology field?

- 1960's
- 1970's
- 1980's
- 1990's

32. Which best describes your experience while studying in your computing/IT courses? (Check any that apply.)

- I had a female friend who took classes in the field with me.
- I had a male friend who took classes in the field with me.
- I had a female college friend who encouraged my efforts in the field.
- I had a male college friend who encouraged my efforts in the field.
- I continued despite opposition from others in the field.
- I continued despite opposition from my friends.
- None of the above applies to me.

Comment:

Continue >>

Save & Exit

Women in Computing Survey

Family background

33. Your position in family birth order: (Please fill in each blank with the appropriate number.)

I am # [ ] of [ ] children.

34. Which best describes your sibling group?

- only girl among boys
- all girls
- approximately half girls and half boys
- only child
- mostly girls, one boy

35. For the majority of your childhood, what was your family makeup?

- father, mother, and one or more siblings
- father and mother only
- father only
- mother only
- father, stepmother, and one or more siblings and/or step/half siblings
- mother, stepfather, and one or more siblings and/or step/half siblings
- father and siblings and/or step/half siblings
- mother and siblings and/or step/half siblings
- grandmother and/or grandfather with/without siblings

Other/comment: [ ]

36. With which person(s) in your family did (do) you feel closest? (If more than one applies, pick the 2 most important and rank them as 1 (closest) and 2 (next closest).)

[▾]	father	[▾]	mother
[▾]	grandmother	[▾]	grandfather
[▾]	sister	[▾]	brother
[▾]	stepmother	[▾]	stepfather
[▾]	stepsister	[▾]	stepbrother

Other(specify): [ ]

37. What was your mother's highest level of education attained? (For this question, □mother□ refers to the person who was the mother figure in your life, whether or not she is/was your biological mother.)

- no high school diploma
- high school diploma
- some college
- college degree (associate)
- college degree (bachelor's)
- some graduate courses
- master's degree
- doctorate
- no mother figure in my life

38. What was your father's highest level of education attained? (For this question, "father" refers to the person who was the father figure in your life, whether or not he is/was your biological father.)

- no high school diploma
- high school diploma
- some college
- college degree (associate)
- college degree (bachelor's)
- some graduate courses
- master's degree
- doctorate
- no father figure in my life

39. What type of job/career did your mother have during your growing-up years?(Note for question #37 also applies here.) (Answer may be homemaker if that applies.)

If your mother worked outside the home, please answer questions 40 and 41. Otherwise, skip to #42.

40. If your mother worked outside the home, check the one which applies:

- always part time
- always full time
- sometimes part time, sometimes full time
- at first part time, then it became full time as children got older

Other:

41. If your mother worked outside the home, how old were you when she started to work?

42. What type of job/career did your father have during your growing-up years? (Note for question #38 applies here.) (Answer may be homemaker if that applies.)

43. What is your race? (Please check one.)

- Asian or Pacific Islander
- Black or African American
- White or Caucasian
- American Indian or Alaska Native

Other:

What is your ethnicity? (Please check one.)

- of Hispanic origin
- Not of Hispanic origin

44. What is the total number of children that you are raising or that you raised?

none 1 2 3 4 5 6

If more than 6, write the number here:

Continue >>

Save & Exit

Women in Computing Survey

Career decisions

45. Which best describes your first experience with computers?

- ( ) We had a computer at home and I first used it there.
- ( ) I first used computers in school in grades K-12.
- ( ) I first used computers in college.
- ( ) I first used computers at a friend's house.
- ( ) I first used computers at a relative's house.
- ( ) I first used computers at the community library.
- ( ) My first experience with computers was with one I bought or built myself.

Other: ________

46. What first interested you in computers? If more than one applies, rank them as 1 (most influential), 2 (second most influential) through 3 (third most influential).

- [▾] the inner workings of the computer
- [▾] the computer's ability to do complex operations
- [▾] the usefulness of the computer as a tool to accomplish other tasks
- [▾] the job possibilities of the computer field
- [▾] I saw someone else using it and wanted to learn about it too

Other: ________

47. How do you consider yourself? (Check as many as apply.)

- [ ] confident
- [ ] sociable
- [ ] likable
- [ ] independent
- [ ] a leader
- [ ] I prefer others to take the lead
- [ ] I like to work on my own
- [ ] I like most to work on a team
- [ ] none of these

48. Which person do you believe influenced your career choice the most? If more than one applies, pick the two most influential and rank them as 1 (most influential), and 2 (second most influential).

[▾] mother	[▾] father	[▾] teacher
[▾] counselor	[▾] other relative	[▾] best friend
[▾] son	[▾] daughter	[▾] no person

Other (specify): [ ]

49. What do you think is the most important reason for your career choice? If more than one applies, please number them from 1 (most important) , 2 (second most important), through the number of choices that pertain to you.

- [▾] pay/benefits
- [▾] genuine interest and desire
- [▾] I'm really good at it
- [▾] availability of jobs
- [▾] parental influence
- [▾] influence of peers
- [▾] ability to devote time/effort to this career

Other (specify): [ ]

50. When did you decide to go into the computing/information technology field?

- ( ) before high school
- ( ) during high school
- ( ) in college
- ( ) during graduate school
- ( ) career change after working at something else

Other (specify): [ ]

51. What is the best description of the person(s) who supported/encouraged your efforts in the computing/information technology field? (If more than one applies, pick the 2 most important and rank them as 1 (most support/encouragement) and 2 (next most support/encouragement).)

- [▾] female friend
- [▾] female sibling
- [▾] male friend
- [▾] male sibling
- [▾] father/stepfather
- [▾] mother/stepmother
- [▾] male teacher
- [▾] female teacher
- [▾] husband
- [▾] wife
- [▾] son
- [▾] daughter
- [▾] my children (son(s) and/or daughter(s))
- [▾] group of mostly male friends
- [▾] group of mostly female friends
- [▾] group of male & female friends
- [▾] no one; did it on my own

Other(specify): [ ]

[Continue >>]

[Save & Exit]

Women in Computing Survey

Career decisions cont.

52. What do you like most about your career? If more than one applies, please number them from 1 (liked most), 2 (liked second most), through the number of choices that pertain to you.

- challenge
- pay/benefits
- my employer
- working hours
- fulfillment
- it's something I always wanted to do
- my co-workers
- I'm good at it
- my ability to devote time/effort to this career

Other (specify):

53. What do you think has been most responsible for your staying in the computing/IT field? If more than one applies, please number them from 1(most responsible), 2 (second most responsible), through the number of choices that pertain to you.

- challenge
- pay/benefits
- my employer
- working hours
- fulfillment
- it's something I always wanted to do
- my co-workers
- I'm good at it
- my ability to devote time/effort to this career

Other (specify):

54. What do you like least about your career? If more than one applies, please number them from 1(liked least), through the number of choices that pertain to you.

- working hours
- lack of chance for advancement
- pay/benefits
- impersonal nature of job
- co-workers
- my employer
- lack of challenge
- lack of fulfillment
- doesn't mesh well with family responsibilities

Other (specify):

55. What is your experience in working for your present employer? (Check all that apply.)

- large company
- small company
- often the only woman in my project group
- usually one of many women in my project group

☐ there are only women in my project group

Other (specify):

56. Please answer this question while thinking about previous employers, if any.

What was your experience in working for the employer for whom you worked longest in the computing/IT field (if it is different from your present employer)?

☐ large company ☐ small company

☐ often the only woman in my project group

☐ usually one of many women in my project group

☐ there are only women in my project group

Other (specify):

This question (#56) does not apply to me since I

○ have had only one employer

○ already gave the information for this employer in previous question (#55)

57. Do you know any women who started in the computing/IT field (in college or in a career) and dropped out or changed to another career?

○ Yes (go on to the next question) ○ No (skip the next question)

58. When thinking of the women from the previous question, why do you think they dropped out of the computing/IT field or changed to another career? If more than one reason applies, please number them from 1 (most important), 2 (second most important), through the number of choices that apply to the woman (women) you are considering.

[▾] academic problems [▾] uncomfortable work/school atmosphere

[▾] did not like the subject/work [▾] discouraged by teachers/supervisors

[▾] career was not compatible with child-raising responsibilities

[▾] career was not compatible with marriage or other family responsibilities (other than child-raising)

Other (specify):

Continue >>

Save & Exit

Women in Computing Survey

59. Please write additional comments from any of the above questions (please tell which question), or other statements you would like to make about your career, why you chose it, why you continue in it, etc.

60. In addition to this survey, I will be conducting telephone interviews with a number of survey participants for clarification of some answers. It is essential to my research to probe some questions in greater depth; please consider allowing me to interview you by telephone. (Your name will not be used in reporting the findings.) The interview will only take a small amount of your time, but it will help my research tremendously. The day and time will be at your convenience.

Please check one of the following:

I AM   I AM NOT willing to answer these and other related questions in greater depth in a telephone interview that will be audiotaped. If you are willing to be phone interviewed, please fill in your email address:

Complete

Thank you for your time and willingness to help us learn more about women in computing careers.

APPENDIX C

INTERVIEW GUIDE QUESTIONS

—I would like to record this interview for research purposes. Do I have your permission to do so?

1. A. When did you decide on a career in computing?
   B. What was your age then? What is your approximate age now?

2. Why did you choose computing as a career?

3. Was there a person who gave you the most encouragement to pursue a computing career or did you mostly do it on your own? Tell me about it.

4. A. What do you like about working in computing?
   B. Why do you continue to work in computing?

5. A. What do you dislike about working in computing?
   B. Did you encounter discrimination or obstacles in school or at work because you're a woman in computing? Explain.

6. What personal characteristics do you have that make you good at your career?

7. A. How old were you when you had your first experience with computers? Describe that experience.
   B. Were you drawn to computers then? In what way?

8. What would you say to a young woman interested in a computing career right now?

9. Is there anything else you would like to say on the topic of women in computing?

10. A few quick demographic questions:
   A. In which state do you live?
   B. How long have you been working in computing?
   C. What kind of work do you do? What is your job title? Where do you work?
   D. Since references to you will not use your actual name, what name would you like me to use instead?

11. Is there anything else you'd like to say or any questions that you have?

APPENDIX D

RESULTS FROM PRESCHOOL THROUGH HIGH SCHOOL
NOT DISPLAYED IN CHAPTER IV

Table D1.

First-Choice Responses to Survey Question 5, "Which Type of Playmates Did You Typically Have as a Preschool/Elementary School Child?"

Type of playmate	Percent (n=50)
One girl playmate	34
Mostly sibling(s)	28
Several girls	18
Group of boys & girls	10
Played alone	6
Several boys	4

Table D2.

Type of School Attended in Grades K-5

Type of school	Percent (n=50)
Public	86
Private, with religious mission	8
Public magnet school	4
Private, no religious mission	2

Table D3.

Gender of Classmates in Grades K-5

Classmates	Percent (n=50)
Boys and girls	96
All girls	4

Table D4.

Type of School Attended in Grades 6-8

Type of school	Percent (n=50)
Public	84
Private, with religious mission	10
Public magnet school	6

Table D5.

Gender of Classmates in Grades 6-8

Classmates	Percent (n=50)
Boys and girls	94
All girls	4
Answer missing	2

Table D6.

Type of School Attended in Grades 9-12

Type of school	Percent (n=50)
Public	84
Private, with religious mission	8
Public magnet school	8

Table D7.

Gender of Classmates in Grades 9-12

Classmates	Percent (n=50)
Boys and girls	96
Coed with some classes single sex	2
Mostly girls (only a few boys)	2

APPENDIX E

RESULTS FROM COLLEGE NOT DISPLAYED IN CHAPTER IV

Table E1.

Type of Undergraduate College or University Attended

Type of college/university	Percent (n=50)
Answer missing	30
Large public	28
Small private	18
Small public	10
Large private	8
Small religious private	2
Public	2
Small technical or community college	2

Table E2.

Undergraduate College Major

College major	Number of participants
Analytical chemistry & art history	1
Business	2
Business administration	1
Computer programming for mainframe	1
Computer science	4
Computer science & applied math	1
Computer science & art	1
Computer science & business administration	1

College major	Number of participants
Computer science & math	1
Computer science & sociology	1
Computer science in engineering	1
Computer technology & math	1
Consumer science	1
Education	1
Elementary education	1
Engineering physics	1
English & creative writing	1
English lit & secondary education	1
Fine art	1
Geology	1
Industrial engineering technology	1
Information technology	1
Liberal arts	1
Management	1
Management information systems	3
Management information systems & psychology	1
Math & computer science	2
Math & history	1
Mathematics	5
Mechanical engineering	1
Music education	1
Nursing	1
Physics	1

College major	Number of participants
Political science & pre-law	1
Pre-law	1
Psychology	1
Statistical genetics	1
Systems & control engineering	1
Answer missing	1
Total	50

Table E3.

College Where Computing Courses Were Taken

Type of college	Percent (n=50)
Arts and Sciences	46
Engineering	16
Business	14
No college computer course	8
Education	8
Not applicable	4
Technology	2
Answer missing	2

Table E4.

Master's Degree Field

Field	Number of participants
Business	4
Computer science	2
Computers & information systems	1
Education	2
Engineering	2
Human ecology & education	1
Journalism	1
Library science & technology (2 degrees)	1
Mathematics	2
Media arts & science	1

Table E5.

Answers to the Question, "Which Best Describes Your Experience While Studying in Your Computing/IT Courses?"

Experience	Percent
I had a female friend who took classes in the field with me.	18
I had a male friend who took classes in the field with me.	16
I had a male college friend who encouraged my efforts in the field.	14
I had a female college friend who encouraged my efforts in the field.	10
I continued despite opposition from others in the field.	8
I continued despite opposition from my friends.	2
None of the above applies to me.	62

APPENDIX F

CHILDHOOD FAMILY MAKEUP

Family group	Percent (n=50)
Father, mother, and one or more siblings	80
Mother, stepfather, and one or more siblings and/or step/half siblings	6
Father and mother only	4
Father only	2
Mother only	2
Mother and siblings and/or step/half siblings	2
Mother, grandmother, and one sibling	2
Answer missing	2
Father, stepmother, and one or more siblings and/or step/half siblings	0
Father and siblings and/or step/half siblings	0
Grandmother and/or grandfather with/without siblings	0

APPENDIX G

CHI-SQUARE SIGNIFICANCE FOR SELECTED PAIRS
OF CATEGORICAL SURVEY DATA

Pairs of Data	Significance
Favorite childhood activity; favorite subject K-5	.090
Favorite subject K-5;favorite childhood TV program	.486
Favorite childhood activity; favorite subject 6-8	.956
Favorite childhood activity; favorite subject 9-12	.989
Common childhood playmates; favorite subject K-5	.416
Common childhood playmates; favorite subject 9-12	.605
Common childhood playmates; number of children in family	.233
Sibling group; common childhood playmates	.345
Family position (birth order); common childhood playmates	.470
Favorite subject 9-12; number of math courses	.964
Favorite subject 9-12; decade of year pursued	.783
Favorite subject 9-12; highest education attained	.376
Favorite subject 9-12; decade of year pursued	.783
Number of math courses; influence on taking math courses	.380
Number of science courses; influence on taking science courses	.003 *
Family position (birth order); closest family member	.955
Family position (birth order); first computer interest	.694
Family position (birth order); first computer experience	.874
Family position (birth order); highest education attained	.665
Family position (birth order); number of children raised	.470
Family position (birth order); family makeup	.983
Family position (birth order); reason for choosing career	.286
Family position (birth order); person with most influence on career	.932

Pairs of Data	Significance
Mother's education; highest education attained by participant	.771
Father's education; highest education attained by participant	.524
College of computer courses; decade of year pursued	.469
College of computer courses; highest education attained by participant	.666
First computer experience; when decided on career	.333
Closest family member; encouraging career person	.844
Encouraging person; person with most influence on career	.725
Reason for choosing career; person with most influence on career	.797
When decided on career; years in computing	.998
Decade of year pursued; first computer experience	.036 *
Decade of year pursued; first computer interest	.148
Decade of year pursued; career reason	.549
Decade of year pursued; encouraging career person	.717
Decade of year pursued; when decided on career	.065
Decade of year pursued; person with most influence on career	.396
Decade of year pursued; like most about career	.381
Decade of year pursued; reason to stay in career	.687
Decade of year pursued; like least about career	.806
Grouped years in computing; decade of year pursued	<.001*
Grouped years in computing; when decided on career	.269
Grouped years in computing; college of computer courses	.358
When decided on career; reason for choosing career	.783
When decided on career; person with most influence on career	.931
When decided on career; like most about career	.976
When decided on career; like least about career	.728
When decided on career; encouraging career person	.759

Pairs of Data	Significance
When decided on career; number of children raised	.263
Career reason; like least about career	.713
Like most about career; reason to stay in career	.036 *
Number of children raised; decade of year pursued	.730
Number of children raised; reason for choosing career	.483
Number of children raised; highest education attained	.597

*significant at .05 level, using 95% confidence level

REFERENCES

REFERENCES

Ambrose, R., Levi, L., & Fennema, E. (1997). The complexity of teaching for gender equity. In J. Trentacosta & M. J. Kenney (Eds.), *Multicultural and Gender Equity in the Mathematics Classroom: The Gift of Diversity* (pp. 236-242). 1997 Yearbook. Reston, VA: National Council of Teachers of Mathematics.

American Association of University Women (AAUW). (1992). *How Schools Shortchange Girls.*

American Association of University Women (AAUW). (2000). *Tech-savvy: Educating Girls in the New Computer Age.*

Ames, P. C. (2003). Gender and learning style interactions in students' computer attitudes. *Journal of Educational Computing Research, 28*(3), 231-244.

Anderson, R. E. (1987). Females surpass males in computer problem solving: findings from the Minnesota computer literacy assessment. *Journal of Educational Computing Research, 3*(1), 39-51.

Baker, D. & Leary, R. (1995). Letting girls speak out about science. *Journal of Research in Science Teaching, 32*, 3-27.

Balcita, A. M., Carver, D. L., & Soffa, M. L. (2002). Shortchanging the future of information technology: the untapped resource. *ACM SIGCSE Bulletin, 34*(2), 32-35.

Barbieri, M.S. & Light, P.H. (1992). Interaction, gender, and performance on a computer-based problem solving task. *Learning and Instruction, 2*, 199-213.

Borg, A. (2002). Computing 2002: democracy, education, and the future. *ACM SIGCSE*

Bulletin, 34(2), 13-14.

Busch, T. (1995). Gender differences in self-efficacy and attitudes toward computers. *Journal of Educational Computing Research, 12*(2), 147-158.

Busch, T. (1996). Gender, group composition, cooperation, and self-efficacy in computer studies. *Journal of Educational Computing Research, 15*(2), 125-135.

Callan, J. M. (1996). Attitudes toward computers: the changing gender gap. *Feminist Collections, 17*(2), 30-33.

Camp, T. (1997). The incredible shrinking pipeline. *Communications of the ACM, 40*(10), 103-110.

Campbell, P. B. (1995). Redefining the "girl problem in mathematics." In W. G. Secada, E. Fennema, & L. B. Adajian (Eds.), *New Directions for Equity in Mathematics Education* (pp. 225-241). Cambridge: Cambridge University Press.

Cannon, K., Panciera, K., & Papanikolopoulos, N. (2007). Second annual robotics summer camp for underrepresented students. *ACM SIGCSE Bulletin, 39*(3), 14-18.

Catsambis, S. (1995). Gender, race, ethnicity, and science education in the middle grades. *Journal of Research in Science Teaching, 32*, 243-257.

Chappell, K. K. (1996). Mathematics computer software characteristics with possible gender-specific impact: a content analysis. *Journal of Educational Computing Research, 15*(1), 25-35.

Cherney, I. D. & London, K. (2006). Gender-linked differences in the toys, television shows, computer games, and outdoor activities of 5- to 13-year-old children. *Sex*

Roles, 54, 717-726.

Clarke, V. A. & Chambers, S. M. (1989). Gender-based factors in computing enrollments and achievement: evidence from a study of tertiary students. *Journal of Educational Computing Research, 5*(4), 409-429.

Clarke, V. A. & Teague, G. J. (1996). Characterizations of computing careers: students and professionals disagree. *Computers & Education, 26*(4), 241-246.

Clayton, D. & Lynch, T. (2002). Ten years of strategies to increase participation of women in computing programs: the Central Queensland University experience: 1999-2001. *ACM SIGCSE Bulletin, 34*(2), 89-93.

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

Colley, A., Hill, F., Hill, J., & Jones, A. (1995). Gender effects in the stereotyping of those with different kinds of computing experience. *Journal of Educational Computing Research, 12*(1), 19-27.

Cooper, J. & Stone, J. (1996). Gender, computer-assisted learning, and anxiety: with a little help from a friend. *Journal of Educational Computing Research, 15*(1), 67-91.

Corston, R. & Colman, A.M. (1996). Gender and social facilitation effects on computer competence and attitudes toward computers. *Journal of Educational Computing Research, 14*(2), 171-183.

Countryman, J., Feldman, A., Kekelis, L., & Spertus, E. (2002). Developing a hardware and programming curriculum for middle school girls. *ACM SIGCSE Bulletin,* *34*(2), 44-47.

Crombie, G., Abarbanel, T., & Trinneer, A. (2002). All-female classes in high school computer science: positive effects in three years of data. *Journal of Educational Computing Research, 27*(4), 385-409.

Damarin, S. K. (1995). Gender and mathematics from a feminist standpoint. In W. G. Secada, E. Fennema, & L. B. Adajian (Eds.), *New Directions for Equity in Mathematics Education* (pp. 242-257). Cambridge: Cambridge University Press.

Dick, T. P. & Rallis, S. F. (1991). Factors and influences on high school students' career choices. *Journal for Research in Mathematics Education, 22*(4), 281-292.

Doerschuk, P., Liu, J., & Mann, J. (2007). Pilot summer camps in computing for middle school girls: from organization through assessment. *ACM SIGCSE Bulletin, 39*(3), 4-8.

Dryburgh, H. (2000). Underrepresentation of girls and women in computer science: classification of 1990s research. *Journal of Educational Computing Research, 23*(2), 181-202.

Durndell, A., Glissov, P., & Siann, G. (1995). Gender and computing: persisting differences. *Educational Research, 37*(3), 219-227.

Durndell, A. & Thomson, K. (1997). Gender and computing: a decade of change? *Computers & Education: An International Journal, 28*(1), 1-9.

Dye, J. L. (2005). *Fertility of American Women: June 2004.* U.S. Census Bureau. Retrieved March 4, 2008, from http://www.census.gov/prod/2005pubs/p20-555.pdf

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly, 11*, 135-172.

Ely, J. A. (1998). Interest in mathematics and science among students having high mathematics aptitude. *Dissertation Abstracts International, 60*(02), 553A.

Erikson, E. H. (1982). *The Life Cycle Completed: A Review.* New York: W. W. Norton & Company.

Farmer, H.S., Wardrop, J. L., Anderson, M.Z., & Risinger, R. (1995). Women's career choices: focus on science, math, and technology careers. *Journal of Counseling Psychology, 42*(2), 155-170.

Farmer, H.S., Wardrop, J. L., & Rotella, S.C. (1999). Antecedent factors differentiating women and men in science/nonscience careers. *Psychology of Women Quarterly,* 23, 763-780.

Fisher, A. & Margolis, J. (2002). Unlocking the clubhouse: the Carnegie Mellon experience. *ACM SIGCSE Bulletin, 34*(2), 79-83.

Fisher, A., Margolis, J., & Miller, F. (1997). Undergraduate women in computer science: experience, motivation and culture. *ACM SIGCSE Bulletin, 29*(1), 106-110.

Francioni, J. M. (2002). A conference's impact on undergraduate female students. *ACM SIGCSE Bulletin, 34*(2), 66-69.

Frazier-Kouassi, S. , Malanchuk, O., Shure, P., Burkam, D., Gurin, P., Hollenshead, C., Lewis, D.J., Soellner-Younce, P., Neal, H., & Davis, C. (1992). *Women in Mathematics and Physics: Inhibitors and Enhancers.* (Grant no. B-1990-6). Ann Arbor, MI: University of Michigan. (ERIC Document Reproduction Service No.

ED 372 906).

Frenkel, K.A. (1990). Women & computing. *Communications of the ACM, 33*(11), 34-46.

Frieze, C. & Blum, L. (2002). Building an effective computer science student organization: the Carnegie Mellon *Women@SCS* action plan. *ACM SIGCSE Bulletin, 34*(2), 74-78.

Gabbert, P. & Meeker, P. H. (2002). Support communities for women in computing. *ACM SIGCSE Bulletin, 34*(2), 62-65.

Gavin, M.J. (1998). A gender study of students with high mathematics ability: personological, educational, and parental variables related to the intent to pursue quantitative fields of study. *Dissertation Abstracts International, 58*(08), 3052A.

Girls can get I.T. (2006, January). *Daughters, 11,* 3.

Henwood, F. (1996). WISE choices? Understanding occupational decision-making in a climate of equal opportunities for women in science and technology. *Gender and Education, 8*(2), 199-214.

Houser, B. B. & Garvey, C. (1985). Factors that affect nontraditional vocational enrollment among women. *Psychology of Women Quarterly 9*(1), 105-117.

Howell, K. (1996). The culture of undergraduate computer science education: its role in promoting equity within the discipline. *Dissertation Abstracts International, 57*(06), 2421A.

Huff, C. (1996). Unintentional power in the design of computer systems. *Computers and society, 26*(4), 6-9.

Huff, C. (2002). Gender, software design, and occupational equity. *ACM SIGCSE*

Bulletin, 34(2), 112-115.

Huggard, M. & McGoldrick, C. (2006, October). *Incentivising students to pursue Computer Science Programmes.* Paper presented at the 36th ASEE/IEEE Frontiers in Education Conference, San Diego, CA.

Humphreys, S. & Spertus, E. (2002). Leveraging an alternative source of computer scientists: reentry programs. *ACM SIGCSE Bulletin, 34*(2), 53-56.

Jaeger, R. M. (1997). Survey Research Methods in Education. In R. M. Jaeger (Ed.), *Complementary Methods for Research in Education* (2nd ed.) (pp. 449-485). Washington, DC: American Educational Research Association.

Jagacinski, C. M. (1987). Engineering careers: women in a male-dominated field. *Psychology of Women Quarterly, 11,* 97-110.

Jagacinski, C. M., LeBold, W. K., & Salvendy, G. (1988). Gender differences in persistence in computer-related fields. *Journal of Educational Computing Research, 4*(2), 185-202.

Janssen Reinen, I. & Plomp, T. (1997). Information technology and gender equality: a contradiction in terminis? *Computers & Education, 28*(2), 65-78.

Jepson, A. & Peri, T. (2002). Priming the pipeline. *ACM SIGCSE Bulletin, 34*(2), 36-39.

Johnson, D. G. & Miller, K. W. (2002). Is diversity in computing a moral matter? *ACM SIGCSE Bulletin, 34*(2), 9-10.

Jones, M. G. & Wheatley, J. (1988). Factors influencing the entry of women into science and related fields. *Science Education 72*(2), 1-16.

Jones, T. & Clarke, V.A. (1995). Diversity as a determinant of attitudes: a possible explanation of the apparent advantage of single-sex settings. *Journal of Educational Computing Research, 12*(1), 51-64.

Kadijevich, D. (2000). Gender differences in computer attitude among ninth-grade students. *Journal of Educational Computing Research, 22*(2), 145-154.

Kelly, A. (1987a). The construction of masculine science. In A.Kelly (Ed.) *Science for Girls?* (pp. 66-77). Milton Keynes, England: Open University Press.

Kelly, A. (1987b). Why girls don't do science. In A. Kelly (Ed.) *Science for Girls?* (pp. 12-17). Milton Keynes, England: Open University Press.

Kiesler, S., Sproull, L., & Eccles, J.S. (1985). Pool halls, chips, and war games: women in the culture of computing. *Psychology of Women Quarterly 9*, 451-462.

Klawe, M. (2002). Girls, boys, and computers. *ACM SIGCSE Bulletin, 34*(2), 16-17.

Koontz, T. (1997). Know thyself: the evolution of an intervention gender-equity program. In J. Trentacosta & M. J. Kenney (Eds.), *Multicultural and Gender Equity in the Mathematics Classroom: The Gift of Diversity* (pp. 186-194). 1997 Yearbook. Reston, VA: National Council of Teachers of Mathematics.

Lazowska, E. (2002). Pale and male: 19th century design in a 21st century world. *ACM SIGCSE Bulletin, 34*(2), 11-12.

Lee, M. (1993). Gender, group composition, and peer interaction in computer-based cooperative learning. *Journal of Educational Computing Research, 9*(4), 549-577.

Lemkau, J. P. (1983). Women in male-dominated professions: distinguishing personality and background characteristics. *Psychology of Women Quarterly 8*(2), 144-165.

Levin, T. & Gordon, C. (1989). Effect of gender and computer experience on atitudes toward computers. *Journal of Educational Computing Research, 5*(1), 69-88.

Linn, M.C. (1985). Fostering equitable consequences from computer learning environments. *Sex Roles, 13* (3/4), 229-240.

Linn, M. C. & Hyde, J. S. (1989). Gender, mathematics, and science. *Educational Researcher, 18*(8), 17-19, 22-27.

Lips, H. M. & Temple, L. (1990). Majoring in computer science: causal models for women and men. *Research in Higher Education, 31*(1), 99-113.

Lynn, K. M., Raphael, C., Olefsky, K., & Bachen, C.M. (2003). Bridging the gender gap in computing: and integrative approach to content design for girls. *Journal of Educational Computing Research, 28*(2), 143-162.

Maple, S. A. & Stage, F. K. (1991). Influences on the choice of math/science major by gender and ethnicity. *American Educational Research Journal, 28*(1), 37-60.

Merriam, S. B. (1988). *Case Study Research in Education: A Qualitative Approach.* San Francisco: Jossey-Bass.

Mitra, A., LaFrance, B., & McCullough, S. (2001). Differences in attitudes between women and men toward computerization. *Journal of Educational Computing Research, 25*(3), 227-244.

Montano, G. (2002). Virtual development center. *ACM SIGCSE Bulletin, 34*(2), 70-73.

Moody, J. D. & Gifford, V. D. (1990, November). *The Effect of Grouping by Formal Reasoning Ability, Formal Reasoning Ability Levels, Group Size, and Gender on Achievement in Laboratory Chemistry.* Paper presented at the Annual Meeting of the Mid-South Educational Research Association, New Orleans, LA.

Nevill, D.D. & Schlecker, D.I. (1988). The relation of self-efficacy and assertiveness to willingness to engage in traditional/nontraditional career activities. *Psychology of Women Quarterly, 12*, 91-98.

Nippold, M. A., Duthie, J. K., & Larsen, J. (2005). Literacy as a leisure activity: free-time preferences of older children and young adolescents. *Language, Speech, and Hearing Services in Schools, 36*(2), 93-102.

Paloheimo, A. & Stenman, J. (2006, October). *Gender, Communication and Comfort Level in Higher Level Computer Science Education–Case Study.* Paper presented at the 36th ASEE/IEEE Frontiers in Education Conference, San Diego, CA.

Parker, M. (Ed.). (1995). *She Does Math!:Real Life Problems from Women on the job.* Washington, D.C.: The Mathematical Association of America.

Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods* (2nd ed.). Newbury Park, CA: Sage.

Pearl, A., Pollack, M.E., Riskin, E., Thomas, B., Wolf, E., & Wu, A. (1990). Becoming a computer scientist. *Communications of the ACM, 33*(11), 47-57.

Pope-Davis, D.B. & Twing, J.S. (1991). The effects of age, gender, and experience on measures of attitude regarding computers. *Computers in Human Behavior, 7*, 333-339.

Pope-Davis, D.B. & Vispoel, W.P. (1993). How instruction influences attitudes of college men and women towards computers. *Computers in Human Behavior, 9,* 83-93.

Prey, J. & Treu, K. (2002). What do you say? Open letters to women considering a computer science major. *ACM SIGSCE Bulletin, 34*(2), 18-20.

Randall, C., Price, B., & Reichgelt, H. (2003). Women in computing programs: does the incredible shrinking pipeline apply to all computing programs? *ACM SIGSCE Bulletin, 35*(4), 55-59.

Rasmussen, B. & Hapnes, T. (1991). Excluding women from the technologies of the future? A case study of the culture of computer science. *Futures, 23*(10), 1107-1119.

Robbins, J. I. (2001). Making connections: adolescent girls' use of the Internet. *Dissertation Abstracts International, 62*(08), 2735A.

Roberts, E. S., Kassianidou, M., & Irani, L. (2002). Encouraging women in computer science. *ACM SIGCSE Bulletin, 34*(2), 84-88.

Schafer, A. I. (2006). A new approach to increasing diversity in engineering at the example of women in engineering. *European Journal of Engineering Education, 31*(6), 661-671.

Schott, G. & Selwyn, N. (2000). Examining the "male, antisocial" stereotype of high computer users. *Journal of Educational Computing Research, 23*(3), 291-303.

Shashaani, L. (1993). Gender-based differences in attitudes toward computers. *Computers & Education, 20,*(2), 169-181.

Shashaani, L. (1994). Gender-differences in computer experience and its influence on computer attitudes. *Journal of Educational Computing Research, 11*(4), 347-367.

Shashaani, L. (1997). Gender differences in computer attitudes and use among college students. *Journal of Educational Computing Research, 16*(1), 37-51.

Sheehy, G. (1976). *Passages: Predictable Crises of Adult Life.* New York: E. P. Dutton &

Co., Inc.

Simonis, D. (1982). Women in science: a developing country. *Iowa Science Teachers Journal, 19*(2), 14-20.

Taylor, H.G. & Mounfield, L.C. (1994). Exploration of the relationship between prior computing experience and gender on success in college computer science. *Journal of Educational Computing Research, 11*(4), 291-306.

Teague, J. (2002). Women in computing: what brings them to it, what keeps them in it? *ACM SIGCSE Bulletin, 34*(2), 147-158. (Reprinted from *GATES, 5*(1), 45-59, 2000.)

Tietjen, J.S. (2004). Why so few women, still? *IEEE Sprectrum, 41*(10), 57-58.

Toh, K. (1993). Gender and practical tasks in science. *Educational Research, 35*, 255-265.

Townsend, G. C. (2002). People who make a difference: mentors and role models. *ACM SIGCSE Bulletin, 34*(2), 57-61.

Treu, K. & Skinner, A. (2002). Ten suggestions for a gender-equitable CS Classroom. *ACM SIGCSE Bulletin, 34*(2), 165-167. (Reprinted from *The Journal of Computing in Small Colleges, 12*(2), 244-248, November 1996.)

Tsai, M. J. (2002). Do male students often perform better than female students when learning computers?: a study of Taiwanese eighth graders' computer education through strategic and cooperative learning. *Journal of Educational Computing Research, 26*(1), 67-85.

U.S. Census Bureau, Current Population Survey (2006). *2006 Annual Social and*

Economic Supplement. Retrieved January 24, 2008, from http://www.census.gov/population/socdemo/education/cps2006/tab01-01.csv

U.S. Department of Education, National Center for Education Statistics (2001). *Digest of Education Statistics, 2001.* Retrieved April 7, 2008, from http://nces.ed.gov/programs/digest/d01/dt286.asp

U.S. Department of Education, National Center for Education Statistics (2007). *Digest of Education Statistics, 2007.* Retrieved April 6, 2008, from http://nces.ed.gov/programs/digest/d07/tables/dt07_292.asp

U.S. Department of Labor (2006). *Bureau of Labor Statistics.* Retrieved July 30, 2007, from http://www.bls.gov/cps/wlf-table11-2006.pdf

Walkerdine, V. (1987). Some issues in the historical construction of the scientific truth about girls. In A. Kelly (Ed.) *Science for Girls?* (pp. 37-44). Milton Keynes, England: Open University Press.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: a meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*, 387-398.

Wu, Z., Cohoon, J. M., & Neesen, K. (2006, October). *Action and Intention: Considering the Relationship between Educational Software and Gendered Career Interests.* Paper presented at the 36th ASEE/IEEE Frontiers in Education Conference, San Diego, CA.

Zastavker, Y. V., Ong, M., & Page, L. (2006, October). *Women in Engineering: Exploring the Effects of Project-Based Learning in a First-Year Undergraduate*

Engineering Program. Paper presented at the 36th ASEE/IEEE Frontiers in Education Conference, San Diego, CA.