DWINDLING NUMBERS OF FEMALE COMPUTER STUDENTS: WHAT ARE WE MISSING?

BY

DONNA SAULSBERRY, B.B.A, M.A.

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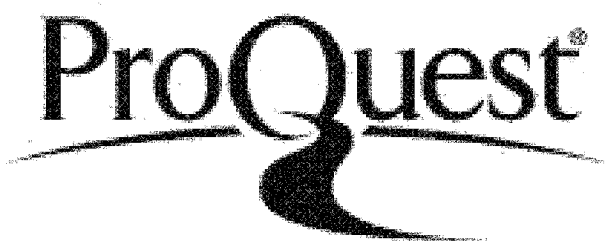

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Professional Organizations

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Association for Computing Machinery

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ABSTRACT

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There is common agreement among researchers that women are under-represented in both 2-year and 4-year collegiate computer study programs. This leads to women being under-represented in the computer industry which may be limiting the progress of technology developments that will benefit mankind. It may also be depriving women of the opportunity to participate in a challenging, economically lucrative career. The under-representation of women in computing has received much attention among collegiate computing programs, government funded research organizations such as the National Science Foundation, and the computer industry itself. But, in spite of twenty years of research, the number of women graduating with computer degrees continues to decline, suggesting that perhaps there are causal factors that have not been identified.

This phenomenological study is an alternate approach to researchers postulating what factors are discouraging women and then attempting to validate them; the researcher asked a group of female students who are pursuing a computer technology degree at a community college to describe experiences which have affected their academic success.

A significant finding was that the women struggled to understand the deductive problem solving method used by the instructors and the pace of the classes made it difficult for them to work out their own problem solving approach.

Chapter 1: Introduction

It is the first day of the new semester. I walk into the Introduction to Computer Networking class I teach and look around the room at the group of new faces, eager to get started with another semester. Even though the faces are new, the fact that they are mostly males is not. That has been the case with every networking class I have taught at Southwest Community College. Even though this class is required for everyone seeking an associate's degree in computer technology at Southwest Community College, the class averaged only 23% female students over the last five years (Cisco Netacad, 2011).

Southwest Community College is not alone in the statistic. The percent of women pursuing computer degrees nationwide is much lower than the percent of males and despite twenty years of research and intervention, the percent of women receiving associate degrees in the computer field has actually decreased from 42% in 2000 to 25% in 2008. The percent of computer field bachelor's degree recipients who are women is even lower: having fallen from 28% in 2000 to 17.7% in 2008 (National Science Foundation, 2010). U.S. Department of Labor statistics show a similar pattern. In 2008, only 25% of those employed by computer companies were women. That percent has decreased from 36% in 1991 (Department of Labor, 2008; National Center for Women in Technology, 2009).

This study was undertaken to explore the experiences of women students studying computers at Southwest Community College with the goal of understanding

these experiences such that strategies can be proposed toward improving the number of women who begin and complete a degree in computer technology. The study explored experiences that affected the women's choices to study computers as well as experiences that affected their success once they began their studies.

Two Issues: Recruitment and Retention (or enrollment and completion)

The literature on the lack of women studying computers at 2-year and 4-year colleges can be divided into two parts: recruitment and retention. Recruitment is focused on encouraging or motivating women to enroll in collegiate computer programs. Retention focuses on encouraging the women who enroll to complete their studies and graduate. The terms recruitment and retention are used to describe these concepts in most of the literature; however, the National Center for Education Statistics, NCES, reports data using the terms enrollment and completion. NCES uses completion to report the students who receive a certificate or degree regardless of length of study. Graduation rate is used to report the students who receive a degree within 150% of normal time; i.e. three years for a two-year degree. Graduation-rate data is not broken down by instruction program so is not useful for exploring the phenomenon of females in computer technology. Another variance from the literature is that NCES uses the descriptor "females;" most of the literature uses the descriptor "women" (National Center for Education Statistics, 2010).

Background

Researchers Margolis and Fisher (2002) have reported some success in recruitment. Their research describes interventions at Carnegie Mellon University

which increased the percent of women who were enrolled in computer science from 7% to 42% over a 4-year period from 1995-1999. One of the changes implemented by Carnegie Mellon during the 4-year period was to lower the admission requirement regarding the amount of prior programming knowledge applicants had to possess. Although Margolis and Fisher and others have reported success at some institutions, researchers cannot track the number of women enrolling in computer programs on a national level because the National Center for Education Statistics data does not separate the enrollment figures by Classification of Instruction Program or CIP code (National Center for Educational Statistics, 2010).

Margolis and Fisher (2002) reported an increase in the percent of women enrolled in the computer program at Carnegie Mellon. However, Carnegie Mellon's NCES reported completion data for the years covered by Margolis and Fisher's study and the four subsequent years does not reflect a similar increase in the percent of women graduating. Completion data, on a national level, is easier to obtain than enrollment data; United States Congress requires all post-secondary institutions with students receiving Title IV financial assistance to report their completion data to the U.S. Department of Education National Center for Educational Statistics. The CIP code, gender, and ethnicity of degree recipients are reported by the institutions (National Center for Educational Statistics, 2010).

Recruitment. It was relatively easy for Carnegie Mellon to track their enrollment data because students are required to formally apply to their computer program and then are formally accepted if they meet the admission criteria and are

selected. In contrast, Southwest Community College, like many public institutions, has no admissions requirements and no procedure for formal admittance to the computer technology program. When students initially enroll at Southwest Community College they are asked to declare a major; but, at least for computer technology, that does not correspond to anyone assessing their aptitude for computers or ensuring that they enroll in any computer courses. Students at Southwest Community College are free to change their declared major at any time by simply completing paperwork. There is not a formal procedure for removing students who drop-out of college or take an extended leave of absence from the declared majors list. This makes it difficult to calculate meaningful enrollment (recruitment) figures in institutions with open enrollment.

Several years ago, two women faculty members at Southwest Community College sought to increase the number of women students in the computer technology department by forming a Women in Technology club. The club, which met monthly throughout the school year to hear guest speakers and discuss issues related to women in technology, thrived for a couple of years and undertook several significant recruiting activities for local high schools. The club members also took annual field trips to places like a computer chip manufacturing plant and a national research lab. But over time, the club's membership shifted from women interested in the technical aspects of computing to women who were less technical and it turned into more of a social club. At that point, one of the faculty sponsors decided to refocus her energies and the club quickly dwindled. The aforementioned difficulties with tracking

enrollment in the computer technology department at Southwest Community College made it difficult to assess the effectiveness of the Women in Technology club as a recruitment tool. The number of females who completed their degree did not increase.

Retention. Over the last ten years, Southwest Community College has awarded an average of 37% of the associate degrees in computer technology to women. The ratio declined from 20 women among the 38 graduates in 2000-2001 to five women among the 23 graduates in 2009-2010 (College Web Site, 2011). When working with very small populations, totals are often more meaningful than percentages. Over the same time period, the National Center for Education Statistics (2010) reported a decline in associate degrees being awarded to computer majors (CIP code 11) who are women from 40% in 2000-2001 to 26% in 2008-2009, the last year for which national statistics are available. The National Center for Education Statistics figures are important because NCES is the only source that compiles data from all colleges and universities in the United States with students who are receiving federal financial aid (National Center for Education Statistics, 2010).

CIP codes may not accurately describe the situation. Although the National Center for Education Statistics compiles data from essentially every college and university, the way the data is sorted by classification of instructional program (CIP code) might be leading to an inaccurate understanding of the trends related to women in computer technology. For example, Southwest Community College proposes CIP codes for new degree programs at the time they are created; the codes are then approved by the state's higher education department (personal communication Jon

Juarez, 2011). There is additional paperwork the college can submit if it is necessary to change CIP codes after a degree program is created. Southwest Community College changed the CIP code under which it reported its computer technology graduates in 2007. Prior to 2007, the college reported its computer technology majors under CIP code 30.999 which is a generic Multi-/Interdisciplinary category. Since 2007, Southwest Community College has reported its computer technology graduates under CIP code 11.03 which is one of the Computer and Information Sciences and Support Services categories. Sanders and Tescione (2002) reported a wide-spread practice of community colleges including women who are receiving degrees which prepared them for word processing and other data entry jobs in the computer or information technology degree statistics.

Sanders and Tescione (2002) contend that the inaccurate classification is primarily responsible for NCES reporting higher graduation rates for females at the associate-degree level than at the bachelor-degree level. NCES reports the number of bachelor's degrees in CIP code 11 awarded to females fell from 27% in 2000-01 to 18% in 2006-07. Other possible reasons for the discrepancy between associate degree completion rates and bachelor degree completion rates are discussed in chapter two.

Importance of Exploring Why Women are Not Earning Degrees in Computers

The lack of women graduating with computer degrees results in the computer industry being dominated by men. The lack of women studying computers and being employed in the industry deserves further study because many contend that it is evidence of a gender inequality that needs to be understood and rectified.

Government and industry spokespeople also contend that the lack of females studying computers will affect the growing need for computer graduates in industry. DARPA, the Defense Advanced Research Projects Agency, contends, "The downward trend in college graduates with STEM [science, technology, engineering and math] majors is particularly pronounced in Computer Science (CS). While computers and internet connectivity become daily fixtures in the lives of Americans, we are steadily losing the engineering talent to protect these systems" (Homeland Security News Wire, 2010). Viviane Reding, European Commissioner for Information Society and Media, said that jobs in the information and communication technologies sector are key sources of growth for the European Union (EU). She said EU's competitiveness depends on attracting and keeping skilled workers, including women, in the high-tech sector. In the forward to a white paper published in 2009, she predicted a shortage of 300,000 qualified engineers by 2010; but stated that only one in five computer scientists are women (Velazquez, Joyce, & Derby, 2009).

Gender inequality. The low percentage of women graduating with computer degrees suggests the possibility that women who want to study and work in technical fields are being discriminated against or at least discouraged (Pearl, Pollack, Riskin, Thomas, Wolf, & Wu, 1990). In a two-year ethnographic study of high school students, Janet Schofield (1995) reported observing a high school computer class in which the boys were allowed to openly harass the girls by teasing them about their appearance and their lack of competence in computer matters. The male teacher did nothing to stop the harassment. In their book *Unlocking the Clubhouse: Women in*

Computing, Margolis and Fisher (2002) report similar experiences at the university level.

The possibility that women are being discriminated against is especially important when one considers that almost 14% of the adult females in the United States lives below the poverty level (U.S. Department of Health and Human Services, 2011). Employment in the computer industry can provide women access to salaries which are significantly higher than those afforded by employment in more traditional women's fields. The median salary for women who work as computer support specialists (a job typically held by those with an associate degree) is $46,859 compared to a median income of $18,759 for women who work as teaching assistants (U.S. Department of Commerce, 2011).

Need for a more diverse work force. The Gender Working Group of the United Nations Commission on Science and Technology contends it is important for all nations to move toward gender equality in science and technology. They believe this will accelerate the pace of national progress and help achieve sustainable development (Huey, 2003).

Viviane Reding, European Commissioner for Information Society and Media, in the forward to a white paper on why girls are not attracted to computer studies and careers, said that opening girls' minds to the opportunities in the information and computer technology sector is fundamental, not only so that no one is left behind but also because there are benefits from "the increased diversity and productivity gains

that have been demonstrated to come from a better balance of women in top jobs and technical jobs" (Velazquez, Joyce, & Derby, 2009. p.1).

Huyer (2003) explains that nations' futures depend on their ability to recruit women into technical education and subsequent participation in science and technology related professions. She says, "Increasing the pool of human resources in the area of technology will contribute to increased creativity, expertise, and competitiveness in the technology sector" (p. 3).

There is also a belief that the lack of females in the computer industry is depriving humanity of the insights of a large portion of its population. When asked by CNET Networks why it is important for women to be involved in computer science, researcher Jane Margolis responded:

> In terms of design teams and designing products, there's evidence from other industries that if you have just a male team, you could have a flawed product. Let's look at air bags, for example. Only 8% of mechanical engineers are female, and most of the teams working on air bags were predominantly male. When air bags were invented based on the male body as the norm, they ended up being potentially deadly to women and children. That's also happened with heart valves and voice-recognition systems; they were geared toward the male (Gilbert, 2002).

Significance of This Study.

This study is unique because of its focus on community college students and its methodological approach. My dual experience as both a former employee of the computer industry and as an educator also makes this study unique because previous researchers have not had both perspectives when studying the topic.

This is a phenomenological study which asked women students to describe their own experiences as they related to choosing to study and complete a degree in

computer technology. Most of the studies described in the literature have asked women to respond to pre-defined research questions rather than asking them to choose the experiences which they think have impacted their computer studies. This research aims to explore the experiences which the women feel are significant. Undertaking this phenomenological approach is important since 20 years of studying what researchers identify as being important has not had a significant impact on the percent of women students who are studying and earning a degree in computers.

Very little detailed research has been published on women who are studying computers at the community college level; and could not find any phenomenological research that has been published about women studying computers at community colleges. Many of the issues which Margolis and Fisher (2002) and others have identified as being obstacles to women at the bachelor's level may not present at the community college level. The obstacles identified in bachelor's programs include large class sizes at the freshman and sophomore level, more emphasis on the theoretical than the practical, and a larger number of required math and programming classes.

Finally, my background as a researcher is unique. I spent over 10 years working in the computer industry and seeing the situation from the perspective of the computer industry. After leaving the computer industry, I became an educator and now have more than 15 years of experience teaching computers to middle school, high school, and college students. My ability to approach the phenomenon from dual perspectives may provide additional insights to the existing research which has been

conducted by sociologists and psychologists without a computer background or by computer people without an educational background.

Problem Statement

There is a common agreement among researchers that women are under-represented in both 2-year and 4-year collegiate computer study programs (National Center for Educational Statistics, 2010; National Science Foundation, 2001). This leads to women being under-represented in the computer industry which may be depriving humanity of important advances. It may also be depriving women of the opportunity to participate in a challenging, economically lucrative career (Huyer, 2003; Gilbert, 2002; Costello, 2012). The under-representation of women in computing has received much attention among collegiate computing programs, government funded research organizations such as the National Science Foundation, and the computer industry itself. The research which exists is primarily focused on two areas: recuriting women students and retaining them. This research proposes a conceptual framework that women studying computers at community colleges are best able to identify what experiences lead them to choose computers as a field of study and what experiences affected their academic success once they began their studies. The need for the proposed framework stems from two concerns. First, there is very little research on women studying computers at community colleges. Second, there are no recently published studies which explore women's experiences as they relate to choosing computers as a field of study or completing their collegiate studies.

Research Questions

This phenomenological study is designed to answer the following research questions:

- What experiences lead women students to study computers at the community college level?
- What experiences affect women's academic success in computer studies at a community college?
    - What experiences contribute to women's success in their computer technology studies?
    - What experiences contribute to women's struggles in their computer technology studies?

The specific interview questions for this study were: What experiences influenced your decision to study computer technology? What have you experienced in your studies at Southwest Community College? What conditions or situations have influenced or affected your college experience?

The women's responses to the interview questions helped identify the experiences which contributed to their success and those which contributed to their struggles. This study will assist community colleges in improving the experiences of female computer majors. This study also adds to the growing body of research about why women are under represented among college students studying and completing degrees in computers.

Chapter 2: Literature Review

This study was undertaken to gain a better understanding of the experiences that lead women to study computers at a community college and the experiences that affected their success in their studies. Understanding these experiences will allow colleges to better support their existing women students and improve their ability to recruit and retain women computer students in the future.

Design of the Literature Review

Rocco, Hatcher, and Creswell (2011) recommend Cooper's taxonomy as a valuable tool in assessing the likelihood that research will be published. This section will discuss this literature review in terms of Cooper's taxonomy. Cooper's (1988) Taxonomy of Literature Reviews suggests that literature reviews can be classified by the following characteristics: focus, goal, perspective, coverage, organization, and audience.

Focus. The focus of this literature review is research outcomes as well as research methods. Randolf (2009) credits the Educational Resources Information Center with suggesting that a research-outcome based review is useful in identifying what information is lacking on a particular topic and therefore providing rationale for new research. The goal of a research-methods review is to explore ways in which the methods inform the outcomes according to Randolf. In this study, I am interested in both the outcome of previous research and the methodology. As discussed in chapter one, the fact that 20 years of research on the topic of women in computers has not

lead to an increase in their participation, suggests to me that perhaps the methodology being used to research the topic needs to be revisited.

Goal. The goal of this literature review is to critically analyze the research with goals of 1) identifying weaknesses in community college studies that my research might remedy and 2) determining which outcomes of research on four-year colleges are applicable to community college programs.

Perspective. Perspective refers to author's own preexisting biases and how they might affect the review. As both a woman who has worked in the computer industry and an instructor of women who are planning to work in the computer industry, I have a preference for practices which are going to help women both complete their studies successfully *and* be productively employed in the male-dominated industry. For example, while it may be possible to insulate women from bothersome male attitudes and behavior while they are in college that may not prepare them for the "macho" culture they are going to encounter once they go to work in the industry.

Coverage. This literature review is a purposive sample, meaning it examined only the central or pivotal articles that were relative to this research. The sample was achieved by performing keyword searches on several databases including ERIC (Education Resources Information Center), WorldCat, E-book Collection (EBSCO), and Google Scholar. I used combinations of the following keywords in Boolean searches: women, females, community college, associate degree, computer technology, computer science, information technology. The central or pivotal studies

were chosen by using the citation index feature of Google Scholar to determine the most cited scholarly works on the topic. The citation index provides the frequency with which a specific article or book is cited (Noruzi, 2005). The searches were limited to research which was published since 1990, since the study of computers was significantly different prior to that time.

Organization. This literature review is organized conceptually with the first section discussing community college studies, the second section discussing studies of four-year computer science programs, and the final section discusses the feminist lens through which the problem has been approached.

This literature review discusses primarily qualitative research literature because that is the dominant type of scholarly research that has been published on the topic. Quantitative data describing the percent of women who have studied and were awarded degrees in computers at both two-year and four-year colleges was presented in chapter one as part of the justification for why this study is needed. Quantitative data was taken from primary sources which included the United States Department of Education, Department of Labor, Department of Commerce, and the National Science Foundation. These were selected because they give a broad look at the status of women in both college and in industry throughout the United States and are the primary sources cited by other literature describing the phenomenon of few women studying and working in computers.

Community College Studies

My original goal was to find detailed literature that would provide insights about women studying in the field of computer technology at community colleges but a three-year search did not yield any in-depth research about community college women studying computers. What exists is descriptions of the outcomes of grants provided by the National Science Foundation and others. A recent report, Increasing Opportunities for Low-Income Women and Student Parents in Science, Technology, Engineering, and Math at Community Colleges, presents an overview of the problem including a reiteration of the statistics that are discussed in chapter one which it augments with statistics on the low economic status of women and student parents (Costello, 2012). After identifying some of the issues facing low-income women and student parents (many student parents are women), it gives a cursory description of seven grant-funded community college initiatives which it deems as promising but not enough description of research protocol or rigor is provided to evaluate the programs. An independent literature search on the programs mentioned did not provide enough addition information to objectively evaluate their effectiveness. The report concludes with a discussion of best practices, based on the poorly described programs. Even though there is not enough information to objectively evaluate the programs, several are described here because of their repeated mention elsewhere in the literature:

The *Community College of Baltimore* has published the results of a National Science Foundation grant to increase the number of females and minorities beginning

their study of computers and to retain those students through the completion of their associate degrees. The grant funded scholarships to allow academically capable, but impoverished, students to pursue a computer degree; it also provided continued support for the students in the form of faculty mentoring, academic seminars, and career information throughout their two years of study. The program was successful in recruiting and graduating some women but the National Center for Educational Statistics data shows that overall the percent of women completing their associate degree in computers declined during the study period (Mento, Sorkin, and Prettyman, 2008; National Center for Education Statistics, 2010).

The literature also discusses another recruiting effort that is been undertaken in Massachusetts by the *Commonwealth Alliance for Information Technology Education*. The alliance initially included six community colleges in low income, high minority areas of Massachusetts but was expanded to include six additional colleges. The goal of the National Science Foundation grant which funds the effort is to increase the number of females and minorities who are studying computers by working with K-12 schools, community colleges, and universities. To date, the alliance has hosted or sponsored a number of recruiting events but has not collected enough data to draw any conclusions about its success. The initial NSF grant was awarded in 2007 (Adrion, Biskup, Boisvert, et. al., 2008; Commonwealth Alliance for Information Technology, 2010).

The *Colorado Institute of Technology* (2006) conducted a survey of the experiences of females in associate-degree computer programs at six community

colleges in Colorado. They found that two-thirds of the women who were studying computers were non-traditional students; many had returned to school after working in low-paying jobs. They chose computers because they thought it would be interesting and because of the lucrative salaries in the field. The women chose to study at community colleges because they viewed community colleges as less expensive and as having smaller classes and more involved faculty. After taking classes, they continued to describe the classes as friendly and non-competitive.

There are other community college programs aimed at increasing the number of women studying and completing degrees in computers but they are not grounded in research and do not provide any verifiable research outcomes.

Foundational Studies of Four-year Collegiate Programs.

Being unable to find rigorous community college studies, I looked to studies of bachelor degree computer science programs for more insights. In addition to research on computer science programs, I have also included research on females in the larger science, technology, engineering, and math (STEM) fields because it underlies the research that computer science researchers Margolis and Fisher (2002) and others have done. There are three books which are foundational to most of what has been written about the low numbers of women who are studying computers and other related technical fields in America's colleges and universities. The first book, *Unlocking the Clubhouse: Carnegie Mellon,* is entirely focused on women majoring in computers. The second book, *Educated in Romance,* is focused on women who were studying the broader fields of math and science. *Talk About Leaving: Why*

Undergraduate Leave the Sciences, the third book, focuses on both men and women who began their collegiate studies in math, science, or technology but then decided to change majors.

In *Unlocking the Clubhouse: Carnegie Mellon,* Margolis and Fisher (2002) reported on a longitudinal study of undergraduate students at Carnegie Mellon, considered at that time to be the third best computer school in the nation. According to the authors, as a result of the institution's commitment to address the factors identified by the study, the ratio of female to total students enrolled in computer science rose from 7% to 42% between 1995 and 1999. During that time, Carnegie Mellon changed the admissions requirement to put less of an emphasis on prior programming experience, assigned more senior faculty members to teach introductory classes, provided training for the faculty and teaching assistants on gender diversity, placed more emphasis on how computing applies to real-world issues, and increased their outreach to high schools.

Margolis' and Fisher's interviewed both women and men students at least once a year during the time of their studies. The appendix to their book includes the questions they asked freshman, sophomore, junior, and senior students. Their research also included classroom observations and journals which they had some of the female students keep. Their research confirmed what many already suspected: computer science is a culture which intimidates most women. The interviews revealed that the problem starts long before college, having its roots in children's early gender experiences and persists through K-12 schooling. Women, who typically arrive at

college with less programming experience than their male counterparts due to practices in their homes and early schooling, continue to experience obstacles based on their minority status (Margolis & Fisher, 2002).

Holland and Eisenhart's book, *Educated in Romance,* is an ethnographic study which followed a group of female students for seven years through their college studies at two universities in the southern United States and the beginnings of their careers. Even though all of the students had strong academic backgrounds and approximately half had initial plans to pursue careers in math and science, the study reveals that most "ended up with intense involvements in heterosexual romantic relationships, marginalized career identities, and inferior preparation for their likely roles as future breadwinners" (Holland & Eisenhart, 1990 p. 4). Based on their interviews and observations, the authors concluded that the female students had been dissuaded from their studies by more important interests in romance.

Even though Holland's and Eisenhart's (1990) descriptions do not appear to be representative of my students or the females I have dealt with in the computer industry, their finding that focus on husbands and child rearing is a factor in women's choices not to persist in technical fields is seen by most researchers as a major concern. Many researchers and computer industry experts cite women's difficulties in balancing child rearing and the time demands of the competitive computer industry as a primary reason for the attrition of females (Etzkowitz et al., 2000; Fonseca, 2007). I witness my female students struggling with their dual roles on a regular basis; assessing their childcare responsibilities is often a key factor in determining which

classes they can take and which activities the Women in Technology club could or could not support.

In *Talk about Leaving: Why Undergraduates Leave the Sciences,* Seymour and Hewitt (1997) interviewed 335 science, math, and engineering students at seven universities to better understand why students in those fields change majors. Among their finding were that men had a higher persistence rate (did not change majors) than women in science, math, and engineering. That held true for computer science as a sub-discipline. They found that the women who persisted and the ones who did not persist did not differ in performance, attitude, behavior, abilities or motivation; but, differed in their attitudes and coping strategies.

Contrasting Community College Programs with Four-year Programs.

The three books discussed above all describe four-year collegiate programs. Even though much of what they discuss is relevant to community colleges, some of their findings do not appear to relate to community colleges.

Community colleges emphasize skills more than theory. Classes are typically taught in hands-on computer labs where students learn the skills by actually performing them. Distance education classes often use software-based simulators to provide the hands-on component. In contrast, many four-year programs consists of what Tonso (2003) describes as abstract, generalized knowledge that is represented mathematically.

Another major difference between community college computer technology programs and typical four-year institution computer programs is the lack of emphasis

on math and programming classes which are often problematic for women (Margolis and Fisher, 2002). For instance, an associate degree at Southwest Community College only requires one math class and one programming class in contrast to four-year programs which require 8-10 math classes and 15-20 programming classes (New Mexico State University, 2012). Other graduation requirements for an associate degree at Southwest Community College include core classes such as freshman English, communications, and business as well as computer instruction in productivity software, operating systems, hardware, networking, systems analysis, and an additional 15 credit hours in the student's area of specialization. Within the associate degree program, students can choose an option in hardware, programming, or networking (College Web Site, 2011).

Community college student-to-instructor ratios are typically lower than those found in freshman and sophomore level classes in four-year programs. Southwest Community College's student-to-instructor ratio is 18 to 1. Margolis and Fisher (2002) noted that large classes and the lack of example driven instruction were cited as obstacles by the females at Carnegie Melon.

The educational background of faculty teaching computers at the community college is different from the bachelors programs described in the research. Of the eight faculty members in the Computer Technology Department at Southwest Community College, only two have computer science degrees; the rest came into the industry through business, education, math or science. Three of the eight faculty members are female (College Web Site, 2011).

Analysis of Research on Four-year Collegiate Programs

Existing studies which have explored the backgrounds and attitudes of successful female computer students have identified a number of common factors. There are over 30 factors which have been identified as affecting the recruitment and retention of females. I have chosen to group the recruitment factors into the following categories: family and societal influences, elementary and secondary schooling, career aspirations, and self-perceptions. I grouped the retention factors into self-efficacy, minority status, supportive relationships, pedagogy, and economic status.

Recruitment. For the purposes of this study, recruitment is related to encouraging or motivating women to enroll in collegiate computer programs.

Family and societal influence. Researchers found many of the patterns for male and female behavior are established in children's families of origin, during their preschool years. Jane Margolis (2002) tells of dropping her daughter off at kindergarten and witnessing the boy kindergarteners hovered around the computers and the girls crowded around the art table and the reading couch. In the book, *Unlocking the Clubhouse*, which Margolis coauthored with Allan Fisher, they attribute this in part to a "computer gender divide" in families of origin. They provide the story of Mary, one of the first-year students at Carnegie-Mellon that they interviewed, as an example. Her chemical-engineer father was an avid computer user who bought new computers as soon as they came out. Her mother worked part-time and was "very computer illiterate." Mary explained, "She knows how to type, do normal jobs like that, nothing very interesting" (p. 21). Mary's experience was typical

of the women Margolis and Fisher interviewed. Even though parents claim they treat their sons and daughters equally, Margolis' and Fisher's interviews found that females recalled spending more time watching from the sidelines while their brothers and fathers tinkered. Women students also reported that computers were more often placed in their brother's bedroom, even if they were the one with the most interest.

While boys spent some time "tinkering" with the hardware, they also spent a great deal of time playing computer games. A number of studies have criticized the computer game industry for being very male oriented in its focus on competitive, aggressive games (Sanders & Tescione, 2002). A 2006 study of girls in Germany reported that they dislike computer games because of the lack of meaningful social interaction, violent content, and gender based stereotyping of game characters. This may hold true for girls in the United States to some extent; but, overall the percentage of U.S. women who are playing video games is increasing. This can be attributed to at least a subcultural of women being interested in playing games traditionally played by men and the emergence of new games designed to appeal to women's interests (Hartmann and Klimmt, 2006). An example of a girl friendly game is *The Sims* which has sold over 100 million copies, 60% of which went to girls. In addition to providing girls with entertainment, *The Sims* helps prepare them for roles as computer programmers by giving them practice managing complex systems, tinkering with tools, and reasoning with spatial representations (Hayes and King, 2009).

The Sims is only one of many computer games which helps improve spatial skills which are highly correlated with success in technical fields. Research has

shown that students with stronger spatial reasoning abilities are more likely to be successful in introductory programming classes (Jones and Burnett, 2008). Spatial ability refers to skill in perceiving the visual world, transforming and modifying initial perceptions, and mentally recreating spatial aspects of one's visual experience without the relevant stimuli (Net Industries, 2012). Studies report that women typically under-perform men in spatial tasks; some attribute this to nature while others insist that it has more to do with nurture. Either way, spatial skills are shown to be enhanced by playing with Lego blocks, Erector sets, and computer games, all of which are typical male activities (Baenninger and Newcombe, 1989; Jones and Burnett, 2006; Levine, Huttenlocher, Taylor, and Langrock, 2006).

Margolis and Fisher (2002) cite parental involvement in computers as another key factor; 65% of the women in Margolis and Fisher's study came from households where one or both parents were involved with computers either as a job or a hobby. The ethnicity and socio-economic status of the family are also factors (Sanders, 2006). In 1997, well after the time that the current generation of college freshman would have been in pre-school, Blacks and Hispanics were less than half as likely to own a home computer (National Telecommunication and Information Administration, 1997). Shashaani (1994) also reported that gender and socio economic status were highly correlated with early access to computers.

In an interview with CNet News, Margolis explained the ramifications of girls having limited computer access at home by saying "Because of early socialization in schools and at home, and a sort of early claiming of the computer as a boys' toy, the

girls who wanted to major in computer science and got into one of the top computer science departments actually came in with less hands-on experience, which then led to a difference in confidence during the program" (Gilbert, 2002).

Elementary and Secondary Schooling. Research has found that teachers and counselors, as well as parents, perpetuate the practice of allowing males to dominate computer access. In her two-year ethnographic study of high school students, Janet Schofield (1995) describes a typical high school setting in which the computer lab that was open to all students during their lunch break but was quickly claimed by a group of white male "nerds." The observers noted that when girls or Black boys came in, they were not invited by the nerds or the teacher to join the group at the computers, so they consequently stood around for a little while and then left. In addition to depriving the girls of access, the incident also served to strengthen the girls' beliefs that computer geeks are loners and social misfits. Schofield says that the women perceived that men used computer to "fill up the void in their lives left by the difficulties they faced in forming meaningful friendships" (p. 155). Schooling seems to solidify female perceptions that geeky males are social misfits who can only relate to the computer (Sanders, 2006). In addition to the efforts of the geeky males to prevent others from using the computers, Schofield observed that in computer class they openly harassed the girls by teasing them about their appearance and their lack of computer competence. She noted that the male teacher did nothing to stop the harassment (1995).

Aside from perhaps being less likely to stop harassment, the prevalence of male computer teachers can deprive girls of access to female mentors and role models (Etzkowitz et al. 2000; Pearl et al., 1990; Sanders, 2006). According to Sanders (2006) mentors and role models are often confused. Mentors are personal associates who are trusted guides and advisors. Seymour and Hewitt (1997) found that the influence of people significant to the students was the most important factor in their choice of careers. Among the influential people were teachers, counselors, and family members.

Role models, in contrast, are examples to follow. In many cases there is not a personal relationship. Jepson and Pearl (2002) reported that a lack of female role models was one of the main reasons women are less likely to pursue technology careers. Organizations such as IWITT (Institute for Women in Trades and Technology) and ACM-Women (Association for Computing Machinery – Women) both make posters and other learning materials about female computer scientists available to educators and other groups (National Institute for Women in Trades and Technology, 2010; ACM's Women in Computing 2010).

Even some female computer teachers and counselors are biased in their assumption that computing is a male domain (Sanders, 2006; Shashaani, 1993). Girls often need teachers and counselors to notice their talent and direct them toward college computer programs but teachers and counselors often fail to respond to this need among their female students. Margolis and Fisher (2002) explain, "Too many teachers and counselors look primarily to boys to have a flair for computing. They are

looking for girls who 'look like boys'—whose interest in computing mimics boys. But as our research shows, girls' interest in computing is often quite different" (p. 48).

Cheryan, Davies, Plaut, and Steele (2009) reported that even the atmosphere of a computer classroom can affect girls' interest in pursuing a career in computers. In one research project at the University of Washington, they set up two classrooms with 10 computer programming books or manuals, six software boxes or CD cases, and some loose papers. In one of the rooms they added a Star Trek poster, a video game, comics, junk food, and soda cans (all stereotypical items which had been chosen by both men and women as being associated with computer scientists). In the other classroom, they added a nature poster, art, water bottles, healthy snacks, coffee mugs, general interest books, and magazines (items which are not stereotypically associated with computer scientists). They then had male and female students spend about a minute in one classroom or the other, allegedly while their guide retrieved something. Afterward, they had the participants fill out a questionnaire about their interest in computer science as a career. The women who had spent time in the room with the Star Trek poster and other items stereotypically associated with computer scientists were less likely to express an interest in studying computer science than those who had spent time in the room with the nature poster. There was no difference in the interest in studying computer science among the men who had spent time in the room with the Star Trek poster and those who spent time in the room with the nature poster. The authors postured that "environments can act like gatekeepers by preventing

people who do not feel they fit into those environments from ever considering membership in the associated groups" (Cheryan, et.al., 2009, p. 1045). Mussweiler (2003) says that portraying a group in a way that is contrary to how people see themselves may cause them to not want to join the group.

Tonso (2003) observed that when girls do get access to school computers they are much more likely to work with applications such as word processing than with programming which is the mainstay of most computer degree programs. In fact, experience in programming is a requirement for entrance into many prestigious computer schools. Math performance and anxiety have also been shown to limit the number of women who pursue college studies in technology (Margolis and Fisher, 2002; Sanders, 2002).

Career aspirations. Women are not as likely to aspire to a career in computers for a variety of reasons directly associated with what they perceive the day-to-day work is like. Among their perceptions is that the industry is comprised of macho males who tend to be social-misfit loners that are obsessed with their work (Margolis & Fisher, 2002). They often visualize computer workers sitting alone in their cubicles for days at a time performing boring work with little or no interaction with anyone else. While the industry is male dominated and highly competitive, team work has become a mainstay in companies like Microsoft (Express Computer Online, 2007; Galacho, 2007).

Researchers have also found a difference in the ways that men and women select computer careers. A number of studies have found that men are more likely to

choose computers to fulfill their own interests and enjoyment; whereas women are more likely to choose careers on the basis of how they can contribute to other fields (Margolis & Fisher, 2002; Seymour & Hewitt, 1997).

Self-perception. The belief that one is capable of performing in a certain manner or attaining certain goals has been identified as being a problem for women. Even in situations where they perform or score as high as men, they still perceive themselves to be less capable (Margolis & Fisher, 2002). This is more thoroughly discussed in the retention section on self efficacy.

Retention. In this study, retention is defined as continuing to successfully complete classes until an educational goal such as graduation is realized. In addition to being less likely to begin studies in computer programs, women are also less likely to complete their studies in computer science. Research has shown that women typically drop out in their sophomore year (Margolis & Fisher, 2002; Seymour & Hewitt, 1997). The reasons cited in the research will be grouped into five categories: self-efficacy, minority status, economic situation, supportive relationships, and pedagogy.

Self efficacy. Self efficacy is important as a recruitment factor because to the extent that girls feel incompetent in math or computers based on their high school experiences, they will not pursue computers as a college endeavor. But, self-efficacy is also important as a retention factor. Even women who find themselves confident based on their high school experiences often lose their confidence in college, especially in their freshman year. Margolis and Fisher (2002) noted the loss of self-

efficacy even among women who were doing as well or better than their male peers. They contend that it was in part due to the women's comparison of themselves to their male peers who had more experience, were more singularly focused, and spent more free time programming. At Carnegie Mellon, they also attribute the loss to women transitioning from being at the top of their high school classes to arriving at college and being surrounded by men who were also at the top of their classes but had much more experience. In *Unlocking the Clubhouse*, Margolis and Fisher use Carmela's comment as an example:

> Then I got here and just felt so incredibly overwhelmed by the other people in the program (mostly guys, yes) that I began to lose interest in coding because really, whenever I sat down to program there would be tons of people around going, "My God, this is so easy. Why have you been working on it for two days, when I finished it in five hours" (p. 79)?

Regarding experience, Margolis and Fisher's study found that 25% of the freshmen men, had paid programming experience before arriving at college, compared with 4% of the women. Most of the women's experience came from high school classes, they had seldom programmed outside of school. Partially based on Margolis and Fishers' study, in 2000 Carnegie Mellon relaxed the programming experience requirement in the admissions criteria (Margolis & Fisher, 2002). Seymour and Hewitt (1997) found that most of the women they interviewed entered college at a peak of self-confidence based on high school performance, SAT scores, and encouragement from high school teachers and counselors as well as parents; but, their confidence quickly eroded when they entered college and they found themselves feeling isolated, insecure, and questioning whether they could successfully complete a technical degree.

Views of intelligence are yet another factor which Margolis and Fisher attribute self-efficacy to. They explain that some believe that intelligence is something you are born with and there is nothing you can do to change it while others believe that intelligence can be improved through hard work and practice. Those who adhere to the first belief tend to withdraw from challenge; those who adhere to the second are more likely to be motivated by challenge. The Carnegie Mellon study found that females who were born and raised in the United States are more likely to adhere to the first belief and withdraw whereas females who were born and raised in other countries, especially those from Asian cultures, are more likely to persist based on their belief that hard work and practice will improve intelligence. A woman from Russia they interviewed explained "You have this bridge you have to walk over, and you just don't look down. . . .There were cases when I started looking down and it was really scary. I'd think 'WHY am I putting myself through this?' . . . But I have to do this, anyway, because I have to" (Margolis & Fisher, 2002, pp. 97-98).

Seymour and Hewitt (1997) concluded that women have a tendency to internalize academic problems, blaming themselves for their lack of ability, while men tend to blame external factors such as poor teaching or course materials. Margolis and Fisher (2002) echoed that conclusion.

Minority Status. Women computer students being significantly outnumbered by male students in their classes is also problematic. Being the only woman in a class is intimidating and discouraging especially if the men students put the woman down or chide her that she is only there because "she is a girl" (Margolis & Fisher, 2002).

Tonso (2003) quotes from an interview with a male student who was describing female students in the engineering school she was researching, "Big, easy, sluts [who] go to school here. If she's pretty, guys ask her out too much and, if she goes out with them, she bombs out of school because she doesn't study enough. The women who stay aren't pretty" (p. 11). She describes the overall atmosphere at the school as being so biased against females that even females who were raped did not speak out because doing so would have meant that they were not willing to take one for the team.

Even when institutions put structures in place to encourage more women and minority students it can backfire and create a preexisting negative atmosphere if the current students perceive the women and minorities are going to displace the status quo (Schoenbauer, 2008).

Much of the discrimination against women is undoubtedly intentional on the part of males but Pearl, Pollack, et al. (1990) found that discrimination can also be unintentional when males unthinkingly exhibit the biases they were raised with sometimes without even realizing they are offensive. They also point out that even trivial discriminatory incidents can be problematic when they become a consistent pattern. These contribute to women withdrawing from the field or being otherwise marginalized.

Research also shows that individual females perform worse when they believe they are being viewed as a representative of women in general. Steele (1997) argues that in math and science programs where women are a minority they are plagued by

"stereotype vulnerability" in which they become fearful that they will confirm the stereotype that already exists. He describes an experiment where two groups of female students were given identical, difficult math tests. One group was told that the tests showed a gender difference with women performing poorer; the other group was told there was no gender difference in the performance. Those who were told there was no gender difference performed significantly better (Steele, 1997).

Supportive Relationships. Women are known for being more relational than males; women studying computers are no exception. Both Margolis and Fisher (2002) and Powell (2005) found that one of the most discouraging factors for females is a lack of fellow female students to share their interests and struggles with. In her study at the University of Pennsylvania, Powell found that the female computer students were in such need of fellow female camaraderie that they spontaneously formed their own female support group which met regularly for meals and discussions. During the time period covered by Margolis' and Fisher's study (2002), the women undergraduates at Carnegie Mellon tried but could not get enough momentum going to sustain a group. Women computer students at Truman State University also tried to sustain a group but failed due to a lack of administrative support and critical mass; however their efforts were not in vain. The effort served as a wake-up call for the faculty who got $40,000 from the nearby Boeing Plant and started a very successful women's support group. The group conducted a one-week head-start camp for incoming freshmen women who had declared computer science as a major, a mentoring program, a role model program, and a support group. Within five years,

91% of Truman's female computer students who had been actively involved in the support group graduated with their bachelors' degree in Computer Science. 75% of the women who were not part of the group failed to earn the bachelor's degree in Computer Science (Beck, 2007).

In addition to needing camaraderie and support from each other, women students also need faculty mentors. Seymour and Hewitt found "failure to establish a personal relationship with faculty represents a major loss to women, and indeed, to all students whose high school teachers gave them considerable personal attention" (p. 267). Their cross-institutional study found that women were more likely than men to assume that they will be able to develop personal relationships with their instructors.

Unfortunately, the dearth of women faculty members in college computer programs makes finding a female mentor extremely difficult in some cases. According to the Computing Research Association, in 2006-2007 women comprised only 10% of full professors, 13% of associate professors, and 19% of assistant professors in computer departments (Vegso, 2007). Even though there are more female assistant professors than associate or full professors, Etzkowitz, Kemelgor, and Uzzi found that at the assistant-professor level many women spend so much time on their familial responsibilities and the research and publishing required for tenure that they do not have the time to mentor their female students as they would like (2000). They further observed that younger women faculty members tend to be more relational and collaborative whereas the older generation tends to be made up of women that possess a highly-competitive, individualist style that mimics the

traditional male stereotype. Several studies have also noted that male professors can mentor women students as well and in reality that is probably more often the case (Pearl et al. 1990).

Pedagogy. Margolis and Fisher (2002) found that "poor teaching" had a more detrimental effect on women than on men. They never define poor teaching, but their interview questions indicate that they are referring to teaching that does not accommodate a student's preferred learning style. They note a female preference for smaller classes, project oriented classes, and for teaching by example. Other teaching techniques which can be beneficial to women include avoiding traditional weed-out practices in first-year courses, providing opportunities for collaboration, providing women student with role models by discussing the historical contributions that women have made to computing, using a supportive rather than a defensive communication style, and accommodating a holistic style of reasoning in additional to the sequential style typically used by males (Tonso, 2003).

Smaller class size. In their 1997 cross-institutional study, Seymour and Hewitt found that women objected to large classes because of their impersonal nature. The women they interviewed found it harder to develop a personal relationship with the professor (noted above as important to women).

Project oriented class. In the research by Margolis and Fisher (2002), women expressed a preference for project oriented classes which involve problem solving, an activity which is well suited to female's preferred global learning style (Felder & Silverman, 1988). Sanders (2006) reported that university computer programs

typically reserve these for advanced classes which "come too late for most women" (p. 19).

Collaborative learning. Seymour and Hewitt (1997) cite lack of opportunities for collaborative learning as a primary factor in students' decision to withdraw from technical majors; this was especially true for women. They observed that in situations where collaborative learning was not facilitated by the professor, women organized their own collaborative study groups; but, they also noted that the individual competitiveness of many classes made this impossible.

Weed-out practice. Stemming from the belief that not everyone is capable of understanding and programming a computer, but that a select few are born with those talents, freshman computer classes are often designed to weed-out those who were not born with the talent (Margolis & Fisher, 2002; Seymour & Hewitt, 1997). While many believe that it does take a certain amount of talent to understand and program a computer, it is important to ensure that the core skills, beyond what is required for high school competency, are taught in the college study program and the students are not penalized for their lack of prior programming experience. Margolis & Fisher have noted that women typically have significantly less programming experience when arriving at college than their male counterparts. Instructors also need to be conscious of not letting the more experienced students intimidate those who enter college with less experience (Gavin-Doxas & Barker, 2005).

Role models. Margolis and Fisher (2002) and Seymour and Hewitt (1997) both cited role models as being an important factor in the retention of female

students. Even though the first "computers" were women, they are rarely mentioned in computer textbooks. In 1943, six women were the ones who actually programmed ENIAC, the world's first electronic computer which was developed and used for the Manhattan Project. Jennings Bartik, one of the six women, says for 50 years the female programmers were totally ignored by the University of Pennsylvania and Aberdeen Proving Grounds, the institutions which handled the public introduction of ENIAC. In their discussion of the role that women played in the ENIAC project, Todd, Mardis, and Wyatt (2005) said:

> Prior to 1966, society generally assumed the women shown in the various pictures taken of the ENIAC were either models or secretaries doing trivial tasks. But then women rarely ventured into the male domain of hardware development prior to World War II, even if they did possess college degrees. It was generally expected that a university-educated woman would marry or teach. Thus, was the case with Jennings Bartik who in 1945 was advised by a male professor not to take the position with the Moore School of Electrical Engineering, but instead urged her to become a teacher and 'respected member of the community' (p. 381).

These kinds of attitudes are responsible for the contributions of women not being acknowledged in most textbooks, necessitating educators who want to provide their students with female role models to supplement their instruction with information from the Internet and other sources. IBM has a women's history museum on their website and there are other historical accounts available through Women in Technology International and the Association for Computing Machinery websites (ACM's Women in Computer, 2010; International Business Machines, 2008; Women in Technology International, 2008).

Defensive versus supportive communication style. Computer science classes have been identified as having a defensive communication style, meaning that there is an intentional effort to maintain social and communication distance between students and teachers. In a defensive climate, professors create a competitive environment by allowing or encouraging students to show that they are better by outperforming their peers. Posturing, which is defined in the Longman Dictionary of Contemporary English (2012) as pretending to have a particular opinion or attitude, is also a part of defensive communication. In their study, Garvin-Doxas and Barker (2004) found that male students often spent a great deal of time posturing, which intimidated the female students and further reduced their self-efficacy. They found a defensive climate is associated with higher numbers of women not persisting in their studies.

Global versus sequential. Research suggests that females tend to be more global learners whereas males are more sequential (Rosser, 1989; Volman & van Eck, 2001). Global versus sequential has been specified by Felder and Silverman (1988) as one of the learning styles which affects students' potential success in the classroom. Sequential, the dominant style of technical education, is defined as being a linear thinking process involving incremental steps. Global, the style preferred by most females is defined as a holistic thinking process in which learning takes place in large leaps (Litzinger, Lee, Wise, & Felder, 2005). Rosser contends this may be one of the more difficult aspects for the 'females in technology' issue to tackle since by design computers are inherently linear (Rosser, 2005). In their 1988 work, Felder and

Silverman do however offer concrete suggestions about how technical engineering instruction can become more effective for global learners.

Economic Status. Seymour and Hewitt (1997) note that socio-economic status plays a significant role in women's decisions to withdraw or to persist when faced with adversity. They found that females from advantaged socio-economic backgrounds were more likely to withdraw, taking advantage of a "safety net" that allowed them to redirect and pursue other things. On the other hand, minority females from working-class families did not have that option so they were more likely to persist.

Along with high socio-economic status being associated with women not completing their computer degrees; at the opposite end of the spectrum women from low socio-economic groups are at a greater risk also. Seymour and Hewitt (1997) found that financial problems were a factor in 16.9% of the decisions to not complete degrees in STEM fields. They also note that students in these fields find it more difficult to work because of the majors' greater demands on their time. Those who do persist and complete their degrees while working find that time devoted to work comes at the expense of study time, often resulting in lower grades and added discouragement in the highly-competitive field.

Conceptual Framework: Feminism

"Equity is fundamentally about people being treated with respect for their needs, interests, and desires" (Tonso, 2003). Calls for gender equity in public colleges and universities, and in careers, grew out of the civil rights movement. They were

legalized by the 14th Amendment's guarantee of equal protection. Lau v. Nichols (1974) case said that concerning education, not only did things have to be equal on paper but that classroom adjustments had to be made to compensate for perceived deficiencies (Tonso, 2003).

The oppression of women began long before the "birth" of computers. Computers were born into a very male dominated world. The belief that females are the weaker sex and that wives need to be in subjection to their husbands has roots that go back to the beginning of time. The Bible traces the roots to Eve's disobedience in the Garden of Eden when God proclaimed, "Your desire will be for your husband, and he will rule over you" (Gen. 3:16 New International Version). In addition to Christianity and Judaism, Islam also subordinates women "Men are the maintainers of women because Allah has made some of them to excel others and because they spend out of their property; the good women are therefore obedient..." (Qur'an 4:34). Prior to this study, the religious foundations of male superiority had already become a topic of disagreement among the female computer technology majors who are the subject of this research, with at least one referring to her husband exclusively as her partner claiming that she refuses to be in subjection to any man and another arguing that the Bible is always right and that wives are supposed to be in subjection to their husbands.

In the *1997 Annual Review of Anthropology*, Visweswaran described three waves of feminism in the United States. She describes the first as suffrage feminism which was roughly from 1912-1920. Cott (1987) notes that the label "feminist" was

not coined until around 1910. The first wave was followed by a time period from about 1920-1960 which was characterized by a disaggregation of the women's movement (Cott). The second wave was heralded by the publication of Betty Friedan's (1963) book *Feminine Mystique* which is credited with having ignited the women's liberation movement. The third wave was characterized by the influences of queer theorists and women like bell hooks (1981) and Gloria Anzaldúa (1987) who focused on issues of women in ethnic minority groups. The first wave culminated with the passage of the 19th Amendment in August 1920 which guaranteed women the right to vote in all United States elections. Visweswaran (1997) characterizes the move from the first wave to the second wave as "embodying the transition from an understanding of gender as a largely empirical category designating women to an emerging form of social critique linked both to theorization of a 'sex/gender' system and the development of gender 'standpoint theory,' the notion that women share a point of view despite cultural or class differences" (p. 595). She describes the shift from the second to the third wave as being characterized by a movement away from unified female consciousness to the theories of multiple consciousnesses advocated by hooks (1981) and Anzaldúa (1987).

French feminist philosopher Julia Kristeva (1981) identified three similar phases of feminism. She identified the first as seeking universal equality between males and females. She criticized it for overlooking sexual differences. Kristeva identified the second phase as seeking a uniquely feminine language; but rejected its premise that language and culture are essentially patriarchal and must be abandoned,

contending instead that language and culture are the expressions of all speaking beings including women. Kristeva described the third phase as seeking to reconcile identity and difference. She identified with this phase, believing that women have multiple identities, including sexual identifies.

Markwick (2006), based on Kristeva's (1981) three types of feminism, has suggested three stages of gender reform in education: the first being providing females equal access to the symbolic order, the second involves rejection of the symbolic order and a celebration of femininity. Curriculum becomes more girl-friendly. The third stage represents a female post-structuralist position which denies the existing dichotomy of gender and sees it instead as a discursive construction. Yates (1998) saw the first two stages of Kristeva's classifications as problematic since they treated females as a single category, without acknowledging the differences between them. Markwick's dissertation study of females studying information technology at a tertiary institution in Australia found that females provided conflicting descriptions of their abilities and interests as they moved back and forth between trying to demonstrate technical and gendered competence (Markwick, 2005). This reaffirmed Jones (1993) finding: A girl who is hard-working and high achieving may also wear highly "feminine" clothing and routinely defer to boys as she negotiates both intellectual and non-intellectual feminine subjectivities (p. 159).

Rosser (2005) used different labels but contended that roughly the same stages or waves of feminism can be seen in the information technology work place. She saw

the first stage as liberal feminism in which women strive for equal (not special) consideration without discrimination based on sex. From Rosser's perspective, liberal feminism is concerned with women having equal opportunities in the information technology workforce. Rosser advocates that not only does there need to be more women in technology but they need to be more equally distributed with some being at the top designing/decision making level. Social feminism is what Rosser labeled the second wave. It targets the focus that males have put on technology and the uses to which it is being put. She describes social feminists as objecting to the "social shaping of technology" that has been imposed by men, believing that if females were more involved, technology would be directed more toward the "greater good" and less toward "monetary gain." The third wave correlates to Rosser's racial and ethnic feminism which is concerned with females who are also part of ethnic minorities and are subjected to even more discrimination.

Chapter 3: Methodology

This was a phenomenological study which explored the experiences of second-year female computer technology students at Southwest Community College. The research questions were: What experiences lead women students to study computers at the community college level? What experiences affect women's academic success in computer studies at a community college? and the secondary questions: What experiences contribute to women's success in their computer technology studies? What experiences contribute to women's struggles in their computer technology studies? The women's experiences were obtained through individual interviews, a focus group, and an Internet survey. The goal of using three methods to explore the women's experiences was to get a more detailed and balanced picture of the situation

Research Design - Phenomenology

Even though most of the studies of female computer students have described themselves as ethnographies, I concluded that a phenomenological study will better help me and the administration at Southwest Community College understand and improve the experiences of our female computer students. Creswell (2007) contrasts ethnography with phenomenology by explaining that the former focuses on describing and interpreting a culture-sharing group and the latter focuses on understanding the essence of individual experiences. Having worked with the women students at Southwest Community College for the last ten years I do not think there are enough of them or that they have enough in common to constitute a culture which

is defined as "a group of people whose shared beliefs and practices identify the particular place, class, or time to which they belong" (Microsoft, 2007). My observation is that the female students do not appear to socialize with each other and in most cases seem to prefer males as study-partners and friends. Demographically they are a very diverse group covering a broad spectrum of ages, ethnicities, and life experiences. Phenomenology is specifically designed to allow for the women's differences; yet identify the commonality of their experience in reference to their studies at Southwest Community College, (Creswell, 2007).

van Manen (1990) describes a phenomenon as an object of human experience. Creswell (2007) defines phenomenological research as describing the lived experiences of a group of individuals in relation to a phenomenon. It focuses on the commonality of the experience among a group of people. Stewart and Mickunas (1990) described four perspectives of phenomenology. The first was a focus on philosophy as the search for wisdom, without the influence of empirical data. Second was forgoing prejudgment of what was "real" until it could be established by lived experience. Third was intentionality of consciousness and fourth was interrelating subjective and objective factors and conditions.

Creswell (2007) divides phenomenology into two types: (1) hermeneutic phenomenology which was advocated by van Manen (1990) and focused on the researcher's interpretation of the research participants' descriptions and (2) psychological phenomenology which was advocated by Moustakas (1994) and put more emphasis on the participants' descriptions than the researcher's interpretations.

This research project on women in technology uses the psychological approach advocated by Moustakas. Consistent with the psychological approach, I have attempted to bracket or set aside my views as I described the experiences of the students (Creswell, 2007). In spite of the best efforts of researchers, Moustakas notes that it is almost impossible to totally set aside one's own experiences. This is a limitation of phenomenology.

Researcher Perspective. I chose to approach the research problem of decreasing numbers of women who complete computer degrees using a phenomenological approach because it will provide me with the tools to have the women themselves identify which life experiences were important in their decision to study computers and what they experienced once they began their studies. By the time of this research, there was a host of quantitative data compiled by the Center for Educational Statistics, the National Science Foundation, and the Association of Computing Machinery. The goal of the research conducted by the National Science Foundation and the Association of Computing Machinery Women was to increase the number of women graduating with computer degrees; but, in spite of their efforts, the numbers continue to decrease. The problem has been approached qualitatively by Margolis and Fisher, Seymour and Hewitt, and Holland and Eisenhart with mixed results. Margolis and Fisher (2002) had some short-term success at

Carnegie Mellon, the site of their study, but nationally and at Carnegie Mellon the percentage of women who are studying computers has continued to decline.

By having the women students themselves identify experiences that contribute to their success and struggles at a community college, this research aimed to identify changes which can lead to the increase of women who are studying computers.

Phenomenology, the methodology of this research, is part of the larger domain of qualitative research. Creswell (2007) said qualitative research should begin with the researcher's assumptions, worldview, and theoretical lens. This section briefly discusses my assumptions, worldview, and theoretical lens.

Assumptions. My first assumption is that the human-kind would be better served if there were more women in the computer fields, especially in research and development as well as management. This would facilitate future development being targeted at areas that women are typically more interested in. Facebook, who's Chief Operating Officer is a woman, is a good example of a computers being used to facilitate relationships. Kristin Tolle, a research director at Microsoft, is a good example of women researching ways to use computers to improve health care in impoverished nations (Robertson, DeHart, Tolle, and Heckerman, 2009). Facilitating women's entry into the computer industry will also improve their economic situations. A recent salary survey revealed senior-level employees average over $124,000 annual base-pay. Middle-level employees average over $94,500 annual base pay (Computer World, 2012).

My second assumption is that by modifying early childhood and schooling experiences, we can increase the number of women who want to pursue a career in computers. Chapter two discusses a variety of experiences that increase or decrease women's likelihood of choosing to study computers. I also assume there are actions that the computer industry itself can take to make women more interested in pursuing careers in computers. Examples are encouraging more team work, enforcing anti-discrimination policies, decreasing the over-time demands on employees and providing on-site child care.

The third assumption is that there are actions colleges can take that will improve women computer students' academic experiences and encourage them to persist to graduation. Chapter two discussed experiences which have already been identified as improving or discouraging women students' experiences.

Worldview. Creswell (2009) describes four primary worldviews as they relate to research: postpositive, social construction, advocacy/participatory, and pragmatic. He contends that the worldview of the researcher tends to inform whether they do qualitative, quantitative or mixed method. Based on Creswell's descriptions I am using a social constructivist worldview for this qualitative research. He describes this view as focusing on subjective meanings of experience; researchers who have a social constructivist worldview look for the complexities of views rather than narrowly classifying them into a few categories or ideas. Creswell said, "The goal of the research is to rely as much as possible on the participants' views of the situation

being studied" (p. 8). This type of research uses open-ended questions which is what I have done in both the individual interviews and the focus group.

Theoretical Lens: Feminist Perspective. This research was approached from a feminist perspective. Creswell (2007) explained that the feminist perspective views women's situations and the institutions that frame them as problematic. It is my belief that the lack of women in computer classes and in the computer industry is a problem. This research is an attempt to discover which institutions frame women's lack of participation in computers and identify specifically which parts of those institutions are problematic. Initially I was not sure I wanted to label myself as a feminist but after discussions with my advisor and additional research on the topic, I realized that I did take a feminist perspective. In relation to the feminist perspective, I strongly agree with the statement made by Candice Osterfield (2010), of the Providence Women's Issues Examiner:

> The term 'feminist' often elicits negative connotations of angry women looking to bring down the average man. But the reality is that feminism is simply the viewpoint that both genders are equal and should be treated as such, both inside and outside the boardroom. Perhaps continued research from the feminist perspective will lead to greater equality between the sexes, and increase in the number of female executives, tighten the pay gap, and negate the awful aftertaste the word feminist has become.

Wadsworth (2001) explained that feminist research is carried out by women who identify themselves as feminists and is aimed at pointing out the ways women are less than equal to men. She said, "The largest portion of feminist research has been devoted to hearing women speak, in our own words, about our own such experiences." This research is built on the notion that women are best able to tell their

own stories. They are the ones who should identify the experiences which contribute to their successes and to their struggles in their quest to prepare themselves for careers in the computer industry.

Power imbalance. Regarding feminist research, Brayton (2012) says, "It actively seeks to remove the power imbalance between researcher and subject" (p. 4). I have actively sought to remove the power-imbalance; since I am a woman, the male-female power imbalance was removed. But there was a possible power imbalance in the instructor-student relationship I had with the research subjects. This was partially dealt with by having a former female student conduct the 2011 interviews and assign pseudo-names to the interviewees before giving the interview data to me. However, there is a possibility that the women were still not convinced of their anonymity and did not describe some experience for fear that it would affect their grades and/or the recommendations faculty members would give prospective employers.

Research Setting

Southwest Community College was established 35 years ago as a vocational-trade school under the auspices of a large land-grant institution. It is within 45 miles of the Mexican border, in an area which was dominantly agricultural until World War II. During the war, the federal government established three large military bases in the area which have continued to expand, bringing in a host of aerospace and defense contractors.

Southwest Community College's computer technology program was established 26 years ago to provide skilled technicians to local government and businesses. Historically, computer technology graduates have been hired in minimum-wage, entry level positions with the more lucrative positions being filled by 4-year graduates of the land-grant institution's engineering and computer science programs. However, under the leadership of a new department chair, within the last six years, the computer technology department has strengthened its curriculum and is now targeting the placement of its students directly into network administration type positions along with providing them adequate preparation to complete their bachelor's degree in business, engineering, or computer science within two or three years after receiving their associate degree.

The computer technology department is located in the Business and Information Systems Division which has been led by three deans in the last five years. The computer department is being led by its second department chair in its 26-year history. When the original department chair became dean, he was replaced by a full professor who had been in the department for over ten years. In addition to the department chair, the department has eight full-time faculty members. Two have degrees in computer science, the rest have their degrees in business, math, science, and education. Two have doctorate degrees; seven including the department chair have master's degrees, and one has a bachelor's degree. Three of the faculty members are females. Eight faculty members, including the department chair and the three women, are tenured.

College wide: 63% of the student body selected Hispanic on the ethnicity portion of their college admission form, 22% selected White, 2% selected Native American, 2% selected Black, and 11% selected other. Eighty-two percent of the students at Southwest Community College receive financial aid. The average age of the students is 26.

Research Subjects

Interview participants. The interview participants were the female computer technology students who had completed at least 21 credit hours of computer classes and were enrolled during the 2009-2010 or 2010-2011 academic year. There were a total of 11 participants. The requirement that the interviewees had completed at least 7 of the required computer technology courses (21 credit hours) was to ensure that they had taken a wide enough variety of computer courses and instructors that their experiences would be reflective of the computer technology program as a whole. I had intended to interview all nine of the eligible female computer technology students who were enrolled during the spring 2010 semester, but my father had cardiac surgery in January 2010 and caring for him during his recovery became my top priority. Consequently three women from the 2009-2010 class were interviewed and eight women from the 2010-2011 class were interviewed. The eight from 2010-2011 comprised all of the women from that class who met the 21 credit hours requirement and were willing to be interviewed. One woman declined to be interviewed.

The eight women were identified by having one of the college's advisors search the student database using declared major (computer technology) and last

semester enrolled as the search criteria. The names, gender, and cumulative credit hours were then exported to a spreadsheet. After eliminating those with male gender, I used a computer technology department database to ascertain the number of computer technology credit hours each of the women had completed. A column was then added to the spreadsheet for that information. The new column was then sorted and the females who had completed 21 credit hours of computer technology courses were identified. The women who had been interviewed in the spring of 2010 had been identified using a similar process.

In an effort to protect the anonymity of the interview participants, I chose to not collect any demographic data on them. Because the population was so small, their demographics would have made them significantly more identifiable.

Focus group participants. The women who were interviewed during the Spring 2011 semester were invited to participate in the focus group but one had a time conflict and was not able to participate. The three women who had been interviewed in the spring of 2010 had graduated and were not available.

Internet-survey participants. The survey participants were the women students who were enrolled in spring 2011 and had completed at least two computer technology courses. The stipulation that they had completed two computer technology courses was to eliminate those who had declared computer technology as a major but were not actively pursuing the degree. The first computer technology course is a requirement for a number of majors at Southwest Community College, so having enrolled in it alone does not indicate the women were actively pursuing a

computer degree. (As discussed in chapter one, students at Southwest Community College sometimes declare a major without actively pursuing a degree in that field. They decide to change to another field of study but do not file the paperwork to officially change their major.) Twenty-one women were identified as having completed two computer technology courses by using the spreadsheet described in the interview section above. Once the women were identified using the spreadsheet, I sent them each an email describing the research and asking them to participate by taking the anonymous survey. Two weeks later, I sent them a reminder email. I left the survey open for 9 weeks. During that time 12 of the 21 women to whom I had sent the email, responded and completed the survey. Some of the twelve who took the survey were probably the same women that had been part of the interview and focus groups but because the survey was anonymous, I could not confirm that.

Data Collection

The research data collected was from individual interviews, focus group discussion, and an Internet survey. Using three different sources to collect the information is known as methodological triangulation (Denzin, 2006.) The purpose of triangulation is to give a more detailed and balanced picture of the situation (Altrichter, H., Feldman, A., Posch, P. & Somekh, B., 2008). Cohen, Manion, and Morrison (2000) also say that triangulation is an "attempt to map out, or explain more fully, the richness and complexity of human behavior by studying it from more than one standpoint" (p. 254). Altrichter, Feldman, Posch, and Somekh (2008) say it gives a more detailed and balanced picture of the situation.

Individual interviews. Eleven female students, who had completed at least seven computer technology courses, were interviewed individually. I conducted the first three interviews; a former female student conducted the remainder of the interviews. While I was tending to my father's health in the spring of 2010, my permission to do research expired; so I had to apply for a renewal to complete the data collection the following year. When they renewed the permission, the Institutional Review Board that governs Southwest Community College stipulated that I could not interview students who were currently enrolled in classes I was teaching. The board's concern was that because some of the women I would have been interviewing were currently enrolled in a class graded by me, there was a conflict of interest and perception of bias. Seven of the eight women were enrolled in classes I was teaching that semester. The agreed upon solution was a former female student to interview the last eight students. She was familiar with the topic and had prior interview experience.

I contacted each of the women to be interviewed by email and told them I was writing a dissertation on the female computer technology students at Southwest Community College and asked them if they were willing to be interviewed. All of the women that I contacted except one agreed to be interviewed and we scheduled a convenient time and place. The original research plan had been to conduct the interviews in a neutral setting such as at the college snack bar or in one of the labs where the students typically meet to study and visit but trial audio recordings at those locations revealed they were too noisy to get a clear recording so the interviews were

conducted in my office. With the women's permission, each of the 30-60 minute in-depth interviews was digitally recorded. I then attempted to transcribe them verbatim using Nuance Dragon Speak voice-recognition software but the women's accents and use of phrases and technical terms made it necessary for the interviewer to do a great deal of manual correction. I had not used the software prior to this and was unable to get it to do a word-for-word transcription without reference to what it perceived as context. (The software was written to transcribe dictation and appeared to try and make complete, grammatical sentences out of everything the interviewees said; when in reality they were speaking in disjointed phrases relating experiences or portions of experiences as they remembered them.)

Even though the women gave their permission to record the interviews, the recorder seemed to make them nervous or less willing to say things. In the interview sessions I conducted, after the women said they were through and I turned the recorder off, they seemed to relax and provided more authentic explanations of the experiences they had described during the recording. The other interviewer described similar experiences in her interviews. The information the interviewees provided after the recordings is not reflected in this research because I presumed they did not want it included.

The three women I interviewed were very familiar with me, having taken at least two classes each from me. Two of the three had also participated in out of town field-trips I had chaperoned. The women interviewed by the former student were less familiar with her but some had attended classes or been involved in student

organizations with her. The familiarity probably made the women more willing to talk openly but was also problematic in that both groups of women (those interviewed by me and those interviewed by the former student) assumed they did not need to re-describe experiences they had already discussed with me prior to the research.

The interview style was an unstructured, conversational interview of the type described by Struebert and Carpenter (1995). The women being interviewed were encouraged to explore the topic in-depth with me or the other interviewer to ensure the whole range of their experiences was explored. The intent was for this to generate rich and detailed descriptive data. Unfortunately, most of the women who were interviewed did not provide detailed descriptive data without being prompted; so the interviewer had to ask a number of "prompt" questions.

Each of the participants was given a written explanation of the purpose of the research and interview and signed a consent form before being asked the broad opening question: "What have you experienced in your studies at Southwest Community College?" and the follow up question: "What conditions or situations have influenced or affected your college experience?" Additional prompt questions were used to assist the participants in exhausting the description of their experience.

Focus group. At the end of the Spring 2011 semester, after the individual interviews had been conducted, the group of women who had participated in the individual interviews were brought together as a focus group to discuss their experiences at Southwest Community College. The purpose of the focus group, which was moderated by the former student who had conducted the interviews, was

to validate and further explore what the women had said in their individual interviews. I wanted to explore their socially constructed knowledge and see if it provided richer, detailed descriptions than the individual interviews. One topic I asked the moderator to explore was any academic difficulties the women had experienced and if they had experienced any difficulties with the male students. Academic difficulties were an area that the women had not elaborated on during their individual interviews even though one mentioned that she had failed a class. Having taught them and assisted them with their academic advising, I knew there had been others who had repeated courses or feared they were going to have to repeat a course and that those had appeared to be significant experiences to them at the time.

The other topic I asked the moderator to explore was the women's experiences with male students. During the recorded interviews, most had related experiences of being encouraged by the male students; but, one had related discouraging experiences involving the male students. Several others had brought up discouraging incidents after the recorder had been turned off. I wanted to see if revisiting the issue would get the women to describe more experiences related to male students; but they quickly redirected the discussion toward problems with male instructors.

The focus group was conducted the last Friday of the spring 2011 semester in one of the college's conference rooms. Student organizations commonly use the conference room for meetings and meals so it was a familiar place to most of the participants. I provided snacks and drinks to make the women more comfortable. Immediately after the focus group session, the female computer technology faculty

members provided lunch for all of the women students. The focus group was facilitated by the same former student who conducted the interviews since the participants were already familiar with her. The intent had been to record the session but the recorder malfunctioned. In lieu of a recording, the facilitator took detailed notes.

The facilitator started by asking the participants to respond to a few of the more common or shared experiences individuals had provided in their personal interviews. From there, the discussion was directed toward increasingly unique descriptions, in an effort to determine if the rest of the group just did not think to mention similar experiences in their interviews or if they have not had any similar experiences. The facilitator's notes were carefully analyzed and new information which had not been provided during the individual interviews was noted.

Internet-based survey. A third source of information, in addition to the individual interviews and the focus group, was an Internet survey. All 21 of the female computer technology students who were enrolled during the spring 2011 semester and had completed at least two computer classes, were asked to respond to the Internet-based survey which was conducted using Survey Monkey (Survey Monkey, 2011.) The goal of the survey was to assess the extent to which the opinions of the survey group, some of whom had taken less classes so had less experience in the computer technology department, matched those reported in the literature and those described by the interview group. (The interview group who had completed at least seven computer courses was asked to participate in the survey along with the

women students who had completed at least two courses.) At the time I proposed the survey, based on my enrollment, I thought there would be significantly more women who had completed between two and seven courses, but when I filtered the women for those who had declared computer technology as a major and had enrolled for the spring 2011 semester, I discovered that was not the case.

The women were invited to participate in the survey via two different emails which included a written explanation of the purpose of the research. The survey stayed open for two months. During that time, 12 women completed the survey. The Likert-type survey, which I designed and pretested on a group of six former students, consisted of 18 statements which summarized what has been documented as the experiences of female students at other institutions. The first 17 statements were positive statements which described encouraging experiences that had been discussed by the researchers described in chapter two. The final statement was: I need to work to support myself and my family while I attend college. Working while attending college is not identified as encouraging women to persist but I wanted to maintain consistency with the other positive statements. The survey was pretested on a group of former female students in 2010 as a pilot. In a follow-up email, the participants in the pilot survey suggested some minor grammatical changes that were addressed prior to sending it out to the 2011 survey group. (See Appendix A for the complete survey.)

Data Reduction

Interviews. As discussed earlier, the interviews were recorded using a digital audio recorder and transcribed using Dragon Speak software. The interviewer

reviewed and corrected the Dragon Speak transcription as necessary before giving then transcripts to me.

After reading each woman's interview transcript several times, I isolated the individual experiences they described and sorted them into themes. Isolating the individual experiences was necessary because in many cases the women rambled in disjointed phrases until they congealed their memory of an experience enough to describe it to the interviewer. After I went through all of the interview transcripts in this manner and isolated the experiences, I used highlighters to identify and classify themes by color coding which appeared in more than one interview. I had intended to use a word search routine to identify words and phrases that occurred across interviews and identify themes that way; but quickly realized that the women's descriptive language was not similar enough for that to work so I started all over doing it by hand through a color coding process. (As I discussed in chapter one, the women did not associate or socialize with each other for the most part. This confirmed that they had not adopted a common language, at least in terms of describing their experiences.)

Focus group. As mentioned earlier, the audio recorder malfunctioned during the focus group session so I was left with the facilitator's detailed notes. Using a process similar to what I had used with the individual interviews, I identified the individual experiences that were described by the women and sorted them into the themes I had identified in the interviews; in the process I verified that no new themes were suggested. I then matched the experiences described in the focus group with

those described in the interviews and added any experiences that were not already recorded in the data.

Internet survey. The survey stayed open for two months, after which I closed it and downloaded both the raw data (how many respondents chose each possible answer for each of the 18 questions) and the Survey Monkey analysis of the data. Since I had not delivered a survey using Survey Monkey before, I also analyzed the raw data using a spreadsheet. My results confirmed the accuracy of Survey Monkey's analysis tool. The results were then compared to the experiences reported in the research and those described by the interview group.

Chapter 4: Results

This research project was designed to help answer two major research questions: What experiences lead women to study computers at the community college level? What experiences affect women's academic success in computer studies at a community college? The related research questions are: Which experiences contribute to women's success in their computer technology studies? Which experiences contribute to women's struggles in their computer technology studies?

A qualitative phenomenological research design was employed. The study used three different data points to understand the experiences of the participants: individual interviews, focus group, and an Internet-based survey. The research subjects were the women students who were studying computer technology at Southwest Community College. The interview group consisted of the women students who had completed at least 21 credits of computer technology courses and were enrolled during the 2009-2011 school years. The women students who were enrolled during the spring 2011 semester comprised the focus group participants. All of the women computer technology students who were enrolled in spring 2011 and had completed more than six credit hours in their major were asked to complete the Internet-based survey.

Eleven women were interviewed over a two-year period. Some of the women were interviewed by me; the rest were interviewed by a female former student. The interview questions we asked the women were: What experiences influenced your decision to study computer technology? What have you experienced in your studies at

Southwest Community College? What conditions or situations have influenced or affected your college experience? These are consistent with the questions recommended by Moustakas (1994). The women's responses were digitally recorded and then transcribed. The interview data was handled confidentially and pseudonyms were assigned to each of the research subjects.

At the end of the spring 2011 semester, the women who had been interviewed were brought together as a focus group to explore their socially constructed thoughts about their college experiences. The same research assistant who had done the interviews mediated the focus group. I had intended to have her digitally record the focus group session as she had done with the interviews but the recorder malfunctioned; so she gave me her detailed notes. In her notes the research assistant did not indicate who said what so the focus group discussion was completely anonymous.

The experiences the women described in their individual interviews and in the focus group are presented here in three sections which are based on the research questions:

- Experiences that lead women to study computer technology at the community college
- Experiences that contributed to women's success in the computer technology program
- Experiences that contributed to women's struggles in the computer technology program

I used the data reduction methods discussed in chapter three to identify the themes and decide which experiences belonged in each theme. To answer the two related research questions, I divided the themes into two groups: experiences that had contributed to the women's success and experiences which they viewed as obstacles. This process was complicated, yet informing as a few of the women saw the same experience as contributing to both their success and their struggles. For example, if they had a professor who did not stay on topic, that caused them to struggle; but having to learn to research and understand the topic on their own ultimately contributed to their success. I related those incidents in the section on experiences that contributed to the women's struggles.

This chapter is arranged by topics which correlate to the research questions. To assist readers, who want to "reassemble" the women's stories, within each topic, I italicized and bolded each woman's name at the beginning of her experiences related to that theme or topic. To further assist, Table 1 summarizes key facts each woman revealed about herself. As discussed earlier, no demographics were collected.

Experiences That Lead Women to Study Computer Technology

The next section describes the experiences the women shared regarding their decision to study computer technology at the community college. Approximately two-thirds of the women who took the Internet-based survey (Appendix A) agreed or strongly agreed with the statement "I chose to study computers because of the contribution they make to other fields such as health or the environment." One woman who took the survey commented, "Technology is interconnected with

everything and hopefully the advancements I made will benefit not just the computer technology industry." Most (over 90%) of the women agreed or strongly agreed with the survey statement "Computers are my hobbies." The survey did not ask when it had become a hobby so it is impossible to know if that was a factor in deciding to study computers at the community college. As mentioned earlier, the survey group included the women who were in the interview group as well as the larger group of women who had competed between six and 21 credit hours of computer technology courses.

The remainder of the information in this section is from the individual interviews. No additional experiences that lead the women to study computers were brought up in the focus group. This topic was not brought up by the facilitator or the participants.

Martha, who grew up in Mexico, wanted to study computers since she was 14 years old. She explained, "When I was in middle school they went to my house to see if I could go to a computer course and I was so excited. I asked my dad if I could go and he said 'I don't have enough money to pay for that' so I had to stop there." For her and her brother, formal schooling stopped after the eighth grade. The high school was three hours away and the family did not have enough money for bus fare. They had walked an hour each way just to be able to go to middle school. After immigrating to the United States and learning English, Maria got her high school equivalency diploma. She then got married and had two children. Two years ago, Maria began the fulfillment of her childhood dream by enrolling in the computer

Table 1

Summary of Key Facts Women Revealed About Themselves

	Childhood	Why study computers	Current job	Family	Other	Goal
Alice	Grew up on a Kibbutz in Israel	Decision based on a comparative analysis	Network technician	Children, referred to spouse as mate	Military veteran	Bachelor's degree
Arial	Abused by father	Wanted to be valued for brains, not body	Laundry			
Caroline	Mother was a computer technician		Cable company	Married with children	Part-time student	NASA
Cynthia		Always curious when growing up		Married with children		Associate degree, computer job
Karla		Since she was 8	Southwest College computer technology department		Started college while in high school	
Martha	Poor, child-hood spent in Mexico	Since she was 14		Married with children		Computer job
Mary		Military peers got her interested	Psychologist office	Married with children	Military veteran	Military-working with computers
Megan	Parents worked for government	Needed to support herself				Department of Defense
Rachel	Wanted to give her daughter a better life than she had		Southwest College computer technology department	Married with daughter	Started college while still in high school	Aerospace engineer
Sally		Chose computers after medical career plans did not work out	University Admissions Department		Military veteran	Bachelor's degree
Sandra	Grew up in a mining community	Initially wanted to be a geologist				Bachelor's degree in computers or psychology

technology program at Southwest Community College. After receiving her associate degree she plans to pass her CCNA (Cisco Certified Network Associate) and Security+ industry certifications and get a job in networking. When asked if she planned on pursing a bachelor's degree she said she would have to get a good paying job first.

Karla has been interested in computers since she was about eight years old. She was amazed that "a piece of metal could do so many things." She said, "Just pressing a button opened a whole new world. When I started the Internet it was like the idea of being anywhere in the world from where you are sitting at." Her passion continued through adolescence, motivating her to pursue a career in computers. She got her first computer when she was a freshman in high school. She says she bought it with her own money and that it was the first computer the family had in their home. No one at home helped her with it; she just figured it out on her own. She said her siblings were "not into" computers and that she was the first one in her family to go to college. She says that one of the reasons she chose community college was that when she first started taking college classes she was in high school and community college was the only place she could go. She says another reason was that she wanted to go for a 2-year degree first; explaining that computer technology seemed more interesting to her than computer science which was more complicated. Lower tuition was another factor. She sums up her decision to attend community college by saying, "I just thought it would be easier, less students, more interaction with teachers and other students as well. Since I started working here when I was in high school I

interact more with the other teachers in the department. I feel very comfortable here and after I met everyone I just wanted to stay here."

Rachel also began her computer technology studies as a high school student. Rachel's long-term goal is to become an aerospace engineer. After taking a college computer class while she was still in high school, Rachel was encouraged by the male instructor to explore the community college as a starting point. After graduating from high school, Rachel enrolled full-time at Southwest Community College and is now spending the spring and fall semesters studying computer technology at the community college. During the summers, she is participating in a faculty-mentored research program for community college students at the local university where she plans on pursuing an engineering degree after completing her associates. Rachel's long-term goal of becoming an aerospace engineer was inspired by her male cousin who is in the Air Force and her desire to "not sit behind a desk." She says she wants to be involved in big projects like NASA. She explained that she wants a career which lets her work hands-on in the field. She said another influencing factor was that she was "really into math." She took trigonometry in high school even though she was not required to. An additional motivation for Rachel to study both computers and aerospace engineering was the economic benefits afforded by careers in those areas. She said, "I'm doing this because I want my daughter to have a life I didn't have." She experienced some of that life style when she moved in with a friend's family after moving out of her mother's home because she did not get along with her. Her

friend's mother who took her in was a mechanical engineer and became a mentor for Rachel.

Sandra, another of the younger students, took a break after high school to "deal with some family issues" but enrolled at Southwest Community College a couple of years later. Sandra did not elaborate on the family issues in relation to the break she took; but later in the interview talked about the difficulties of her brother having to care for her sisters after their parents passed away. Having grown up in a mining community, she said that since her earliest memory she had wanted to be a geologist. She said she had her mind set on it but helped a friend fix his computer and "got a little curious" so she decided to go into computers. She really enjoys computers and would like to become a programmer. She plans on continuing on for her bachelor's degree in computer engineering and possibly psychology.

Like Sandra, computers were not Sally's first career choice. ***Sally*** enjoyed working with computers in high school, especially programming. But, she initially chose to study physical therapy in college with the eventual goal of going to medical school. After a medical condition of her own caused her memory "to be not quite the way it used to be", she gave up on that goal. She explained, "You need to be able to rely on your memory in the medical field in the courses and everything and you can't just use research when people need you right there." She says that after high school she joined the military and worked as an eye specialist for a while and realized that although she likes people, it was emotionally and physically draining to have other people relying on her for support. According to Sally, at that point she gave up on the

medical field and decided to give her support to computers instead. She explained that "having gotten more accustomed to working with computers over the years" she liked them enough and that computers are a field that still needs people. At another point in the interview she said that she likes the logic of computers. Sally compared programming them to working puzzles which she said she also enjoys. She explained: "You have to figure it out where the problem is. So, to me, that's like playing with a puzzle; finding out where the little silly missing something is whether it's a semi-colon or whatever. I like to find that sort of thing so I enjoyed the programming that I did." She continued, "I think computers are fascinating. Just with 1's and 0's how it comes together to do all that it does. I think it's just fascinating and it controls so much these days in so many different environments." Sally is currently working in the administrative office of a nearby university. She said that studying computers "opens the door to working in lots of different areas depending on what you like." Her goal right now is "just to finish her [bachelor's] degree first and foremost." She will make more specific career decisions after that.

Mary, a 13-year U.S. Army veteran, wants to complete her associate and bachelor's degrees in computers and then go back into the Army as an officer and complete her twenty years in the military so she can retire. She became interested in computers in the military when she was a supply sergeant who was deployed in Iraq. She says "the guys in my unit were really into computers" and they would explain them to her. When she got on the computer she would look up more information. She said if she could not figure it out, the "guys" would help her. One of Mary's "army

buddies", who is a computer instructor at another community college, "switched over from doing supply into the computers" and has offered to help her get into the computer unit in the Army when she completes her degree.

Cynthia said she was always curious about computers when she was growing up. She was enjoying the hardware classes she was taking at the time of the interview. She said, "It feels good to fix my own computer. I don't have to ask someone to help me—a man to help me." Her goal is to get a good job in computer maintenance. She said she enjoys taking computers apart and putting them back together and would like to find employment doing that. She said that after she gets her associate degree, she would like to get a bachelor degree but that her main goal is just to graduate with her associate's.

Arial shared some difficult things in her interview. Early in the interview, she revealed that she had been sexually abused by her father from the time she was four years old. She said she chose to pursue a career in computers so people would value her for her brains instead of her body. She said she was further motivated when she applied for a secretarial job with the county and found out that they would not hire her because she was not bilingual "even though being bilingual didn't have anything to do with the job." She said that was when she decided to learn computer languages so she "wouldn't have to be bilingual." As soon as she could, Arial moved to another city to get away from her abusive father. While there, she attended a community college and got some of the basics out of the way. Describing that time, she said, "I kind of wanted to go into computers; you know, data entry." After her dad died she

moved back home and started her computer technology studies at Southwest Community College. She said she likes hardware; things she can see and touch.

Caroline, who attends college part-time while working for a cable company has an eventual goal of going to work for NASA, probably in the area of forensics or programming. When asked why she chose NASA, she said, "When you think of NASA you think of spaceships. It's like a job you would never even imagine yourself at. It has a lot of potential even from where it is now. It will always be around." She also mentioned the relatively good pay and the retirement. Her current job with the cable company "doesn't seem like it is enough; it's not in the direction I want to go." Caroline is continuing to work there for the time being because she cannot find anything else with comparable pay.

Alice, who is in her early fifties, prides herself on being logical. She says her mate (she prefers the term mate to husband even though they have been legally married for over twenty years) had been pushing her for years to go back to school. When she finally agreed Alice made her selection of what to study by making a list and comparing options. She had always wanted to study biology but she was also interested in getting into anthropology as well as computers. So, she made a list and "wrote biology –I can do this, anthropology I can really do this, and computers. When I was done I was looking at the list and I had more computers on one side than anything else on the other side." Alice, who grew up on a kibbutz in Israel, had no exposure to computers until after she immigrated to the United States as an adult. She was introduced to computers for the first time a little less than ten years ago so they

are relatively new to her. She finally gave in and got a computer because her children and husband wanted it. She said she resisted because "we get dependent on them [computers] and then we won't do anything for ourselves like we're used to doing." The family's first computer was an old computer that required them to boot it from DOS every morning. She enjoyed working with it and got better than the rest of the family at remembering the DOS commands; but, was excited when her mate purchased the family a new Windows 98 computer. She took care of and repaired the computer but decided that, at about the same time she decided to go to college, she had gotten herself as far as she could go with the computer on her own so she enrolled in the computer technology program at Southwest Community College. The first class she took was Introduction to Computers. She said that even though it was a "very generic class" she learned things that fascinated her. She discover that she "not only enjoyed [the class] and was learning a lot" but she also liked helping others "understand what computers do and how they work and help them get over their fear of that machine."

Alice's long-term goal is to get a bachelor's degree in computer engineering. She is currently working part-time as a network technician but has not decided which area of computers she eventually wants to devotes herself to. She "loves programming" but is very good at anything to do with system's administration. She explained, "I'm very anal and I like seeing things work together, fall into place." On the other hand she "loves the idea of networking because again it's everything working together; it's the programming; it's seeing the big picture; it's making sure

all the little things tie in and work harmoniously." She concludes, "I don't know right now. I'm hungry for knowledge. Whatever I can use it for later . . . there are so many options."

Megan said that because her dad is an engineer and her mom is a nurse she did not have the option to *not* go to college. She said, "I first started out as a paralegal major and then I did government then I decided I needed to support myself so I needed to go into computers. I'm still deciding if I want to do computers but anyway. . ." She described that when she was a child her father, "used to always put me on his knee and do the MS-DOS configurations ... and do things like play Mickey Mouse Roundup." She said he taught her not to be intimidated around the computer. He always told her to do whatever she wanted to. She remembered him saying, "As long as you excel at it—give it a try."

Megan's goal is to work for the Department of Defense in the area of cyber security. She chose security because she "loved" the security class she took at Southwest Community College. She said she "thinks of possibilities when lots of other people didn't think of possibilities like what happened on 9-11. Nobody even thought something would happen like that. I love to think of those possibilities of what could happen." She said she chose the Department of Defense because her father and grandfather both worked there. She says her mom and uncles work for the government also. In fact, she said, "It's just a family tradition to work for the government...In this unstable economy it's a good idea to work for the government. They are the ones that are hiring. You have job security and you have retirement."

Experiences That Contributed to Women's Success in Their Studies

The next section is organized into four themes that emerged from the data: 1) faculty supports female students, 2) women are encouraged by interactions with other students, 3) mentors contribute to students' success, and 4) academic practices that encourage success.

Faculty supports female students. Over 80% of the women who responded to the Internet survey agreed with the statement, "I have a close relationship with a computer faculty member who mentors me." One of the respondents commented, "All of the faculty in my department mentors me in some way or another. It is one of the many reasons I enjoy learning in this environment." The focus group did not reveal any experiences related to faculty supporting students beyond what had been described in the interviews.

Three of the women who were interviewed had worked in the Computer Technology department office as paid student employees. Three others had completed their required 180 hours of cooperative education experience as unpaid lab assistants in the Computer Technology department. ***Karla*** felt that definitely contributed to her success. She said, "I think that the great advantage I have is I'm working here because I think I have an opportunity no other student has; like for example, I can just go work at the labs anytime and no others will be able to do that. I think I have the experience that almost no one else has that's because I'm here with all of you guys. I get to do so many things—I'm very privileged."

Other women such as Sandra and Arial talked about how much a specific male faculty member had helped them. ***Sandra*** said, "Ted is my advisor. He is the one who has taken me through all of these courses. He's my guy. He's the one who does all my stuff. He makes sure I'm doing ok in classes. He assures me of everything so I'm very happy with that." Referring to Ted and another male faculty member, ***Arial*** said laughingly, "They dealt with the blond one who was confused. They helped me though all of my problems. You know, one year it was my daughter, another my health, and now my teeth." She added, "Kevin even took us to his house to build computers. When I had trouble with my tower [computer] he took it to his class and they fixed it in just a few seconds."

Caroline, on the other hand, preferred women instructors. She said they seemed like they "know more than any of those men I have ever taken... maybe it's because they're women... the mothering instinct...they teach. They know how to teach in a way that people can understand. The women seem to stress more on the importance of the curriculum than some of the men."

Megan was encouraged by the entire faculty. She said, "The instructors that are there—they are very approachable at the branch [community college]. I love the way they take time out of their way to just help you."

Women are encouraged by interaction with other students. Seventy-five percent of the women who responded to the survey agreed with the statement "The male students in the computer department respect and treat me as an equal." One commented, "I think they all respect me as a computer technology student. In some

cases I think I might intimidate them but that happens in most of my life not just here." The survey respondents were divided in their responses to the statement "I am in regular contact with other female computer students who provide me with support and companionship." One half of the women said they agreed. One fourth said they disagreed. The remaining quarter did not express an opinion.

Fellow Students. The women who were interviewed knew the topic of the research was to explore the experiences of female students so they all talked about what is was like to be classes with dominantly male students. A few also talked about the other females who were in their classes. Sandra said, "Most of them [fellow students] seem surprised that they see a girl in the classroom but they don't mind it. If you are here for a learning experience it's probably why. We're all here for the same thing." She continued:

> Most of the guys in my classrooms are older guys. I like to listen to them talk. They have different stories and they really interest me. They are really helpful; nice guys. The only girl that's in the other class is very quiet; she's not very talkative. They guys are very nice; very interested in what everyone else is doing. We all pretty much work together.

Caroline said she became "really good friends" with some of the male students; explaining that they "treat me like I am one of them." However, she said the men in her network security class were "way above her knowledge." She said, "They are really nice and everything but they are on a level I'm not!" Later in the interview she said "I like it because I think it scares the men that women actually know something; a big change from the past where women stayed at home and cooked

meals and that's all they did...raised kids." Referring to male students in her classes, ***Sally*** said:

> Even as a kid, I tended to hang out with the guys more than the girls anyway. I was never one of the prissy kind of girls so that [having mostly males in class] didn't faze me one way or the other really. The logic base of a lot of the computer classes you were taking there is no emotions that are needed to come into play. It doesn't matter if you're a guy or a girl you need to just learn it.

Alice talked a little about being mentored by one of the male students in her classes; but she mostly talked about how she mentored other female students. Referring to a specific male student, she said:

> He is someone I go to when I don't understand. I don't let him brush me off; I never did. I say, 'okay fine show me' and he gets frustrated because he says, 'I sit there and show you and then you do it completely different and you find your way. You just need me to tell you this is how you can do it but for you to go at a completely different angle and come up with the right answers. So I told him this is how it works for me—you know I need to hear yours for it to click and open a door somewhere else so I can do it and he finds it as a waste of time.

Alice calls the group of students she encourages and mentors the "duckling group." She described it like this: "When I see women being afraid to ask questions, being afraid to approach the teacher saying, 'Look I don't understand' which is how we started the duckling groups, it is so much easier to say, 'Let's come to my house.'" When asked by the interviewer who the ducklings were, she responded:

> They are mostly females but some males as well and each class has its own duckling group. It wasn't so much can you explain this to me as you can do this. It was emotional support and encouragement that yes I know it may be difficult but if you stick to it with my help and other peoples help you can succeed. You can do this.

Reflecting on why the students she was mentoring in the Introduction to Networking course classes did not enroll for the next course in the series, she said, "A lot of them were there not because they wanted it but because someone else said they should. 'It's a good class,' and they gave into that kind of pressure and found themselves drowning and so I would get the oxygen and they would finish it with an okay grade and they would understand it but they wouldn't go on [with additional network classes]."

Support through student organizations. The women also talked about how experiences with two student organizations encouraged them in the pursuit of their degree. At the time of her interview, Alice was president of the Debug club. She saw the organization as providing her an opportunity to develop leadership skills and a chance to mentor other students. She said one of the goals of the Debug Club is to provide its members with more hands-on experience building and repairing computers than they get in class. Their computer clinics, in which they allow staff, students, and the public to bring in computers for repair, also give them an opportunity to serve the college and the community. The organization also provides the students with camaraderie.

Arial said that the Women in Technology student organization was a "huge" support for her. She said it "made me feel I was part of something. I was included!" She said the two female faculty sponsors "stuck with me no matter what." ***Caroline*** said the trip the Women in Technology group took to the Intel chip manufacturing

plant was "awesome." She talked about "actually getting to see part of Intel." She also said the two female faculty members were a great support.

Mentors encourage women students. The response to the Internet survey questions about faculty mentoring students was described earlier in the faculty section. The focus group participants did not describe any mentoring experiences which had not already been described in the individual interviews. The women who participated in the individual interviews described several mentoring experiences outside the computer technology department.

One of the computer technology faculty members helped ***Rachel*** submit an application for SCCORE, Summer Community College Opportunity for Research Experience, which is hosted annually by a local university. Rachel was accepted; she said her experience during the two summers she spent participating in the SCCORE program definitely contributed to her success in school. Rachel, whose eventual goal is to become an aerospace engineer, got to work on a mechanical arm that will operate in the zero gravity of space. She said it was especially challenging to learn about the x, y, z axis and the rotations and zero gravity environment the mechanical arm will have to function in. Rachel said she was lost at first but by the end she wrote the report on the atmospheric pressure. She said, "They were explaining to me little by little as they were doing it. I was pregnant at the time so some of it was really confusing but I got the most of it."

Rachel says most of what she learned through the SCCORE program did not directly apply to computer technology but she was strongly influenced by the people

she met there. One of the mentors talked to Rachel about her experiencing of becoming a mother while she was still in college. Rachel said the mentor told her, "She kept going to school. She didn't drop out or anything. She seems content and happy." Rachel continued, "I have my daughter and I want her to have a life I didn't have. Economically that's what I want."

Sally says interacting with people from the Information Technology department at the university where she works had inspired her to keep pursuing her education. She said that when they came to fix the computers in her area they were "willing to explain what they were doing." She continued, "Sometimes they weren't good at what they were explaining but they would show me things and the more I learned the more curious I got and I enjoyed what I was learning." She concluded, "There has been a lot of inspiration over time from people. I feel the more I learned, the more I don't know." ***Mary's*** experience being mentored by the men who served with her in the army was discussed in previous section on experiences that lead women to study computers.

Academic practices that encouraged success. This section discusses academic practices the women described as helping them with their studies. Several of the Internet survey questions measured the extent to which the Southwest Community College women agreed with statements describing practices which had been identified in the literature as being helpful to women at other colleges. All of the survey respondents except one agreed with the statement, "My computer classes are small enough that I get the personalized attention I need." Eighty percent of the

women also agreed that "My computer instructors call on male and female students equally." The majority of the respondents (75%) agreed with the statement, "I prefer having a computer instructor explain the "big picture" before they go into the individual steps." This is identified in the literature as helping women succeed in computer classes (Rosser, 1989; Volman & van Eck, 2001).

Two thirds of the survey respondents did not agree with the statement, "My computer instructors encourage competition by encouraging students to show that they are smarter than their peers." Instructors encouraging competition by allowing students to show they are smarter than their peers is identified in the literature as being discouraging to women (Garvin-Doxas & Barker (2004). As mentioned earlier, all of the survey statement used a positive wording. One of the women who completed the survey commented, "They [computer instructors] are more interested in having the students who are quicker at picking up the information help their peers understand the information better." The survey respondents were unanimous in the agreement with the statement, "My computer instructors have a goal of helping everyone succeed." The women in the focus group did not describe any new experiences that contributed to their success.

Megan said that she like the security class best. She explained, "I loved different things; thinking more broader-view things that people don't even think of." ***Caroline*** said she liked programming classes but did not elaborate on why.

Alice believes that her fluency in Hebrew, Spanish, and English helped her learn computer programming languages easily. She said, "It's the rhythm and the

syntax and the minute you get the rhythm and the syntax of any language, that when it falls into place for me. I also play musical instruments which I think uses the same area of the brain." She added that by helping other students, she got a better understanding herself. She concluded that portion of the interview by saying, "It's not the teacher; it's what I do to challenge myself in the class. That is an advantage I know I have."

Referring to the Introduction to Networking class, ***Mary*** said:

> It's new to me. I'm a little worried as far as a grade but learning stuff– like this past test we had I was really studying. I would read it and then try to Google the other perspectives of it but the teacher has been really informative. She has broken it down step by step. I appreciate the help cause some things I don't know. I'll ask if I don't understand.

She said she was thinking about taking the second networking course but that she wanted to understand the "whole concept first before I go up higher."

Cynthia, who had to repeat the Introduction to Networking class said, "In [Introduction to Networking] class I'm learning more because this is my second time taking it and its being explained more clearly. I'm doing much better." She did not provide any more discussion about why she did not complete the class the first time.

Experiences that Contribute to Women's Struggles in Their Studies

As discussed at the beginning of the chapter, the participant stories were not offered as binaries – experiences that contributed or did not contribute to success. Instead the women discussed how the same experience would challenge them thus making them stronger thereby contributing to their success. This section is divided into four themes: faculty practices that discouraged women students, student

interactions that discouraged women students, academic practices that discouraged women students, and family responsibilities that made it more difficult for women to succeed

Faculty practices that discouraged women students. The Internet survey results did not reveal any practices which discouraged women students. The focus group did not add any additional information in this area. ***Arial*** talked about how discouraging the instructor of her android programming class was. She said, "I asked the instructor to slow down three times but he just wouldn't. I got so discouraged I just quit. You know once I'm lost, I'm lost. Then the bad self-esteem kicks in. You know the same s*** my dad would tell me, 'Just smile and look pretty.'" She went on to discuss another faculty member who was outside the computer technology department that had also discouraged her. She said her public speaking instructor "kept making comments about my chest." She said, "A bunch of the girls wrote him up on their evaluations." She believed he had gotten fired.

Sally was discouraged by her first operating systems class instructor. She said, "We didn't talk about the coursework very much but the book itself was very thorough and the course was laid out in a way that if you followed the coursework you got the work out of it." She said, "I didn't think the instructor really had much to offer. I think he knew his job [well enough] to do his own work but not to teach it..." Later in the interview she said, "There is so much material out there and in a program like computer and information technology it encompasses so much that you can find yourself getting a little lost within it." After thinking it over she concluded, "Most of

the instructors I had were very helpful and supportive. The kind of reminded us that you aren't expected to know it all. That's why you are in school."

Caroline observed, "As men were my teachers it seemed like they tried to dumb it down like when a questions is directed toward me I notice that the way it's worded is not as technical as it would have been when they ask a male."

Some of the women students had trouble with women instructors also. ***Arial*** was discouraged by a women office technology instructor who told Delores, her computer technology advisor, that she was not attending an office technology class so she should not be an officer in the Women in Technology student organization. She said, "I don't know why she got so mad. I did all the work. I just had trouble sitting there. She was so boring." ***Alice*** was seriously discouraged by a female network instructor who could not answer any questions "beyond a kinder level." This is more thoroughly discussed in the section: Academic practices that discouraged women students.

Experiences with male students discouraged some women. There were not any discouraging student interactions noted in either the Internet survey or the focus group. Most of the women who were interviewed did not view the male students in the computer technology program as a discouraging factor but *Mary* did. She said, "As far as the guys, it's been kind of weird. I'm used to being around guys being in the military but in class it's been different. They aren't really [pause] I just need to get the grade." She continued, "Besides being around the guys, maybe they feel kind of uncomfortable." The example she gave was, "In the [network] lab, I actually asked

one of the guys if he wanted to pair up [as lab partners] but he just looked at me like...So it was me and Jon [who did become her lab partner]. I have him in several other classes so we get along pretty good."

Rachel said that in her Introduction to Networking class there was a man sitting right next to her who knew a great deal about cabling since that is what he did for his work and that he got upset when she passed a test that he had failed. She said, "He didn't say anything, but he looked at my score and at his and he couldn't believe I passed it and he didn't." She says she likes being in classes with men because it challenges her; she works hard to disprove the men's stereotype that women are not as good at computers. She said that when she speaks up in class the men are "really amazed by it."

Academic practices that discouraged women students. This section describes the classroom experiences that discouraged the women or caused them to struggle. Of the women who completed the Internet survey, 58% agreed with the statement, "My computer instructors emphasize sequential steps more than the overall project." Two disagreed with the statement. The others did not agree or disagree. One of the respondents who did not agree or disagree explained, "I think each instructor is different and teaches in their own way." Emphasizing sequential over holistic learning is described in the literature as discouraging most women (Rosser, 1989; Volman & van Eck, 2001).

Over 80% of the women who responded to the survey agreed with the statement, "My computer instructors provide plenty of opportunities for us to work

together in groups." Working in groups is identified as helping women students in the literature (Seymour and Hewitt, 1997). In a possible contrast with the literature, over half of the women who responded to my Internet survey did not agree or disagree with the statement, "I prefer working in groups than by myself." One commented that it depends on the assignment or the situation.

The women in the focus group also discussed academic practices which they felt made it more difficult for them to succeed. In reference to an operating systems class, a woman in the focus group said, "The instructor couldn't keep my attention. It was all lecture; we didn't get any experience." Another woman said she liked the labs provided by the simulation software because at least it provided hands on. The other women agreed that they liked the labs provided by the simulation software, but said they did not like "the boring explanations" that the software provided.

Another comment made in the focus group was that a woman did not like the PC Maintenance course because the instructor always presented troubleshooting as a series of "boring" steps; rather than looking it as a problem with symptoms to be solved. Another woman said the instructor did not utilize the book. Referring to another course, the women commented that they were "brushed off" by two different instructors when they tried to ask questions. The instructors responded to their questions by saying "We will go back to that" (but they never did), "we need to move on," or "we're on a schedule." When asked by the facilitator if they gave the same responses when male students asked similar questions, the women all said they did. One woman said, the instructors "do not have any patience." The facilitator then

asked the women if they had tried going to the professor's office to ask questions or get help. Two women said they had gone to one of the instructor's office and that he was very patient and answered all of their questions when they were in his office.

When asked by the focus group facilitator about group projects, a couple of women said they had not done any group projects. Of the group projects they had done, the women said they liked most of them. One woman brought up that some group members had not done their share of the work and that they had "to carry too much." The other women agreed. Someone commented that the instructors "didn't know and didn't care" that the work had not been equally shared.

In her individual interview, ***Mary*** explained why she did not like group work. She said "I am just here to learn. Networking [class] has been groups and it's been kind of hard. This is the first group class I have had. I would rather figure it out by myself."

Referring to the second networking course, ***Alice*** said it was especially hard because she had not gotten the information that she needed in the prerequisite Introduction to Networking class. She said the students could not get any information "above a kinder level" out of the instructor of the first class because she "didn't have it." She says her class was offended by the instructor using Peter Packet, a game created to help children from eight to eleven years of age understand how packets move through a network. She says that even though the second networking class was hard, "Once I fell into it, I enjoyed it—I love it--I like the challenge. I like the fact that I have to think really hard to get things to fall into place. There's so much more

information that's coming in that I need to organize into my little boxes. Make everything fall into a pattern."

Karla, said the Introduction to Networking class was the hardest class she ever took. She took it online using a lab simulator and did not get any physical hands-on experience. But after getting some experience helping physically maintain the network lab as a student employee in the Computer Technology department she said, "When you get to see how it's done and why, then you understand a little better. Even if you go to class they tell you it's supposed to be like this because of bla, bla, bla [pause] it makes sense but you don't get it 100% until you start doing it yourself."

Megan said C++, a programming language, was hard for her. She explained, "It's just so much effort; there are so many lines to learn. If you are missing one little dot or something the whole program is wrong." She said it was easy for most of the guys in her programming class but it intimidated her. She said, "I just feel like I wasn't really into it; I don't like it that much. It was too meticulous. I didn't like that; I was just too myopic I think. It's so narrow and so focused on one issue. I like different aspects of computers rather than just programming."

Rachel said the "how to work with clients" portion of the system analysis class was especially challenging. She said, "You got to understand how to ask the right question and not. You need to learn how to analyze. Not everyone understands the jargon or technical terms for computers."

Mary said that the math class was difficult for her but did not elaborate. She also mentioned that at first she had trouble with the simulator used in the Introduction

to Networking course, but said that once she figured it out, she was "ok with it." ***Sally*** said she had trouble understanding object-oriented programming but did not elaborate.

Alice said she was discouraged at first because she had to take so many prerequisites that "had nothing to do with computers." As far as computer technology classes, she said her worst class was game programming because it "bored the living day lights out of me." She said, "It's not my cup of tea; I'm not interested in sitting there designing and writing a game." She said she "wants to sit down and write hard code." She does not want to work through other media. The game programming instructor uses software that structures the program for the students.

Family responsibilities that made it more difficult for women to succeed.

Several of the women who were interviewed mentioned family responsibilities and situations that made it more difficult for them to complete their degree. Over two-thirds of the women who completed the survey agreed with the statement, "I need to work to support myself and my family while I attend college." The focus group did not describe any new experiences related to their family responsibilities. The women who participated in the individual interviews discussed several family experiences which made it more difficult for them to complete their studies. This is consistent with a recent study published by the Institute for Women Policy Research (Costello, 2012).

By the time she was interviewed, ***Alice's*** children had gotten jobs and moved out of the family home and her mother-in-law who was in her nineties had moved to

New York to live with other relatives. However, she said that when she first started her degree she had to arrange her classes so that she could go home periodically and be with and take care of her mother-on-law. Describing her overall college experience, she said it was primarily her mate who was unhappy about the hours she spent at school. She explained, "The irony—my mate was the one that's been pushing me to go to school, go to school. That first semester I only took one class. The second semester I took four classes which was a shock so the next semester I only took two and I don't regret many things in my life but I regretted that decision." She said at the end of the semester she told her mate, "This was your last freebie because you pushed me to go to school; but what was it you expected me to do? Did you expect me to take ten years to finish my associate's degree?" She told him she would rather not go at all than "do it by drops." She gave him an ultimatum, "Either I go full time and I go after it or I don't go at all." When asked by the interviewer if his objection was because he had to take care of their children or his mother, she responded. "I still took care of everything but when I went full-time I didn't have time to do a lot of things."

Alice explained that because her mate had advanced very rapidly in his career, she had taken care of everything for a number of years. She said:

> I had been his support and I wasn't there to give that support 24-7. I was still there to give it but not 24-7. He had a conflict with 'I know how smart you are and I want you to use your brain and I want you to do something' and on the other hand 'I got so comfortable with the way things were that it's hard to let it go' so it took him almost a year to find [pause] and it's still a struggle. It's still a fight—you're here to support me but I'm not quite here to support you.

She said he was torn between being very proud of her and not liking the fact she was not there to do everything.

Martha said that after emigrating from Mexico she studied hard for a whole year to learn English but since she did not have any children she did not "have anything to worry about." After learning English, she successfully got her GED (Graduate Equivalency Diploma). She says after that she got married so she had to stop. After several years she and her family finally made the sacrifice for her to go back to school; but she said, "It's hard. When you have kids [pause] my husband is the only one working. We've been having trouble. We don't have a house right now and I know this [completing her degree] is going to help a lot."

Many of ***Arial's*** difficulties are rooted in her family of origin. As a result of the sexual abuse by her father, she says her self-esteem is an obstacle to her success. She explained, "I guess I don't think I deserve it. I'm self-destructive." She talked about having trouble retaining what she learned in school. She said the doctor told her that her brain works on overload to protect her from the abuse. She explained, "He was my biological father. He said it was my fault because I was so pretty. I found cocaine. It helped me become super woman. It numbed me: both on the inside and the outside." She says she went through drug treatment at a half-way house but that she could not get away from her father until he died. She said she attends 12-step meetings but needs to do more of them.

Sandra said that at first her brother was "a little bit iffy" about her going to college. After their parents died, he had become the caretaker for her sisters. Even though he did not support her decision to attend college at first, she said that now that she is finishing her associate's degree, he is very surprised and very happy. She said

that he dropped out of school after the sixth grade but that he wants to go back and get his GED so that he too can have something to be proud of.

Caroline, who works full time, said it is sometimes difficult to juggle her job, classes and children but that in some ways she does better when she is under pressure. At a different point in the interview, she said the reason she did not take the advanced networking classes was because she was pregnant at the time.

Internet Survey: Other data

In addition to specific statements about academic activities, the survey was constructed to learn to what extent the larger group of more current students agreed with general statements. These included the statements "I believe females are as good at computers as males" and "I am confident that I will complete my computer degree and do well in my future job" with which those who completed the survey were unanimous in their agreement. Another statement the respondents were in unanimous agreement was "My family supports my decision to study and pursue a career in computers."

When asked to what extent they agreed with the statement "There are female computer scientists who are my role models." 75% of those who completed the survey indicated they agreed or strongly agreed. One of the respondents commented, "There are not as many as the males; however I am hoping to change this by becoming a female role model for others interested in this field." One of the women said she had not met any females in the computer industry other than her instructors. One respondent did not express an opinion.

Chapter 5: Findings

The computer technology program at Southwest Community College, like computer programs at most colleges, has significantly less women than men enrolled in its program. The purpose of this study was to better understand the experiences that led women students to choose to study computers at the community college level and the factors that contributed to their success and struggles in their studies. It is hoped that by understanding these factors, collegiate computer programs will provide better support to their existing women students and will more effectively recruit and retain women in the future.

This phenomenological study collected data from the female students at Southwest Community College in three different ways: individual interviews with women who had completed at least one-half of the computer courses required for an associate degree, a focus group comprised of the same women, and an Internet-based survey of any women who had completed at least two classes. Chapter four described the data that was collected; reporting the results in categories which correspond to the research questions: What experiences lead women to decide to study computer technology at the community college level? What experiences affect women's academic success in computer studies at a community college? The two sub-questions were: What experiences contribute to women's success in their computer technology studies? What experiences contribute to women's struggles in their computer technology studies? Within each category, the women's experiences were further organized into themes which emerged as the data was read, reread and

analyzed. The method I used to analyze the data and develop themes is explained in detail in chapters three and four.

This chapter will present the findings suggested by this research. It will focus on the women's experiences which are not consistent with what was described in the literature review in chapter two. The discussion of each finding will be followed by discussions of pedagogical foundations and implications for practice as related to this finding. My purpose in connecting pedagogy and my findings is to familiarize or remind computer instructors of the pedagogical practices and theories which will improve learning for all of computer students, especially females. My hope is that by discussing the pedagogy immediately after the finding it will assist instructors in seeing the correlation between the finding and the pedagogical practice. This is followed by suggestions for policy changes that would increase the number of women who succeed in their computer technology studies. The chapter ends with recommendations for future research and researcher reflections.

Finding I: Women May Prefer an Inductive Reasoning, Problem Solving Style

Alice's description of her experience being tutored by a male student may be indicative of the difference between how males and females prefer to solve problems. Alice said that the male student would become frustrated that even after he showed her exactly how to work a problem, she would not accept his solution method; but, would instead go work out a different method of solving the problem which made more sense to her. She said the male thought "it was a waste of time."

A woman in the focus group was unhappy because the instructor of her PC Maintenance course presented troubleshooting as a series of "boring" steps; rather than looking it as a problem with symptoms to be solved. Karla talked about struggling with the Introduction to Networking class until she actually got into the physical network lab and figured it out for herself. Mary talked about needing to use an Internet search engine to see if there was another perspective (other than her instructor's) that would help her understand the material better.

All of these are indicative of women preferring a different method of problem solving than what was being presented by instructors or male tutors. Authors like Gurian (2011) contend that females learn math, science, and technology differently than males. He says this is partially based on biological differences. Gurian's book, *Boys and Girls Learn Differently: A Guide for Teachers and Parents* describes an encounter with a recent college graduate who had really struggled with physics in high school. The graduate described watching her male teacher and the male students at the blackboard, she said, "They were going so fast figuring things out, and I couldn't quite get it" (p. 298). Gurian advocates sex-segregated education; believing that girls learn better when they are in classes with other girls and are taught by women. He contends that girls learn concepts better when they can work with them hands-on. They have trouble with concepts being rapidly presented on the blackboard. Gurian also postulates out that teachers tend to teach in their own preferred learning styles, meaning that male teaching optimizes learning for other males boys and female teaching optimizes learning for other females. According to

his website, Gurian's theories have been successfully tested on a number of schools in the Midwest.

Hodgins (2011) also contends that differences in the anatomy of typical male and typical female brains affect their respective learning styles. He asserts that males are visual learners (indicates that seeing things on the blackboard would improve learning); females are verbal learners meaning they need detailed verbal explanations. It is possible that male teachers and students are showing (visual) without verbally explaining what they are doing.

Hodgins (2011) and Gurian (2012) agree that males tend to use deductive reasoning and females tend to use inductive reasoning. Hodgins says:

> Males tend to be deductive in their conceptualizations, sharing their reasoning process frequently from general principle and applying it, to individual cases. Females on the other hand, tend to favor inductive thinking, adding more and more to their based of conceptualization. They tend to begin with concrete examples (p.7).

This is another possible factor contributing to these women's struggles. Males can accept the new material presented in a lesson with the understanding that they will use it to deduce a general principle later; females, on the other hand, may try to immediately identify a general principle based on the material and become frustrated if they do not understand the material well enough to identify a principal or it they identify the wrong principle.

Pedagogical foundations. The women in this study revealed that in college classes they may need varied teaching approaches to master the content. Historically, computer education has its roots in the vocational education movement of the last

century which was based on a behaviorist model (Doolittle, 1999). Doolittle cites the use of performance objectives to provide structure for lesson plans, criterion-referenced measures to measure task completion, and reliance on incumbent worker task lists as the primary source of curriculum as evidence of behaviorism. Comp TIA, the Computer Technology Industry Association, acknowledges that their certification tests are based on performance objectives and are derived from incumbent worker task list (Computer Technology Industry Association, 2011). Additionally, even a cursory look at the textbooks published by Microsoft® and others reveals that they are deeply rooted in behaviorism, providing students with an exhaustive set of problems and recommended solutions for them to learn. A specific example is the Microsoft MCSE® exam prep books which list the performance objectives at the beginning of each chapter and then provides exam tips throughout (Holme, Thomas, Mackin, McLean, Zacker, 2004).

Much of the success of Southwest Community College's computer technology program is reflected in the preparation and achievement of students that pass the national certification exams such as the Cisco CCNA, Microsoft MCSE, and CompTIA Security+. In many cases successfully passing the exams gives associate degree students an equal or better chance at being hired in the competitive information technology marketplace than their four-year counterparts who have not passed the exams. Thus, it is important to the college to use methodologies which result in high pass rates on national exams (Simply Hired, 2012).

Researchers such as Doolittle and Camp (1999) have advocated a model for technical education which encompasses both behaviorism and constructivism. They suggest that even though there is still a need for objectives and competencies based on the incumbent worker tasks in technical education, in today's increasingly complex world there is also a need for students to build their own mental models and construct their knowledge in a way that they can use it to solve new and previously unforeseen problems. Even though Doolittle and Camp, did not specifically address the issue of gender, assisting students in building their own mental models and constructing knowledge would, most likely, benefit women and men, whose preferred approach in learning is constructivist. Doolittle and Camp (1999) postulated that while most career and technical educators would be at odds with radical constructivism and some of the aspects of social constructivism, cognitive constructionist tools could enhance technical education.

Implications for practice. Some specific tools Doolittle and Camp (1999) discussed included having learning take place in authentic environments such as labs, making the content and skills relevant to the learners through programs such as cooperative education, using formative assessment, having teachers function as guides and facilitators rather than as instructors, and teaching content and skills within the framework of students' prior knowledge.

Doolittle (1999) explained the importance of new material being "understood within the framework of prior knowledge" by discussing the importance of a teacher finding out if a student is consistently misunderstanding and using an incorrect procedure to solve a certain type of problem based on some error in their thinking due to previous

background experiences. Even though the student may get the correct answer part of the time, their misunderstanding will lead to difficulties in the long term if it is not discovered and corrected. Students' misunderstanding of a problem, based on their prior knowledge, occurs frequently in computer technology and other technical education fields.

There are many opportunities to enhance the education experiences of women students in the field of technology. Next I offer five suggestions that emerge from the constructivist literature or have been informed by constructivist theory and gleaned as related to this finding.

Concept mapping has been used in a variety of educational pursuits in science and technology. Some of the instructors at Southwest Community College are using a concept mapping program called Cmap to assist students in correctly associating new material within their framework of prior knowledge (Novak and Canas, 2004). Concept maps are hand-drawn or computer generated graphics for organizing and representing a student's understanding of the relationships between concepts (Novak and Gowin, 1984). Concept mapping software can also be used by both students and faculty to demonstrate various approaches to solving complex problems, allowing males and females to quickly see and validate or invalidate each other's approaches. A detailed bibliography, as well as free downloads of the software, is available on the Cmap website (Florida Institute for Human and Machine Cognition, 2011).

Even though Doolittle and Camp (1999) anticipated technical educators would be hesitant to accept social constructivism, Southwest Community College has also found some social constructivist tools useful in assisting women students. The Cmap software

discussed above has a collaboration feature, including a chat window, which allows students to work together simultaneously to resolve and document their understanding of the relationships between concepts or the approaches for problem solving if it is being used as a problem solving tool. Vygotsky's (1978) description of the Zone of Proximal Development is a good example of why social constructivism may also benefit computer education. Vygotsky explained that the zone of proximal development lies between what students can do by themselves and what they can do with the aid of a more capable peer or teacher. Over time, students internalize the understanding they gain from their more capable peers so that they can solve increasingly difficult problems on their own. By constructing concept maps in collaboration with their peers, students increase their ability to understand increasingly complex problems.

Female peer mentors are another social constructivist tool which is useful when teaching women computer students. If mentoring relationships do not form naturally as happened with Alice and her group, instructors may need to facilitate the process by arranging study groups. Another suggestion would be to use female teaching assistants. I have had at least one female network lab assistant each year for the past three years and it seems to have helped the women significantly. I have noticed that during this time, more women are completing the three course network sequence and with better grades. Anecdotally, I have observed that the women are also more confident in labs and class discussions.

In *Coping Strategies for Women in Computer Science* (2006), Jacque, a bachelor's computer science student described her experience with the difference between male and female learning styles. She said:

> I have really struggled with the fact that many of the computer science classes are taught from a male perspective and geared toward a male learning style. Often times the course material is covered in a high-level, abstract way that leaves me with the need to ask many clarifying questions. This is particularly true of assignments that are given. I often have to ask for clarification on what the professor is expecting. It often appears as if my male counterparts are perfectly clear about the expectations of an assignment. If the classes were geared toward a female learning style, I think they would be much more linear in nature. The concepts would be explained from the big picture then drilled down to the detail level. For about the first year in the program, I thought I was the only one in the class who felt like I didn't quite understand what the professors were getting at and/or asking for (Adams, Jensen, Lester, Olson, and Tennant, 2006, p.86).

Jacque's coping strategy was to befriend other female computer students. Finding out they had the same experiences, helped her cope. Some of the women in the study benefited from having female study partners; because hearing a woman's perspective often helped them understand the material better. Jacque said that through encouragement from other female students, she also began to feel more "comfortable taking up their [professor's] time asking them questions" (p.86).

Facilitate learning by using multiple teaching approaches Instructors who use problem-solving methods which are not native to most women and those who use textbooks written by men that discuss only "male" problem solving methods, need to accommodate women who need to work the problems in their "female" problem solving method. Men who are not familiar with typical female problem solving methods can consult with female computer faculty (if there are any in their

department) or with female students who have successfully mastered the lesson to gain insight into additional ways to solve the problem. Web search tools are also helpful in locating alternative problem solving methods. Both the ACM-W and the IWITT websites have links to articles on ways to improve female understanding of various computing topics (ACM's Women in Computing, 2010; National Institute for Women in Trades and Technology, 2010).

Promote individualized instruction thereby allowing women to learn at their own pace. Because of their dominantly inductive reasoning, women may not grasp new material at the beginning of a course as quickly as their male counterparts even though they may have an equivalent or better understanding by the end of the course. Relaxing stringent deadline requirements should give women the opportunity to learn the material at their own pace. Stinard and Warren (1981) found that women enrolled in an anatomy/physiology course which used a self-paced mastery exam schedule performed better than women who completed the same course using a traditional exam schedule. Emphasizing summative assessment (conducted at the end of semester) over formative assessment (conducted periodically throughout the semester as students are learning the material) in final grades should also assist women. Formative assessment was one of the tools advocated by Doolittle (1999) that was discussed in the previous section.

Cluster women together in classes rather than each being placed in a separate section. This might promote women working together on class assignments, improve their experience in the classroom and facilitate a feeling of camaraderie among the

women students. The hardware class, for example, about which Arial described her experience going to the professor's home to build computers, was a class in which four female students had been clustered together. I had provided the male instructor with some of the research on how to optimize learning for female students. In chapter four, several of the women commented about having a positive experience in that class.

Finding II: Instructors Need to Slow Down and Check for Understanding

In both the individual interviews and the focus group, the women described several classroom experiences in which they asked instructors to "slow down" but the instructors would not. For example, Arial described her negative experience with a male programming instructor who refused to slow down, even though she asked him to three times. A woman in the focus group commented that she was totally lost in a programming class. When asked by the facilitator if she asked questions or sought help, she said she tried but that the instructor had already moved on to another topic and would not back up. She said that at the time he was initially covering the topic, she could not even get enough of a grasp of the material being presented to figure out what to ask. Other women in the focus group described incidents in which male instructors either ignored their requests to slow down or responded by saying "We will go back to that" (but they never did), "we need to move on," or "we're on a schedule."

Pedagogical foundations. Women's concerns with the pace of classes may be at least partially based on their difficulties understanding the reasoning and problem

solving techniques that are being used in class. Instructors who continue to maintain the fast pace, without regards to the women's requests to slow down, would appear to be more focused on traditional behaviorist approach to technical education than on the constructivist method which calls for facilitating students construction of their own knowledge. Southwest Community College faculty, like those of many other community colleges, are constantly faced with not having enough time to get through all of the material they need to in their classes.

On the website of Saskatchewan Learning (2012), the concern with time is addressed directly. It states that for technical educators there is an assumption that constructivism takes more time than behaviorism but asserts that a constructivist framework allows teachers to use their time more efficiently. They explain that if teachers adjust the pace and depth to the needs of learners and the curriculum, they will eliminate the need to teach specific content the students have already mastered. If the instructors provide individual or small group projects, the will have more time to interact with and teach individual students or small group of students. The goal is for their classroom to become interdependent learning communities.

Implications for practice. The Saskatchewan Learning group (2012) suggested a good tool teachers can use to deal with the "too fast" pace is individual and group projects. What follows are more recommendations to consider.

Employ a web based learning management system to provide student support beyond class time. Another tool instructors could use is to augment their face-to-face classes is an Internet based learning management system (LMS) such as

Blackboard or Canvas. The instructor can put their lecture notes as well as enrichment material in the LMS, so students who had trouble keeping up in class could use the material to finish solidifying or enrich their understanding. The discussion portion of the LMS can also be used to improve learning opportunities and provide another avenue for students to get their questions answered. Hsi and Hoadley (1997) say electronic discussion can improve learning opportunities and balance gender participation. In their research they found, 78% of the students contributed in electronic discussion compared to only 15.3% participation in class discussion. Females participated more than males in electronic discussion, but less than males in classroom discussion.

Employ instructional assessment strategies at the end of each class meeting. To make sure learning has occurred and that all student questions have been addressed, faculty can use strategies to inform their next step in teaching. One method, called the "muddiest point assessment" was developed by Frederick Mosteller (1989) while teaching an undergraduate statistics course at Harvard. To use muddiest point assessment, at the end of each class, the instructor asks students to jot down the thing they are most confused about from the day's lesson. Mosteller's original plan calls for students to hand the note to the instructor who would address the muddiest points at the beginning of the next class. Courses that use a web-based learning management system could easily use the discussion tool to implement muddiest point assessments in both their face-to-face and distance classes.

Finding III: Women May Choose Computer Careers Later in Life.

Some of the women made the decision to study computers long after they left high school. This find is contrary to Margolis' and Fisher's (2002) research where they found that women were influenced by their early family or schooling to study computers. In the present study, four of the eleven women interviewed for this study decided to study computers in spite of an early passion to study something else, In addition, a few of the women had no clear idea about what they wanted to study when they were children. As examples, Alice grew up in an Israeli kibbutz with no access to computers. She was in her early 50's before she made the decision to study computers. Sally's early intention was to pursue a career in the medical field but changed her mind after developing her own medical issues. Having grown up in a mining community, Sandra's intention when she left high school was to study geology. Megan's first college studies were in the paralegal field. Rachel's passion for the future was to study aerospace engineering but she decided to get a computer degree along the way. Mary made the decision to study computers while she was deployed in Iraq. Arial was unsure what she wanted to do when she was a child and young adult. Because the population was so small, it is impossible to tell if their "late" decisions are typical of community college students; but the topic needs more study. Perhaps some of the money and effort that is spent trying to recruit female high school student needs to redirected toward women in other stages of life. This recommendation will be discussed later on in the chapter.

When the participants were asked about experiences that lead them to pursue studies in computer technology, some of the women discussed both family and societal influence. Both Megan and Caroline had at least one parent who worked in a computer career; but women like Alice did not describe having been affected by either. Family and societal influence are key factors described by the literature as affecting women's decisions to study or not to study computers (Margolis & Fisher, 2002; Powell, 2005. Consistent with what the literature describes, at least some of the women were influenced by their early school experiences. Karla and Rachel described high school experiences which led them to study computer technology and Martha discussed her school identifying her talent for computers. The other women did not mention their early school experiences.

Pedagogical Foundations. The most relevant theory which explains women's decision to study computers is Social Constructivist Career Theory (Lent, Brown, & Hackett, 2002). The theory postulates that people help construct their own career outcomes as a result of their self-efficacy expectations and their outcome expectations. These expectations affect their interests, intentions or goals for activity involvement, activity selection and practice, and performance outcomes such as goal attainment and skill development. The performance outcomes then affect future self-efficacy expectations and outcome expectations. Lent, Brown, and Hackett suggest that this cycle repeats itself throughout ones lifespan. Hansen (1984) however does note that career interest tends to stabilize by late adolescence or early childhood but notes that changes and growth in interest are theoretically possible at any age. Things

such as job restructuring, childbirth, or technical innovations could be triggers for exploring new career interests.

Alice, a participant in this study, was exposed to computers at approximately age 40 and discovered that she was interested in them and was successful at working with them; she began considering them as a career. The remainder of the women had some early exposure to computers, but did not become interested in them as a career until a recent exposure to the technology convinced them they were capable of succeeding in the career field. Megan's motivation to study computers because of the job stability and relatively high salary is an example of outcome expectations.

Implication for practice. Efforts to recruit women in the field of technology should take place beyond the high school years. Many of the women interviewed were not traditional students who enrolled in college immediately after high school. With the exception of Karla and Rachel, they tried other career options before deciding to enroll at community college and study computers. All of the recruiting efforts discussed in chapter two of this research were targeted at high school students. Perhaps, we are missing a sizable portion of women by directing all of our recruiting efforts there. The Institute for Women's Policy Research released a 2012 report entitled Increasing Opportunities for Low-Income Women and Student Parents in Science, Technology, Engineering, and Math, which describes several ways to appeal to non-traditional women on the premise that studying the STEM fields, including computer technology, will improve their economic status. The recruitment recommendations included stressing how much higher wages are in STEM fields as

compared to non-STEM fields even with an associate degree, instituting and advertising a child-care program, and explaining how scholarships and other financial aid available to them.

Cisco (2011), authors of the Cisco Networking Academy program which is used by hundreds of community colleges in the United States, has developed recruiting strategies and materials targeted at non-traditional women. Their key recruiting points are that "girls and women *can do* networking" and the economic benefits of training and employment in the computer networking field. They recommend posting advertisements "in places where women and girls frequent, such as community centers, shopping centers, nurseries, and health clinics."

Recommendations for Institutional Policy

A number of implications for practice have been discussed in this chapter. These suggestions are primarily for instructors; but based on this research, there are also several things the administration of institutions similar to Southwest Community College can do to increase the number of women who both enter and who complete the computer program.

Implement a formal admissions process. Colleges like Southwest Community College would be better served if they developed formal admittance procedures for their computer technology degree students. That would allow progress in recruitment and retention to be better tracked. It would also allow women students to be more formally monitored and mentored.

Relax requirement for minimum number of students per class. Southwest Community College has an institutional requirement that classes will be cancelled if a minimum of 12 students do not enroll. This requirement limits when classes can be offered and necessitates that in the case of many electives all students taking the same course are combined into one class, even if they have significantly different ability levels. In the case of networking, because many students have to work during the day, that class is offered at night. It also means that a number of computer classes are not offered every semester, necessitating that women often take classes they are not ready for because the class will not be offered again before they graduate or need it as a prerequisite for another course.

Enable the Success of a Women Support Group. Several of the women who were interviewed discussed how they had benefited from the Women in Technology student organization. Even though the organization benefited those who initially participated it in, Southwest Community College had difficulty sustaining it. Margolis and Fisher (2002) discussed the difficulties of maintaining a women's support group at Carnegie Mellon as well. Truman State University also struggled initially but faculty members there finally got a $40,000 grant from Boeing Plant to provide funding to allow the group to provide more support. The support was in the form of a summer camp, a mentoring program, and a role-model program (Beck 2007).

Implications for Future Research

This study used a phenomenological approach to explore the experiences of women studying computer technology at a community college. The study was successful at identifying the experiences that the women in the study shared as significant to their lives. Additional focused studies are needed to explore how applicable the findings are to women students at other educational institutions. More exploratory studies are needed to learn of different experiences that women identify as contributing to their success or their struggles.

This research focused on women who were successful in the computer technology studies; but expanding the focus to women who were not successful in their computer studies would provide additional information. Exploring the experiences of women who did not choose computers as a field of study would also provide additional insight. Finally, interviewing male students who were studying computers would assist in identifying which experiences were uniquely or dominantly female. Longitudinal research would also be useful in ascertaining if women change their perceptions of their experiences as they progress through their studies.

One of the specific findings of this study suggests that women's inductive reasoning may make it more difficult for them to learn computer concepts from male instructors and textbook authors who use deductive reasoning. The experience reported by these women deserves further study among other women who are studying computers.

Limitation of This Study

This research explored the experiences of eleven women related to their decision to study computers at a community college. The study revealed some findings which are significant but may not be applicable to other women. This is a characteristic of all qualitative studies but is more pronounced in phenomenological studies which use small populations.

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APPENDIX

APPENDIX A

INTERNET-BASED LIKERT STYLE SURVEY

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I chose to study computer because of the contribution they make to other fields such as health or the environment.					
Computers are my hobby.					
I believe females are as good at computers as males.					
I am confident that I will complete my computer degree and do well in my future job.					
My family supports my decision to study and pursue a career in computers					
I have a close relationship with a computer faculty member who mentors me.					
There are female computer scientists who are my role models.					
I am in regular contact with other female computer students who provide me with support and companionship.					
The male students in the computer department respect and treat me as an equal.					
My computer classes are small enough that I get the personalized attention I need.					
My computer instructors provide plenty of opportunities for us to work together in groups.					
I prefer working in groups than by myself.					
My computer instructors call on male and female students equally.					
I prefer having a computer instructor explain the "big picture" before they go into the individual steps.					
My computer instructors emphasize the sequential steps more than the overall project.					
My computer instructors encourage competition by encouraging students to show that they are smarter than their peers.					
My computer instructors have a goal of helping everyone succeed.					
I need to work to support myself and my family while I attend college.					