PERCEPTIONS OF FEMALES IN UNDERGRADUATE COMPUTER SCIENCE/TECHNOLOGY PROGRAMS TOWARD THE FIELD OF COMPUTER SCIENCE: A MIXED METHODS STUDY

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DEDICATION

For Jim, Elliot, and Julia

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CHAPTER 1: INTRODUCTION

Introduction

The purpose of this chapter is to describe the basis for this study. The object of study for this research project is introduced including the rationale, purpose, research questions, and possible limitations that may impact the findings. The chapter continues with a discussion of the conceptual framework guiding this study. A visual representation of the conceptual framework is provided to communicate the main areas of concentration and the relationships that exist between them (Miles & Huberman, 1994, p. 18). Finally, the chapter concludes with a section that will define terms and phrases used throughout the document.

Object of Study

The object of study for this research is the perceptions held by undergraduate female students enrolled in computer science/technology degree programs.

Rationale

Numerous higher education institutions' science, technology, engineering, and mathematics (STEM) programs have struggled with female enrollment and retention. Of computer science bachelor degrees granted to women, 37% occurred in the 1983-84 academic year (Cohoon, 2001). Since the 1983-84 academic year, the number of computer science degrees granted to women has been in steady decline (Cohoon, 2001). As of 2001, women earned only 28% of all computer science degrees (McDowell, Werner, Bullock, & Fernald, 2006). As a result, the information technology (IT) field (both academia and the workforce) reflects an under-representation of females. The U.S. Department of Labor indicates that women held only 27% of computer and mathematical occupations in 2005 (U.S. Department of Labor, 2006). Women comprise more than half of the population, but elect not to pursue computer science degrees

(Camp, 2002). Klawe, Whitney, and Simard (2009) report that some advancement has been made since the mid-1990s, but that the participation of women in science, technology, engineering, and mathematics (STEM) higher education programs and industry still remains low.

The "incredible shrinking pipeline" (Camp, 2002, p. 129), as this phenomena has come to be known, has been studied since its inception by Camp in 2002. Women cite many reasons why they choose not to enter the field of computing or why they leave once they enter, many of which are gender-based. Gender stereotypes, lack of self-confidence, math anxiety, and fewer opportunities to participate in class discussions contribute to the female population's lack of interest in the field (Scragg & Smith, 1998). Males and females also possess a difference in attitudes towards computers. In addition, males tend to view computers for entertainment whereas females generally view computers as a tool for communication and homework (Verbick, 2001).

Many have offered suggestions (Binkerd & Moore, 2002; Peckham, et al., 2007; Varma, 2006) and many studies (Horwitz & Rodger, 2009) have been conducted in an attempt to identify possible remedies to aid in the recruitment and retention of females in computer science programs. Mentoring programs, modification to department structure, pair-programming, and all-female courses have been suggested (Cohoon, 2001). These methods have been shown to be effective, although the number of women in academic programs remains low. In addition to the difference in attitudes, many believe the lack of female participation in the STEM fields may be associated to the computer experiences of boys and girls, the lack of computer games created for girls, inequity in computer access for girls, and unwelcoming computing environments in education and the computing industry (Gürer & Camp, 2002).

Classroom climate, at times referred to as "chilly," has also been cited as a barrier for women in college (Hall & Sandler, 1982) and especially women in computer science/technology courses (Barker & Garvin-Doxas, 2004). Some question the existence of the chilly classroom (Constantinople, Cornelius, & Gray, 1988; Heller, Puff, & Mills, 1985), but others agree (Allan & Madden, 2003; Foster & Foster, 1994). Many have offered suggestions of how to modify classroom behaviors to make these environments more welcoming to women (Barker & Garvin-Doxas, 2004).

Over the past decade, online learning has increased dramatically. More colleges and universities are offering courses as well as complete undergraduate and graduate degree programs online. The availability and development of course management systems such as Blackboard has fueled this growth. Some studies (McCloud, 2004) conclude that online students perform as well as students in traditional face-to-face (FTF) classroom settings, but this remains controversial. Research has shown that there is little difference in the performance of online students to those in traditional classroom settings (Dutton, Dutton, & Perry, 2002).

More undergraduate computer science/technology degree programs are being offered online each year. Studies (McCloud, 2004; McDonald, Dorn, & McDonald, 2004; Picciano, 2002) have been conducted to determine the effectiveness of online courses in undergraduate computer science programs. Many (Barrett & Lally, 1999; Gal-Ezer, 2007; Gunn, 2003; Hargittai & Shafer, 2006; Hoskins & van Hooff, 2005; Price, 2006; Sullivan, 2002) have also studied the gender differences in online education. In one study, the odds of women passing an online course were twice that of men (Price, 2006). In another study, Sullivan (2002) reported that women stated that anonymity played a large role in making their online class experience positive. Outside of learning outcomes, differences exist. Studies (Gal-Ezer, 2007; Hoskins & van Hooff,

2005) have shown that students enrolled in online programs were older than students enrolled in face-to-face (FTF) programs, and many study participants cited that flexibility and convenience were the impetus for enrolling in an online course (Kleinman & Entin, 2002).

Purpose

Because of what is understood about women in FTF classes and how little is known about online classes, the purpose of this study is to investigate the perceptions held by undergraduate female students' in computer science/technology programs in colleges and universities that offer online and traditional program formats.

Brief Description of the Research Method

A mixed-methods research design was used in this phenomenological study. The first phase of the study focused on the collection of quantitative data through the use of an internet-based questionnaire. The second phase focused on the collection of qualitative data obtained through participant interviews. The role of the second phase was to obtain additional information which was used to assist the researcher in explaining the quantitative data collected during the first phase.

Research Question

This study examined the perceptions of females in online and traditional computer science/technology programs. Therefore the research question that guided this study was:

> How does a difference in course format influence the perceptions held by female students toward the field of computer science/technology?

Conceptual Framework

The conceptual framework that guided this study consists of eight areas. These eight areas along with their associations are provided in Figure 1. To understand the under-representation of women in the computer science/technology field, the barriers faced by women in computing be introduced. Barriers faced by women many times are socially constructed, born from various feminist views, and/or interpreted from the portrayal of the field by various forms of media. Many of these barriers are at times exhibited in the computer science classroom resulting in an environment that is unwelcoming to women.

In addition, behavior patterns that occur within the college classroom may have an impact on the computer science classroom adding complexity to an already unwelcoming environment for women. Student development and student learning styles also may have an effect on some of the barriers women face and with the pedagogy of the computer science classroom.

In conclusion, the online classroom has come to replace the traditional college classroom in some undergraduate degree programs including computer science/technology. This study sought to determine if the course delivery method breaks down or eliminates some of the barriers women face, thus leading to a change in the perceptions women hold regarding computer science and technology.

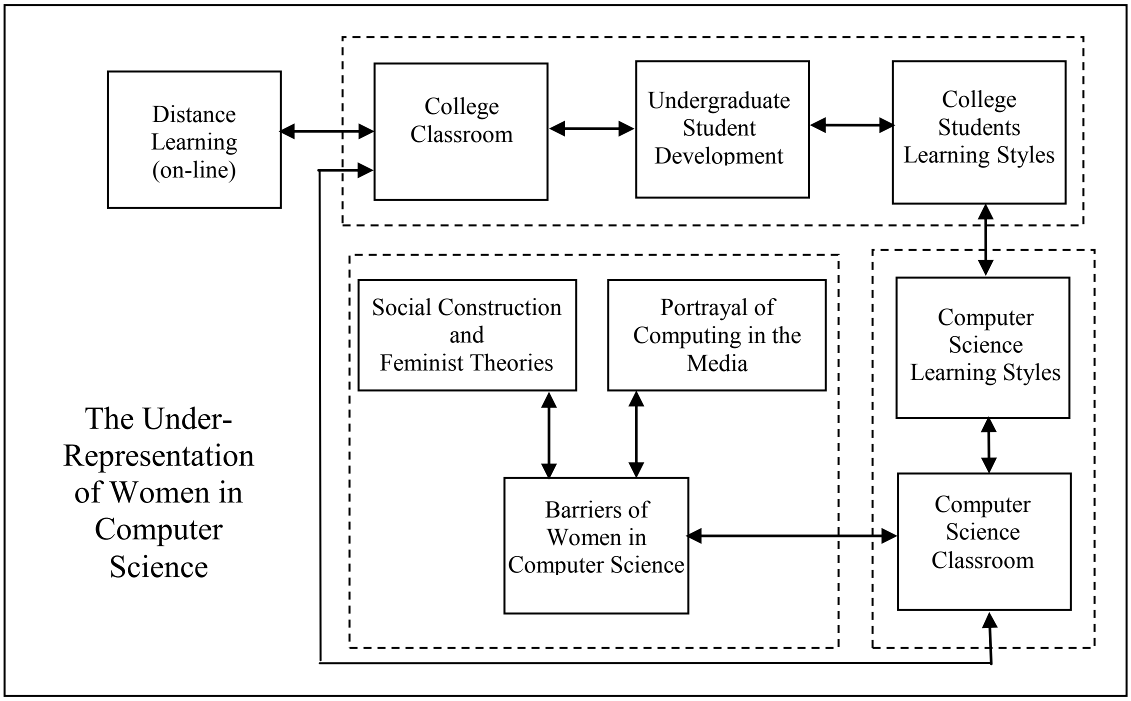

Figure 1 Conceptual Framework

Justification of the Study

An exhaustive review of the literature with respect to undergraduate females in computer science/technology programs reveals a body of knowledge that reports on female participation and under-representation in academia and the computing industry. Prior research in the area of distance/online education, though less extensive, also reports on women in distance education. Though the research in these areas is plentiful, there appear to be no studies, let alone a single study, that has focused solely on how online education may affect the perceptions held by undergraduate women in computer science/technology programs toward the field of computing.

Significance of the Study

The results of this study offer new information to those in higher education regarding the recruitment and retention of undergraduate females in the field of computer science and technology related programs. The findings of this study provide insight into how online programs or online courses affect the perceptions of females with respect to computer science/technology. Prior to the onset of this study, the investigator was unable to locate any previous studies that focused on the perceptions of females enrolled in online and FTF computer science/technology programs towards the field of computer science. Therefore, this study introduces a new area of investigation associated with the under-representation of females in computing degree programs.

Definition of Terms

This section will define terms and phrases used within this study.

Blackboard: Blackboard is a course management system used for the delivery of course materials via the World Wide Web.

Brick and mortar programs: Brick-and-mortar programs are defined as academic programs that are delivered in the traditional college setting allowing students face-to-face (FTF) contact with the instructor and other students in the course. These programs are composed of courses that are taught in a classroom setting and do not rely on a course management system to deliver course content to students.

Course Management System: A course management system or CMS is any system that is developed for the purpose of delivering course content to students via the World Wide Web.

Computer science: Computer science is defined as the study of computation and computer including hardware and software.

Face-to-Face programs: Face-to-face (FTF) programs are those programs in which course content is delivered in a traditional, in-class format.

Incredible shrinking pipeline: The "incredible shrinking pipeline" is a term introduced by Camp (2002) and refers to the continued decline of female participation in science, technology, engineering, and mathematics programs, and more specifically computer science.

Math anxiety: Math anxiety is a term used to refer to an individual that expresses a feeling of anxiety when faced with mathematical concepts through homework assignments, exams, or in a classroom setting.

Online learning: Online learning, sometimes referred to as distance learning or distance education, is defined as an academic course that is delivered to the student using a course management system, allowing the student to be at a remote location, thus removing any face-to-face contact with the instructor or other students in the course.

Pair programming: Pair programming is defined as a method of teaching computer programming where two students work together when learning concepts and creating computer programs.

Prior programming experience: Prior programming experience refers to the experience an individual possesses with regard to computer programming prior to the start of an undergraduate degree program in computer science/technology.

STEM: STEM is an acronym that stands for science, technology, engineering, or mathematics. STEM is most often used in the context of academics.

Chapter Summary

Current and past research continues to report declining numbers of women in computer science/technology fields. It is important to understand the reasons why women resist entering the field or choose to leave after being in the field for a number of years. Past studies have revealed reasons women provide with regard to their perceptions of the field and their inability to adapt to the culture. The goal of this study was to investigate the differences that may exist in undergraduate female perceptions of the field and to add to the body of knowledge in the area of computer science education.

Chapter two will present a review of the literature relating to women in the field of computer science/technology. Information regarding student development in college, learning styles, college classroom environments, the computer science classroom and online learning will be discussed. Chapter three will present the research design and methodology chosen for this study. Chapter four will present the quantitative and qualitative findings of the study. This document concludes with chapter five which will discuss the findings, present limitations of the study, and provide recommendations for practice and future research.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

This chapter will review more than 30 years of literature related to the study. Themes which have emerged from the literature are presented in eight main sections. Section 1: Understanding the Under-representation of Women in Computer Science discusses the under-representation of women in the field of computing. In addition, a history of the struggle to recruit and retain women in undergraduate computer science/technology programs and the information technology (IT) workforce will be introduced. Section 2: Gender, Technology, and Society will address how social constructionist and feminist theories play a part in the gendering of technology. Section 3: Portrayal of Computing in the Media discusses how computing has been communicated over the years through motion pictures and print advertising. Section 4: Barriers of Women in Computer Science/Technology, presents research that addresses the perceptions and attitudes of females, the stereotypes that exist within computing, how early exposure to technology, self-confidence, math avoidance, career guidance and academic preparation affect an individual's decision to enter or not to enter the field. The section concludes with a discussion on the culture and climate of computing. Section 5: The College Classroom discusses classroom climate and introduces the concept of defensive communication in the classroom. Section 6: The Computer Science Classroom will address the environment of the computer science classroom and the behaviors present. Section 7: Undergraduate Student Development provides a brief review of various psychosocial, cognitive, and typological theories. The section discusses learning styles present in computer science classrooms and how learning styles can predict classroom fit. Section 8: Distance Learning reviews the literature pertaining to online learning in higher education with respect to achievement, communication, gender. Section 9: Online Computer Science Programs provides a review of undergraduate online computer science/technology programs.

Understanding the Under-representation of Women in Computer Science

The field of computer science has faced continued under-representation of women for many years, although, this was not always the situation. In the early years of computing, women were very active in research activities and the creation of computer languages. One of the most well-known female computing pioneers was Ada Lovelace. During the mid-1800s, Lovelace used her mathematical talents to construct instructions that would be capable of performing calculations for Charles Babbage's analytical engine (Cooney, 1996). Even though Babbage's analytical engine was never implemented, Lovelace's work had immense impact on modern-day computer programming. The programming language Ada, created by the United States Department of Defense was named in her honor. Rear Admiral Grace Hopper of the United States Navy was also instrumental in the early days of computing. Admiral Hopper was one of the first computer programmers to work with the Mark series of computers at Harvard's Cruft Laboratories. To honor her work in the field, each year a four-day conference is held that focuses on the research and career interests of women in the field.

Over the years, as the computer industry matured, more women began entering the field, especially during the mid-1960s. During this time, female participation grew to almost 40% in undergraduate computing programs. This phenomenon peaked in the 1980s when women earned nearly 37% of all the undergraduate degrees in computer science (Misa, 2010). Since this time, participation by females in academia and the IT workforce has been on a steady decline. Studies (Weinberger, 2004) have been conducted to determine why the decline continues at a time when women now outnumber men overall in undergraduate programs. Those women who do elect to enter the field of computing state a variety of factors for their decision; a high demand in the job market, influence of parents, and the positive representation of computing in the media are just a few (Liu & Blanc, 1996).

A review of the literature reports low numbers of females in undergraduate and graduate computing programs and in the IT workforce. Recruitment and retention of females in each of these areas is a great deal of concern for the industry. The following discusses participation trends of women in the computer science/technology industry and academia including the obstacles faced with respect to recruitment and retention.

Under-representation of Women in Academia

The lack of female participation in undergraduate computer science programs has been the focus of many studies (Camp, 1997; Beyer, Rynes, & Haller, 2004; Weinberger, 2004). Camp (1997) describes the decline of women in computer science programs, stating that the lack of women in college and university programs directly affects the number of women capable of entering the IT workforce. In a 2002 National Science Foundation report, Gürer and Camp provide data on female participation in undergraduate computer science programs from 1970 to 1997. They report that in the 1983-1984 academic year, women earned 37.1% of the Bachelor of Science degrees in computer science. During the 1997-1998 academic year, the matriculation rate dropped to 26%, reflecting a 28% overall loss of computer science degrees granted to women (Gürer & Camp, 2002).

In the year 2000, women earned 22% of the undergraduate computer science and engineering degrees (ITAA, 2003). In 1997, Camp predicted a slight increase of the degrees awarded to women by the year 2007, due to the emergence of the web and the increased opportunities it provided. Although Camp's prediction seemed promising for women, the increase predicted would still be lower than the number of degrees awarded to women for the 1983-1984 academic year.

Most recently, the Computing Research Association's (CRA) 38th Taulbee Survey, (2007-2008) indicated student enrollment by majors and pre-majors per department in U.S. computer science departments was up 6.2% over the previous year (2006-2007). For majors only, enrollment was up 8.1%. This finding is significant, for it is the first time in six years that the total enrollment in computer science programs has increased (Zweben, 2008). In contrast, diversity in undergraduate computer science programs remains poor with only 11.8% of the computer science bachelor's degrees being awarded to women (Zweben, 2008).

Weinberger (2004) found that computer science, computer engineering, and electrical engineering were the three majors most likely to be ruled out by women. The majority of women in the study indicated they would rule out these majors because the courses were not interesting, were too difficult, and/or were too time consuming. The study also found that at least one-third of the women indicated that they would rule out these three majors because they felt the classroom environment would not be welcoming. The women also perceived the coursework of these three majors to be more difficult than the coursework required to become a surgeon (Weinberger, 2004).

The current downward trend in participation by women has been reported in a variety of publications. There do exist professions which women have historically resisted such as civil engineering and surgery (Misa, 2010) but these areas have not been subject to the shifts in participation as the computer science industry. In an attempt to increase participation, researchers and universities have been focused on the recruitment of females into undergraduate computer science programs.

Undergraduate Recruitment

Research related to the recruitment of women in undergraduate computing programs has revealed a wealth of information. Studies have revealed reasons women give for not entering the field. Many of these reasons can be categorized by gender, interest, and motivation.

In 1992, Astin and Astin reported an empirical study supported by the National Science Foundation. The study sought to identify factors in the backgrounds and college experiences of undergraduates in the U.S that affect their choice to study science or enter science-related careers. Although Astin and Astin's study focused on science, mathematics and engineering (SME), it did not include students in computer science or technology programs. Astin and Astin report that peer group characteristics and instructor pedagogy style were two environmental factors that affect students' interest and decision to enter SME areas. Similarities exist between this study and others that focus on the recruitment of women in computing.

Two years of research at Carnegie Mellon University led Margolis and Fischer (1997) to conclude that women's reasons for entering the field are contradictory from males. Many males describe the computer as an alluring, ultimate toy and indicate a fascination with the machine. Margolis and Fischer report women's responses suggest applying computing in areas to better the world around them. Beyer, Rynes, and Haller (2004) found women perceived computing as a purely technical area with no opportunity to collaborate with others.

Studies in this area of recruitment have also resulted in best practices. A paper by Cohoon (2002) presented suggestions, based on current and past research, for the recruitment of females to undergraduate computing programs. Cohoon suggests: reaching out to high school teachers and guidance counselors, developing relationship with community colleges and the local community; developing internal policies and procedures such as program selection criteria and offering multiple points of entry into academic computing programs in an effort to recruit females. Teague (2002) suggests a misperception of the field held by females and that the stereotyping of computing are reasons young women enter alternative fields.

Altering pedagogy was also suggested in a number of studies. Although many of these practices show promise of the recruitment of females, there has yet to be one method that proves to be successful.

An effort (Rich, Perry, & Guzdial, 2004) aimed at the recruitment of women was implemented at the Georgia Institute of Technology (Georgia Tech). All students at the University are required to take an introductory computer science course that includes programming. Rich, et al., developed a new course, CS1315 Introduction to Media Computation, as an alternative to the traditional CS1321 Introduction to Computing course, which was unpopular with students enrolled in disciplines outside of computing. The CS1315 course was designed to promote creativity, relevance, and collaboration in order to appeal to non-computing majors and women in particular, in an attempt to combat computing's poor reputation and negative stereotyping (Rich, et al., 2004).

A similar effort implemented at eight colleges and universities, led by Horwitz and Rodger (2009) was successful in recruiting women and minorities in undergraduate computer science. Their approach, which also included "active recruiting", implemented peer-led team learning (PLTL) in an introductory computer science course. Student evaluations of their effort were very positive with respects to recruitment and retention (Horwitz & Rodger, 2009).

While this research provides valuable information on recruitment, there is also concern with retaining females that do elect to enter undergraduate programs in computing. Many females exit undergraduate computing programs for other fields and report a variety of reasons for leaving, making the issue of retention difficult to understand.

Undergraduate Retention

Research has identified a variety of ways that assist in the retention of females in academia. Implementing pair programming in a first year computer programming course at the University of California - Santa Cruz has increased the retention of both males and females (McDowell et al., 2006). Another study (Cohoon, 1999) has shown that the characteristics of computer science departments with respect to gender may also play a role. Departments retained female students when the faculty was comprised of at least one woman, the department had support of the institution, graduates had access to a strong job market, and there were a sufficient number of females in each course (Cohoon, 2001).

Haller and Fossum (1998) postulated that making role models accessible to female computer science students could assist with retention efforts. Their work included the implementation of a unique type of computer laboratory at the University of Wisconsin – Parkside. Their concept of an academic computer lab differed from the traditional lab setting in that it was designed to employ equal numbers of female and male lab workers. Haller and Fossum (1998) also believed their concept of a computer lab would provide all students the experience of working in unstructured environments by offering students opportunities in maintaining systems, systems development, system administration, and opportunities to be instructional assistants.

The studies mentioned offer strategies for the retention of females in undergraduate education, but academia is not alone when it comes to the issue of the under-representation of females in computing. The IT workforce has also faced similar issues. As higher education struggles to find solutions to the problem of recruitment and retention, the computing industry is faced with their own battle to overcome a male dominated workforce.

The Information and Technology Workforce

The lack of participation by females in the computing industry is concerning. A 2003 "Report of the ITAA Blue Ribbon Panel on IT Diversity" indicates that in 2002 women made up 46.6% of the U.S. workforce. The report also claimed the number of women in the IT workforce fell from 41% in 1996 to 34.9% in 2002. Fewer women graduating from undergraduate technology programs results in fewer women qualified to enter the IT industry. However, a lack of opportunity is not the main culprit for women as it is anticipated that computer and mathematical occupations will increase by 1.1 million jobs. This increase is in part due to advances in computer technology and demands for computer applications linked to internet technologies (Hecker, 2004).

The National Science Foundation (NSF) has been working to address the under-representation of minorities and women in science and engineering, including information technology, through research (Wardle, 2003). The Computer and Information Science and Engineering Directorate (CISE) of the NSF supports research projects designed to improve opportunities for minorities, including women, in the field of computing. An outcome of this focus was the creation of the Information Technology Workforce Program (ITWF) in 2000. The ITWF has identified three themes for research; environment and culture, IT educational continuum, and IT workplace (Wardle, 2003). It is anticipated that research efforts initiated from these themes will provide effective solutions to the under-representation of minorities and women in IT.

While the themes identified by the ITWF are a promising start to research, initiatives to recruit and retain females in the computing industry are also underway. As mentioned, fewer women in undergraduate programs results in fewer potential women in the workforce. Even though women may matriculate from undergraduate computing programs this does not guarantee they will seek employment in the field.

Recruitment of Women in IT

There are many reasons why women choose to either enter or not enter the IT workforce (McKinney, Wilson, Brooks, O'Leary-Kelly & Hardgrave). In 2003, McKinney, et al. conducted a web-based survey of 815 IT professionals from various organizations within the U.S to understand why women are under-represented in the IT profession. The researchers found that both male and females indicated similar reasons for entering the field: "opportunity for job autonomy, advancement, task variety, professional prestige, income, using state-of-the-art equipment, and gratifying work" (McKinney, et al., 2006, p. 82). Males in particular indicated a love of computers and technology as their reason for entering the field. In contrast, females cited job security, flexible work hours, and ease of entry into the field as their motivating factor (McKinney, et al., 2006).

A study by Teague (2002) also examined the reasons why women chose to enter the field of computing. The study was a replica of an earlier study (Clarke & Teague, 1994) of 17 Australian women working in various computing careers. For Teague's study (2002), 15 female computing professionals participated via email interviews. Participants were asked three questions: 1) their reasons for choosing computing as a career; 2) what they like about working in computing; and 3) what they dislike about working in computing (Teague, 2002).

In response to the first question, individuals gave several reasons why they chose a career in computing. Many reported that there was no one single event that solidified their decision and that their decision was made over time. Some decided in high school, some in college, and some after working in other fields. Teague (2002) found that the responses could be classified into two categories: 1) events or influences that caused the women to choose computing; and 2) attributes of the women themselves or of computing careers.

To answer the second question, each of the 15 women supplied a list of items reflecting the attributes of why they liked computing. These 35 attributes were then categorized into five reasons why women enjoy computing: 1) solving a problem and developing a solution; 2) change, challenge, and diversity; 3) career opportunities, money, and travel; 4) interaction with their immediate colleagues and with others inside and outside their organization; and 5) the working environment and the flexibility of hours and work location (Teague, 2002).

The third question resulted in few responses by the women. Most had very few if any dislikes about the job. Most complaints from the women had to do with being a woman in a male dominated field. Of the dislikes reported, they included: 1) spending long hours in front of a computer screen; 2) failures; 3) dealing with hardware problems; and 4) looking through other people's code (Teague, 2002).

The findings of these two studies reveal how men and women's views of the computing industry differ and presents various reasons women enter the field. As one can see, there is no single reason why they enter. As indicated by the respondents many of the women had taken various paths to arrive at their current position and it is clear that most are content with their decision. The results of Teague's study (2002) does not indicate any issues with respect to retention which is not to say the issue is not present. Retention efforts in the workforce are just as prevalent as in higher education.

Retention of Women in IT

Recruiting women to technology positions is just one hurdle faced by IT organizations. Retaining these females is just as important a task as recruitment. Just as females report many reasons for not entering the field, they indicate a variety of reasons for leaving the field.

With respect to retention, many field-related issues are reflected in the literature including cultural fit, expectation gaps, mentors and role models, and career satisfaction (Tapia & Kvasny, 2004). Specifically, women, as well as other minorities, have labeled work in the IT industry as "difficult, isolated, lacking necessary social interactions, and lacking work-family balance" (Tapia & Kvasny, 2004, p. 87). Workers also communicated a stereotyped perception of the field as "geeky" and "nerdy".

To better understand the circumstances that could lead to possible turnover by women, it is advantageous to examine IT personnel. Igbaria, Parasuraman, and Greenhaus (1997) surveyed 464 members of the Association of Computing Machinery (ACM). Data from the study was part of a large-scale research project focused on the careers of IT professionals and managers. Eighty percent of the respondents were male and more than half of the participants were married. The average age was 37.76 years. The aim of the study was to reveal similarities and differences between men and women with respect to "personal, family, job, and career related variables" (Igbaria, et al., 1997, p. 4). The researchers found that with respect to education, a larger percentage of women than men ended their education after attaining a bachelor's degree. Women were less likely to be married and have children. Men reported a significantly higher salary level than women. Men were found to have more IT experience and were somewhat more likely to hold managerial roles (Igbaria, et al., 1997)

A study by Reimenschneider, Armstrong, Allen, and Reid (2006) implemented a causal mapping methodology to study the cognitive structures of 39 women working in information technology. The researchers wanted to understand the potential causes of voluntary turnover of women in the field. Along with causal mapping, focus groups were conducted. Eight concepts emerged from the causal maps: 1) barriers: discrimination, 2) barriers: lack of consistency, 3) barriers: promotion, 4) turnover, 5) stress, 6) managing family responsibility, 7) job qualities, and 8) work schedule flexibility. Links were identified between these eight concepts. Turnover was strongly linked to managing family responsibility. In addition, turnover was linked to stress, work schedule flexibility, job qualities, and barriers: lack of consistency. Barriers: promotion was linked to managing family responsibility, stress, job qualities, and work schedule. Turnover and barriers: promotion, appear to be effects of the same causes, although they are not linked directly to each other. The results also revealed four linkages which were reciprocal, or were the cause of the other: 1) work schedule flexibility and stress, 2) stress and managing family responsibility, 3) managing family responsibility and job qualities, and 4) job qualities and stress (Reimenschneider, et al., 2006). These findings illustrate the complexity of female retention in the IT field.

Reflection upon on these studies does not suggest any one solution to increase the recruitment or retention of females in academia or the IT industry. That is, this collection of prior research presents an understanding of the computing culture from an academic and industry point-of-view, but fails to indicate how or where the negative images of the computer professional originated or how these images infiltrated the minds of so many men and women. The next section, Gender, Technology, and Society, will discuss how individuals have been socialized towards the field of computing and how the consideration of feminist theories can attempt to explain one's perception of the field.

Gender, Technology, and Society

Many in society view a career in computing as a gendered job, that is, "one that is commonly considered to be a woman's job rather that a man's (or vice versa)" (Wilson, 2004, p. 85). For thoughts such as this, especially when speaking of gender and technology, it is not uncommon for an individual to base, whether consciously or unconsciously, this type of gender characterization on social constructionist or feminist theory.

Social Constructionist Theory

The male domination prevalent in computing may be best understood by examining the phenomenon using social constructionist theory. A paper by Wilson (2004) suggests a conceptual framework for the study of gender and technology. Within this framework, Wilson (2004) employs a social constructionist approach. Wilson argues the under-theorization present within computing research, stating that to truly understand the gendered labor divisions that exist in IT one must first understand how society has constructed these role expectations. Wilson (2004) indicates how individuals are socialized to perceive certain types of skills and knowledge as male or female.

Social constructionist theory has been used in IT studies to examine gender differences (Kuhn & Joshi, 2009; Wilson, 2003). Wilson (2003) studied the social construction and interpretation of computing and technology. The study focused on 52 first-semester undergraduate students. Data were collected through the use of questionnaires and semi-structured interviews. The questionnaires presented three significant findings; more females than males reported that they did not read computing magazines, more males than females stated that they were good with computers, and more females than males agreed with the statement, "computers make me feel nervous" (Wilson, 2003, p. 132). In addition, when asked why there were fewer women taking computer science courses, there was agreement that science in general, and computer science in particular was perceived as a male domain and of less interest to women.

Kuhn and Joshi (2009) surveyed recent graduates of an IT program and found that both males and females had similarities with regard to work values and job attributes, and there were subtle differences in the weight these factors played on evaluating potential jobs. Women were less attracted to jobs that were described as *coding* and *testing* than males. Women's job attraction was strongly impacted by an organization's work-life policies (Kuhn & Joshi, 2009).

Feminist Theory

The issue of gender and technology has been studied for many years. Researchers and scholars have written about women using technology and women in the IT workforce. The under-representation of women in the field of computer science/technology can be better understood by reviewing the impact feminist theories may have on this association.

A description of how different feminist theories relate to women in the field was presented by Rosser (2005) in a paper titled, "Through the Lenses of Feminist Theory". In her paper, Rosser examines the impact of feminist theories in three areas: women in the IT workforce, women as users of information technology, and women and information technology design (Rosser, 2005). The author associates these three areas to a variety of feminist theories, from liberal feminism to postmodern feminism, and postcolonial feminism. The following provides a brief description of the feminist theories and illustrates how these feminist views may affect how women are perceived with respect to technology and in the IT workforce. Although this is not intended to be an exhaustive discussion of the Rosser (2005) paper, it will provide the reader insight on varying feminist viewpoints.

Liberal feminists believe that women are suppressed because they are subject to “unjust discrimination” (p. 1). With respect to the IT workforce, liberal feminist focus on employment, access, and discrimination issues. Liberal feminists seek to remove barriers which prevent equal access to all areas of technology; eliminating male domination. The existence of this stance is apparent when taking into consideration the many women who are subject to working in technology as assemblers of electronic parts which demands tedious, eye-straining work, far removed from the upper level decision-making areas, resulting in economic inequality.

Socialist feminists reject individualism and positivism. They suggest reasons why technology is such a male dominated area as bring male’s access to venture capital and the ability to work long hours. Socialist feminist indicate that the “allocation of resources for technology development should be determined by the greatest benefit for the common good” (p.5). Socialist feminists point out that the social shaping of technology excludes women at all levels.

Existentialist feminists believe that it is not the biological differences but the value society places on biological differences between males and females that create the reason women play a lesser role in computing. This historic view can be used to explain the domination and exploitation of women by men. The creation of male-centered video games which represent military scenarios is one example of how women can be viewed as a non-user of technology.

Psychoanalytic feminists believe that gender differences which result in male domination can be traced back to the idea that women are the primary caregivers for children. Psychoanalytic feminist suggest that it is this caregiver role that instills the idea in females to be caring and more holistic as opposed to males who are taught to be independent, autonomous, and distant. This feminist group believes that this is the reason why men are more attracted to programming, whereas women are more at ease running experiments, reading scientific literature, and collaborating.

Radical feminists believe that "women's oppression is the first, most widespread, and deepest oppression" (p.10). Radical feminist reject most scientific theories, data, and experiments because they exclude women or are not women-centered. This type of feminism could interpret the binary number system (1, 0), the basis of computers to be based on the male-female dichotomy representing a "patriarchal mode of control" (p. 11). They would argue that no feminist alternative to technology exists.

Postmodern feminist theories "imply that no universal research agenda or application of technologies will be appropriate and that various women will have different reactions to technologies depending upon their own class, race, sexuality, country, and other factors" (p.12).

Postcolonial feminists believe that the control over technology by the West reflects colonialism by European nations. Control over the lands also included "control over the knowledge of science, history, geography, language, literature, art, and anthropology of the colonized people" (p.14). "The idea that the culture, science, and technology of the colonizer or former colonizing country remains superior to that of the colony" (p. 15) remains reflected in the access of technology and jobs within technology of Third World countries. Many, especially women, gain employment in developing countries due to the off-shoring of labor by organizations. This off-shoring concept promotes sexual exploitation and racial divisions of labor around the globe.

This section described how an individuals' view of the field of computing may be formed, knowingly or unknowingly, through social construction or feminists views. It is interesting to note that individuals hold very strong opinions of the field, when in fact many have never been directly involved in any real-world computing experiences outside of daily computer usage at work or home. Another aspect that may play a part in forming one's view of gendered jobs is the portrayal of computing of the modern-day media.

Portrayal of Computing in the Media

The downturn in female participation in computing began during the mid-1980s. Many struggle to understand this phenomenon and attempt to pinpoint events that occurred in higher education or industry to explain this trend. One area often overlooked is the way computer usage is portrayed in the media including television commercials, print advertising, film, and most currently, images appearing on the internet.

David Anderegg, a professor of psychology has studied the "nerd" stereotype among high school and college aged students. In his book, Nerds (2007), Anderegg argues that film has played a large part in forming the negative images of anyone associated with computing or technology including women. In 1984, a motion picture in theaters and popular among teens was Revenge of the Nerds. This film was one of the first to negatively portray the stereotypical male computer nerd in college. Other films such as The Breakfast Club (1985), Sixteen Candles (1984), and War Games (1983) also characterized the stereotypical nerdy teen male.

Shortly after these films were released similar television sitcoms were introduced that included negative characterization of teens involved with computers and technology. One such sitcom, Square Pegs (1982) followed two female high school freshmen trying to fit in to the many cliques in a California school. One of the characters, Patty Greene was portrayed as brainy, nerdy, girl wearing glasses.

These negative stereotypes also present themselves in other forms of media. Tympas, Konsta, Lekkas & Karas (2010) reported on male and female stereotypes appearing in 1500 computer advertisements appearing in *Computer for All,* a Greek home computing journal published since 1983. Tympas, et al found that women are represented in these advertisements as the keyboard (input) person or the printer (output) person, helping to construct the public's image of women and computing. Advertising images appearing in this journal from 1983 to 2003 were part of the study. The researchers indicated that during this time the image of the personal computer and computing overall changed from a single unit to a "multipurpose networked device" (p.191).

The findings of the study indicated that many advertisements showed men using the telephone near a computer and with women waiting in the background. In addition, men were shown to be relaxed and comfortable around computers. It was also common for the ads to show men using the mouse as opposed to typing on a keyboard. In ads depicting men, women, and computers, men were often shown standing next to a woman seated at a computer. Advertisements for computer screens were also unfavorable towards women. In this category of ads, when women were shown with a computer screen, the image on the screen many times was the reflection of the woman, or displayed another type of feminine image. Whereas when men were shown with a computer screen, the image on the screen was often very technical in nature (Tympas, et al., 2010).

As early as the 1960s the computer firm Entrex ran a series of ads denigrating women. Their ads, promoting their new data-entry systems, targeted at data processing managers claimed, the systems were so easy to use that, "it was no longer necessary to hire intelligent women" (Haigh, 2010, p. 61).

White and Kinnick (2000) analyzed 351 primetime television commercials which aired in 1998 to determine how women were portrayed using computers. Of the 751 computer users in the commercials, 50% were male, 46% female, and 4% undeterminable. The results of this study conflict those of Tympas, et al. (2010). White and Kinnick (2000) reported that women were as likely as men to be shown using a computer and that there was no difference between the men and women in terms of observing someone using a computer. Similar to Tympas, et al., they also reported that most of the computer use did take place in a "male domain". Computer usage was shown in dens, male bedrooms, home offices, and kitchen areas. There were no images of computer usage in girl's bedrooms or in an adult's bedroom.

The negative images of women and computing has also appeared in recent advertisements for mobile phone companies. Döring & Pöschl (2006) studied 288 advertisements in popular German magazines intended for a general audience. This study found women were more likely to be shown in a relaxing setting whereas men were more likely to be shown in a setting of paid work or sports.

Images of men and women in magazine ads showing computer usage have changed in recent years (Döring & Pöschl, 2006; Johnson, Rowan, & Lynch, 2006). Although women are still at times shown negatively in these ads, the negative portrayal of women appeared less often than reported in earlier studies.

The literature in this area illustrates the negative images that have been present over the years in publications worldwide. Films, primetime television shows, and commercials have a tendency to depict men as the knowledgeable user of the computer and women as a user performing tasks that require very little technological ability. These images are viewed unknowingly by school-aged children and teens at a time when they themselves are trying to determine their interests and make decisions for their future education. How much impact these images have on young females is not fully understood but does validate the barriers women report face in higher education and the computing industry.

Barriers of Women in Computer Science/Technology

Females face numerous barriers in the field of computer science and technology, as evidenced by years of research that has uncovered many variables contributing to the under-representation of women. The research yields societal perceptions and attitudes such as science and math are male dominated, gender stereotypes, a lack of self-confidence, math anxiety, and the fact that women enroll in fewer advanced math courses (McDowell, et al., 2006) as just a few reasons women are underrepresented. In addition, the culture of computing appears to be a culture that is not welcoming to women (Margolis & Fisher, 2002). Others (Bjorkman, Christoff, Palm, & Vallin, 1998; Wilson, 2003) have revealed that gender differences exist regarding attitudes and perceptions of computing fields. Many of these perceptions and attitudes are formed early in life, prior to enrolling in high school.

Perceptions and Attitudes

Studies have been conducted which describe the perceptions women hold of the field of computer science (Gürer & Camp, 2002; Scragg & Smith, 1998). Some of these studies focus on both male and female students, but many focus strictly on female perceptions.

Gürer and Camp (2002) indicate a positive attitude towards computers from an early age is important for boys and girls in order for women to enter the field. They state that the amount of experience with computers affects attitudes towards computer related activities. Preschool and elementary school-aged children show positive attitudes towards computers. It is later in life that these attitudes change and become more gender pronounced (Gürer & Camp, 2002).

For most undergraduate computer science majors, the emphasis of their studies is computer programming. For these students, many perceive the field as one focused solely on the art of programming. Students, considered to be juniors or seniors, who have been exposed to a variety of computer science/technology courses, possess a different view of the field due to their exposure (Fisher, Margolis, & Miller, 1997). Students outside the computer science major and students who take computer programming for non-majors also report negative perceptions of the field, due to the emphasis placed on computer programming. These non-majors report interest in programming but admit they have little interest in gaining a deeper understanding of the field (Fisher, et al., 1997).

Stereotypes

Many studies (Beyer, Rynes, & Haller, 2004; Greening, 1999; Kekelis, Ancheta & Heber, 2005; Teague, 2002) reveal negative stereotyping of those in computer science/technology fields. Kekelis, et al. (2005) conducted focus groups and interviewed 126 females in the range of 11 to 19 years and 34 of their parents or guardians. Participants of the study were all active in the Techbridge program, an afterschool program offering females exposure to applications of technology and exposure to career choices in the field. Responses revealed that even though many of the females found technology to be interesting, many had no aspiration to obtain a career in technology. Many viewed a job in the IT industry as boring and would not enjoy a job where the majority of time was spent staring at a computer screen.

When asked to describe the types of people that work in technology, many of the females indicated that workers were very smart, geeky, white or Asian males, and used vocabulary that most would not understand. They also believed technology workers to be antisocial (Kekelis, et al., 2005).

A pilot study by Greening (1999) which focused on stereotypes recognized by fellow students, found that women more frequently than men refer to computing as an antisocial activity. These women also indicated a lack of computer-literate friends. Beyer, et al. (2004) reported that participants of their study considered computer scientists as "unsociable" and nerdy. Female participants of the study rated computer scientists as "smarter" and "more popular" than male participants. Males and females alike, overestimated the number of females in the computer science profession (Beyer, et al., 2004).

The perceptions and attitudes held by females are developed over time. Cooper and Weaver (2003) suggest that exposure to computing at a young age does have implications when making career decisions as young adults. Therefore, it is important that young school-aged children are not introduced to technology and computing in such a way that they develop a very gendered view of the field.

Exposure to Technology

Children and Technology

Developing an interest in technology appears to begin at an early age (Cooper & Weaver, 2003; Fisher, Margolis & Miller, 1997; Klawe, 2002). Children's perceptions of technology begin at home. Children whose parents are employed in technology fields are often exposed to technology at an early age. Some of these children receive their first computer when they are preschool age. As early as kindergarten, boys show a preference for technology (Camp, 2002; Klawe, 2002). Unfortunately, many of the computers are placed within a boys' bedroom as opposed to a girls, insinuating that computing is an activity that boys do (Camp, 2002). As a result, boys are lured to technology and computers, whereas girls become content creating artwork, telling stories, writing, and collaborating (Camp, 2002). Many male students report either having had their own computer or having the family computer in their own room at an early age (Fisher, et al., 1997). As a result, young boys also become more familiar with computer jargon than girls. Girls have fewer opportunities to introduce themselves to computer buzzwords (Gürer, Camp, 2002).

In addition, children are exposed to a variety of instructional tools in the classroom. Many of these tools are in the form of computer games that are meant to teach or strengthen students' skills in a variety of subjects. Cooper & Weaver (2003) report that many of these computer-based learning tools incorporate the type of images often found in video games designed for males. Boys were often excited about using these types of games, whereas girls would rather interact with a game that was straight forward and was focused on learning and not gendered images. In their observations, they report that many of the young girls would rather read a book or finish their assigned work by hand than use a computer-based tool.

Video and computer games are another reason for girls' lack of interest in computers during childhood. Many video games and computer games are developed from a male perspective and are attractive to school-aged boys, whereas there are few games developed specifically for girls. This male dominated market gives boys more opportunity to learn computer skills and motivates boys to create their own games, leading to an interest in computer programming (Klawe, 2002).

This type of gendered computing has been found to impact females' decisions to enter technology programs in high school or college. With this type of introduction to computing, it is not surprising that young girls would develop such negative perceptions and attitudes of the field.

Pre-College Exposure to Computers

Gendered computing environments early in a child's education have been found to impact their overall computer experience prior to college. Researchers (Fisher, Margolis & Miller, 1997; Greening, 1999; Morahan-Martin, Olinsky & Schumacher, 1992; Scragg & Smith, 1998) that study gender issues in undergraduate students have found that lack of prior computer experience is one of many reasons for the under-representation of females in the field. Greening (1999) studied gender stereotyping in computer science and found male and female responses differed when asked to comment on the statement, "Before university I had no experience with computers" (p.206). Both male and female participants of the study indicated that this statement or a statement such as this would most likely be attributed to females.

Scragg and Smith (1998) found similar results in their study of undergraduate students enrolled in an introductory computer science course at the State University of New York (SUNY) Genesco. They found that women had "substantially less pre-college computing experience than did men" (p. 83). Another study of 297 college students enrolled in an introductory computer science course found a significant difference between prior male and female computer experience (Scragg & Smith, 1998). A study of over 600 college freshman (Morahan-Martin, et al., 1992) revealed males possessed more skills and experience than females, especially with computer games. This study also found gender differences in attitudes towards computers.

An ethnographic study conducted at Carnegie Mellon University (CMU) by Fisher, Margolis, and Miller (1997) found a, "significant gap" (p.106) between males and females with regard to prior computer experience. They also noted that 40% of the first-year male respondents were able to bypass the introductory computer class by passing the AP exam. In contrast, none of the female first-year respondents had reported a similar situation.

A random sample of 567 first-year college students, surveyed by Beyer, Rynes, and Haller (2004), found that men were more likely to have opened up a computer, have experience with programming, and reported more hours working with computers than women.

These types of findings are not uncommon and at times can be a direct result of the student's exposure to computing in high school. Males outnumber females in the majority of high school computing classes and the inequity becomes greater in the more advanced courses (Cooper & Weaver, 2003) resulting in male domination, just one of the many barriers reported by females.

Self Confidence

Studies (Beyer, Rynes, Perrault, Hay & Haller, 2003; Brosnan, 1998; Busch, 1995; Fisher, Margolis & Miller 1997; Gürer & Camp, 2005; Miura, 1987; Scragg & Smith, 1998) indicate that female lack of self-confidence in the field is a common barrier. Women often fail to take credit in their accomplishments and performance (Gürer & Camp, 2002). Many women majoring in computer science at the undergraduate level indicate that their self-confidence begins to decline many times in their first year and continues to decline afterward (Gürer & Camp, 2002).

Beyer, et al. (2003) studied gender differences in computer science students. A total of 56 undergraduate students, both male and female, participated. The researchers found that females had less confidence in their computer aptitude than did the males. Even when ACT scores were similar between the sexes, female confidence levels remained low.

Another study also found that first-year undergraduate students differed in their computer confidence levels (Fischer, et al., 1997). In this study, females reported having less computer experience, less preparedness for classes, and less ability to master course material. In contrast, male students rated themselves "highly prepared" for their classes and reported attaining an "expert" level of knowledge in one programming language. The researchers also found upper-class women's confidence levels rise during the junior and senior year.

Beyer, Rynes, and Haller (2004) found that first-year college students who had taken a required computer science course had significantly higher confidence than students who had not taken a required computer science course. It was also reported that men in the study were significantly more confident than women.

Math Avoidance

The previously mentioned study by Astin and Astin (1992) found that one of the strongest and most predictive factors of determining undergraduates' interest in SME areas was mathematical and academic competency. These are viewed as positive factors in a student's interest in a science major and career.

Prior research that focuses on the barriers women face in the field of computer science often reveals reference to mathematics avoidance, sometimes referred to as "math anxiety". Females often indicate that their inability to be successful in math is a direct correlation to their lack of participation in computer science or related fields. It is unclear when or why women develop a disinterest in mathematics and math related careers.

Test results for mathematic ability in elementary school-aged children are similar to one another, with females outperforming their male counterparts at times (Hyde, Fennema, & Lamon, 1990). By the middle and high school years, females begin to fall behind in test scores (Hyde, Fennema, & Lamon, 1990). By the high school level, female's interest in math is at its lowest and these students tend to enroll only in required math courses. Males, on the other hand, enroll in additional math courses.

There has yet to be one reason found by researchers why women opt out of majoring in math or entering careers that are math-related. The literature suggests many reasons such as parental beliefs, self-efficacy, and the gender stereotyping in math (Jacobs, 1991; Jacobs & Eccles, 1992).

A study of gender stereotypes on parents and children's attitudes towards math (Jacobs, 1991), found that mothers' beliefs about their children's ability were influenced by the child's grades from the previous year with higher grades indicating a higher ability. It was also found that a mother's belief had a strong influence on the child's own beliefs about his/her own mathematical ability. Fathers who held stronger gender stereotypes believed less in their daughter's mathematical abilities as opposed to their son's abilities.

Career Guidance

Lack of information regarding careers in technology is another cause of under-representation revealed in many studies (Kekelis, Ancheta & Heber, 2005). Kekelis, et al. (2005) found that many females at the elementary or secondary levels lacked knowledge regarding technology careers. Those that expressed an interest in obtaining a career in the field had little information of the types of opportunities available. Many of the girls in their study stated that the most direction they received regarding their education was to graduate high school and attend college (Kekelis, et al., 2005).

Family influence appears to have an impact on careers choices and majoring in the sciences (Gürer & Camp, 2002; Seymour & Hewitt, 1994). Socio-economic status and ethnicity appear to play a role in how family members, especially parents, communicate with their daughters about technical careers. White parents indicated little involvement with their daughter's career decisions, whereas African American, Asian, and Hispanic parents supplied more support and involvement in career guidance (Kekelis, et al., 2005).

In addition, females whose families included a parent, sibling, or other relative working in the sciences, (e.g., medicine, biology, engineering, etc.), appeared to have more information regarding technical careers and possessed a more positive perception of the field. These particular females are likely to engage in conversation with family members who express job satisfaction and provide a detailed description of their job activities (Kekelis, et al, 2005). A study (2003) conducted by Rowell, Perhac, Hankins, Parker, Pettey, and Iriarte-Gross at Middle Tennessee State University surveyed 651 male and female undergraduate students enrolled in a one-hour University Experience course or a three-hour General Studies course. Of the 651 study participants, 163 expected to major in a STEM area with 38 entering a computer major. The study found that females are more likely to be influenced by their family when it comes to computer usage. The study found no significant difference between males and females understanding of computing careers. Fisher, et al. (1997) found that most of the students they studied, both male and female, were first introduced to computers by a parent working in the computing industry or by a parent who provided the child with a computer.

Academic Preparation

Many studies have revealed the importance of prior programming experience to student success in undergraduate computer science/technology courses and programs (Bunderson, Christensen, & Elizabeth, 1995; Sackrowitz & Parelius, 1996; Scragg & Smith, 1998). For the most part, the findings are consistent. In their book, *Unlocking the Clubhouse*, Fisher and Margolis (2002) describe males' "magnetic attraction" (p. 40) to computers and technology, stating that by the time males enter high school they have had significantly more exposure to computers than females.

A study conducted by Goode, Estrella, and Margolis (2006) interviewed and observed high school students and educators in three California schools. They wanted to know why so few African American, Latino/a, and females were not participating in computer science courses in high school. Their research revealed four areas that appear to impact this phenomenon; opportunity, relevance, lack of social networks, and the lack of higher-order thinking with the computer science curriculum (Goode, et al., 2006).

Females who do enroll in high school computer classes most often enroll in courses that focus on computer applications as opposed to computer programming (Rodger & Walker, 1996). Studies show that women become more interested in computer science when they can apply it across disciplines as opposed to programming for fun. This also has been documented at the college level. In a questionnaire administered to female computer science and engineering students, Liu and Blanc (1996) report that many of the incoming females were competent with respect to computer applications but were lacking with respect to computer terminology and computer programming. They also indicate that many of their study participants had not taken any advanced placement (AP) mathematics or computer science courses. One student revealed that she was unaware for what the term "code" (Liu & Blanc, 1996, p. 34) actually meant. Other students reported that they did not know the meaning of many of the computer terms used by their professors.

To understand the factors involved with the under-representation of women in computer science/technology programs and in the workforce, an examination must be made of existing literature that influences the choices females make in college.

Computing Culture and Climate

As with most disciplines, the area of computer science has a distinct culture. This unique culture applies to not only computing professionals but to students as well. Some believe that the culture of computing is the reason women avoid entering the field. Embedded within this culture is a climate that has been referred to by many as "chilly" (Hall & Sandler, 1982). A review of the literature indicates that the culture and underlying climate does have a direct impact on women's participation.

The culture and its effect on female participation (Bernstein, 1997; Bjorkman, Christoff, Palm, & Vallin, 1997; Blum & Frieze, 2005; Kielser, Sproull, & Eccles, 2002; Wilson, 2003) has been studied for many years. Negative views of the culture of computing impact educational programs and industry alike. The culture is one of male-domination and riddled with gender stereotypes.

This section provided information on the many barriers females face with regard to the field of computing. Many of these barriers are encountered prior to entering college. Many females indicate that the classroom environment in undergraduate computer science/technology courses mimics the culture previously described. The next section will discuss the college classroom environment and introduce research which suggests an unwelcoming climate for females.

The College Classroom

Defensive Communication

The concept of *defensive communication* between individuals was introduced by Gibb (1961). This group dynamic occurs when any member of the group exhibits characteristics reflective of *defensive behavior*. Gibb defines defensive behavior as, "that behavior which occurs when an individual perceives threat or anticipates threat in the group" (1961, p. 141).

Acts of defensive behavior may be present in verbal and non-verbal communication and can occur in persons communicating information (sender) or in the receivers of information (listener). For senders, they may have concerns regarding how they appear to others and make an effort to put forward a more favorable presence to the group (Gibb, 1961).

Defensive behavior in the sender produces a reaction of defensive behavior in the listener. When this behavior pattern is present within listeners the information being conveyed by the sender becomes distorted. The listener may also react by not hearing or forgetting the information, become competitive with the sender, or exhibit signs of jealousy (Gibb, 1961).

The Chilly Classroom

Researchers who study the concept of defensiveness in the classroom commonly refer to the phenomena as "chilly". One of the first references to the concept of the chilly classroom climate appeared in a paper by Hall and Sandler (1982). Focusing on the college classroom, the authors describe how a chilly classroom climate can affect learning for all students, especially women. Hall and Sandler describe how an instructor's overt and subtle behaviors can discourage women's classroom participation, career aspirations, and lower confidence levels (1982).

Critics of the Chilly Classroom

Since the introduction of Hall and Sandler's work, some researchers (Constantinople, Cornelius, & Gray, 1988; Heller, Puff, & Mills, 1985) have questioned whether the chilly classroom climate actually exists. Critics claim that Hall and Sandler's conclusion was based not on empirical data but on anecdotal evidence.

Heller, et al., (1985) suggest that the work by Hall and Sandler resulted only in the creation of a "two-fold hypothesis" (p. 447). They state, "First is the suggestion that some faculty actually behave differently towards women. Second, is the idea that differences in faculty behavior effect how women view their abilities, ambitions, and levels of self esteem" (p. 447). Working with this hypothesis, Heller, et al., conducted their own survey of undergraduate men and women to test the behaviors of male faculty at a liberal arts college observed by Hall and Sandler (1982). Respondents were 429 students; 216 females and 213 males. Students completed a survey of questions based on a five-point Likert scale which addressed Hall and Sandler's concerns regarding faculty behavior. The researchers did allow students to add additional comments describing their own personal experiences.

Survey results indicated that no differences existed between the way faculty members treated men and women with regard to the behaviors Hall and Sandler reported. However, two differences were revealed that appear consistent with a chilly classroom climate; 1) students' perceived math ability, and 2) confidence in academic ability. These differences were reported by freshman and had diminished by the sophomore level (Heller, et al, 1985).

At the time of Heller, Puff, and Mills' research, very few studies existed which focused on the effects of faculty behaviors on women. Most of the previous research on the college classroom was directed towards sexual harassment.

Constantinople, Cornelius, and Gray (1988) conducted an observational study to examine the effect the instructor's gender had on male and female student's class participation and behavior. The researchers used 58 trained undergraduate students to act as observers in the classes in which they were enrolled. Constantinople, et al. concur with Hall's claim that men participate more frequently than women in the classroom but conclude that student behavior is determined more by the gender of the instructor not by the instructor's behavior. However, of the 48 classrooms observed, only five were considered STEM courses, and of the five, only one was a computer science classroom, leaving room for more research of STEM courses.

Proponents of the Chilly Classroom

In response to reports of the non-existence of the chilly classroom, Foster and Foster (1994) conducted an empirical study to test Hall and Sandler's claims of chilly behaviors in the classroom. This study sampled four professional schools at a medium-sized mid-western college: The College of Business Administration, the College of Education, the College of Engineering, and the College of Health and Human Services. A total of 316 students responded to the survey. The Foster and Foster (1994) survey focused on the 14 chilling practices reported by Hall and Sandler (1982), whether the instructor engaged in the chilling practice was male or female, and whether the student viewed the behavior as important (Foster & Foster, 1994).

Results indicated that significant differences on the importance of the instructor's chilly behavior did exist between male and females. No significant difference was found between male and female responses on the number of chilling behaviors observed or the gender of the instructor displaying the behavior. The study also found significant differences between the four schools in students' perceptions of the gender of the instructors exhibiting chilling behavior. Male instructors were viewed more likely to participate in chilling behaviors, and in one school, males and females responded that more women than men exhibited chilling behavior. The researchers conclude that their findings support claims of the existence of the chilly classroom climate, first reported by Hall and Sandler (1982) (as cited in Foster & Foster, 1994).

Allan and Madden (2003) conducted a mixed methods study which examined junior and senior female students at a land grant research university. Participants of the study represented six disciplinary areas. The survey data collected (n = 395) did not alone indicate the presence of the chilly classroom, although data collected through open-ended survey questions and focus groups revealed that actions consistent with defensive behavior did exist at the university. The researchers indicate that the research methods employed to assess classroom climates are important to gain a thorough understanding of the environment.

This section introduced the concepts of defensive communication and the chilly classroom. As just reported, there is disagreement as to whether the chilly classroom does exist. The next section will discuss the climate of the computer science classroom. Similarities will be shown between the suggested chilly classroom and the computer science classroom climate.

The Computer Science Classroom

Due to its nature, the environment of the computer science classroom has been identified in many studies (Barker & Garvin-Doxas, 2004; Garvin-Doxas & Barker, 2004) as one of the many challenges women face in undergraduate computer science/technology programs. This environment has been reported to be unwelcoming to students, particularly to females. This section will report on the presence of defensive communication behaviors and the chilly classroom climate in undergraduate computer science classrooms.

One qualitative study that spent more than 348 hours in 13 computer science classrooms reported a classroom climate that reflected a communication pattern of "defensiveness" (Barker & Garvin-Doxas, 2004). Classrooms that exhibit this phenomenon create an environment where some students feel like they possess a lack of intelligence and are less likely to ask questions (Barker & Garvin-Doxas, 2004). These classroom characteristics are consistent with the characteristics reported by females enrolled in undergraduate computer science/technology programs.

Barker and Garvin-Doxas also state that status is given to those who have the ability to write "elegant programs" (p. 134), have the ability to reason well, and provided assistance or other needed information. In the courses observed by the researchers, they note "the types of people who belong, their status, and typical behavior of different types of belonging are set up and defined early on" (p.134) and that over time "students become aware of whether they belong as well as where they fit in the CS social hierarchy" (p.135).

Garvin-Doxas and Barker (2004) conducted a case study of computer science classrooms to examine classroom communication patterns defined as defensive as opposed to supportive. The researchers did find gender differences in self-confidence due to classroom environment. The researchers provide suggestions for instructors to create a more supportive classroom environment (Garvin-Doxas & Barker, 2004, p.16, 17):

- Use students' names
- Create opportunities for natural and personal self-disclosure, such as small group work
- Acknowledge, take seriously, and be open to any sort of question
- Ask students to posture to explain what they mean
- Explain to students that experience is good but that it is not equal to intelligence
- Create additional opportunities for students to talk about what they are learning and to hear how others articulate their understanding
- Acknowledge the difficulty of mastering the content and conceptual understanding
- Support diversity
- Support students with as well as without programming experience
- Use more than one instruction method for each concept to support differences in students' experiences and learning needs
- Support students who need to understand how they might apply the knowledge before they can learn the details.

If the concept of a “chilly” or “defensive” classroom climate does exist within undergraduate computer science programs, then an environment is being created in higher education that does little to promote student learning. To fully understand the impact a chilly or unwelcoming classroom environment can have on learning, a review of student development and learning styles will be discussed.

Undergraduate Student Development

Understanding the development of undergraduate students is essential when studying various aspects of the college experience such as environment, learning process, and student life. Since the focus of this study is female perceptions and attitudes of the computer science/technology field(s) and how the mode of learning may affect these perceptions and attitudes, it is imperative to understand the differences research has uncovered with respect to gender and the college years. This section will provide an introduction to undergraduate student development and the differences that appear to exist with respect to females. In addition, a discussion on student learning styles and their effect on undergraduate computer science/technology education will be introduced.

Student Development

Researchers have developed theories regarding student development. This collection of theories can be categorized into three areas; psychosocial and identity development (Chickering, 1969; Chickering & Reisser, 1993; Josselson, 1987), cognitive and structural (Baxter Magolda, 1992; Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982; Kohlberg, 1976; Perry, 1968), and typological (Holland, 1973, 1985, 1992; Jung, 1971; Kolb, 1984; Myers, 1987). Although many of these theories are applicable to the area of student affairs, theories of student development also can aid faculty in the classroom and in academic advising (Evans, Forney, & Guido-DiBrito, 1998).

Psychosocial Theories

Arthur Chickering is one of the most cited student development theorist (Evans, et al., 1998). Building on the work of Erik Ericson, Chickering's theory (1969) identified seven vectors of development; developing competence, managing emotions, moving through autonomy toward dependence, developing mature interpersonal relationships, establishing identity, developing purpose, and developing integrity. Chickering states that the seven vectors serve more as a map to identify where students are in their development and where they are headed (Chickering & Reiser, 1993).

A brief description of each of Chickering's seven vectors (Chickering & Rieser, 1993) follows:

1. *Developing competence*. There are three types of competence that develop in college: intellectual competence, physical and manual skills, and interpersonal competence. Students' overall competence increases as they learn to trust their abilities, receive feedback from others, and integrate their skills.
2. *Managing emotions*. College students exhibit a variety of emotions such as anxiety, anger, fear, hurt, boredom, and tension. These emotions can be detrimental to the education process and need to be controlled. Students must learn how to regulate these negative emotions to provide balance.
3. *Moving through autonomy toward independence*. Students need to learn to be self-sufficient, be less bound to others opinions, and take responsibility for their own choices. Movement through this vector requires both emotional and instrumental independence.

4. *Developing mature interpersonal relationships*. For individuals to develop mature interpersonal relationships they must be able to tolerate and appreciate differences and develop the capacity for intimacy. This is achieved by the ability to create healthy relationships and make lasting commitments.
5. *Establishing identity*. Identity formation relies in part on the previously described vectors. Establishing identity involves: comfort with the body and appearance, comfort with gender and sexual orientation, sense of self, clarification of self-concept through roles and life style, sense of self, self-acceptance and self-esteem, and personal stability.
6. *Developing purpose*. Many students are capable of developing their identity but this does not always include their purpose in life. Developing purpose involves three elements: vocational plans and aspirations, personal interests, and interpersonal and family commitments.
7. *Developing integrity*. This vector is closely related to establishing identity and developing purpose. Three sequential, yet overlapping stages are involved: humanizing values, personalizing values, and developing congruence.

In 1971, Ruthellen Jossselson embarked on an inquiry to "understand the internal and developmental roots of identity formation in women" (p. 33). Over the course of three years, Josselson interviewed sixty female college students chosen from four different colleges and universities.

Through her work, Josselson identified four identity-status groups: *identity achievers, moratoriums, foreclosures, and diffusers.* Josselson (1971) describes each of the four groups as follows:

- Identity achievers. This group reflects women who were able to define a path for themselves in which they had truly chosen.
- Moratoriums. Those who identified as moratoriums were those who felt life was very complicated. They experienced conflict on who to be, what to be, and whom to believe and were unable to choose a path for themselves.
- Foreclosures. Individuals in this group displayed an "intense early attachment to one or the other parent" (p. 34). Foreclosures do not have the ability to ever leave home and develop an independent self.
- Identity diffusers. Those identified as identity diffusers displayed a variety of pathological problems that made it impossible for identity formation.

Cognitive and Structural Theories

Baxter Magolda's (1992) work, "Knowing and Reasoning in College", outlines four distinct "ways of knowing" (p. 3) by college students. Baxter Magolda's longitudinal study of over 101 men and women began in 1986 and used interviews to gather data from study participants. Interviews began during the participants first year in college and continued each year thereafter. The final interview was conducted the first year after graduation. It is from these series of interviews that Baxter Magolda derived the four way of knowing: *absolute knowing, transitional knowing, independent knowing,* and *contextual knowing.*

Baxter Magolda (1992) describes each of these ways of knowing as follows:

- Absolute knowing. Individuals who exhibit an absolute way of knowing believe all knowledge is communicated by instructors and other experts. They share materials and what they have learned with others. They believe that knowledge is certain or absolute.

- Transitional knowing. This type of knowing reflects an individual who understands knowledge and engages in the active exchange of knowledge. They believe that the nature of knowledge is partially certain and uncertain.
- Independent knowing. Independent knowers think for themselves and share their views with others. They view their peers as a source of knowledge and view the nature of knowledge as uncertain; everyone has his/her own beliefs.
- Contextual knowing. Contextual knowing involves the exchange and comparison of one's ideas and perspectives with others. They believe the role of peers is to enhance the quality of learning and the role of professors to promote the application of knowledge and discussion of perspectives. Contextual knowers believe that the nature of knowledge is judged on evidence.

Belenky, Clinchy, Goldberger, and Tarule (1986) describe how women's ways of knowing are different than males. They argue that:

> Our major educational institutions – particularly our secondary and postsecondary schools – were originally founded by men for the education on men. Even girls' schools and women's colleges have been modeled after male institutions to give women an education "equivalent" to men's (pp. 5, 6).

Belenky, et al. (1986) began their work in the 1970s and included interviews of 135 women participants from nine different institutions. After a careful examination of the interview data, the researchers defined five ways of knowing for women: *silence, received knowledge, subjective knowledge, procedural knowledge, and constructed knowledge.*

Silence as a way of knowing, and can be described as a dependence on external authority. Women with this type of knowing often grew up in isolation and seldom had friends. Discussion with family members and others was discouraged and is based on the phrase, "seen but never heard". Women which represent this way of knowing gain knowledge through observation and view authority as being all-powerful. In addition, "these women have little awareness of their intellectual capabilities" (p. 134).

Received knowers receive and reproduce knowledge. They gain knowledge by listening to friends and authorities alike. They believe that ideas and ideals are "concrete and dualistic" (p. 37) and view things as right or wrong, true or false, or black and white. They believe knowledge is created outside of the self and must look to others even for self-knowledge.

Subjective knowers distrust logic, analysis, and abstraction. They lack self-concept and fear that supporting their opinions may result in the loss of connections with others. In addition, they believe that truth is an intuitive reaction. The predominant learning mode for subjective knowing is inward listening and watching.

Procedural knowers believe knowing requires careful examination and analysis. Procedural knowing has elements of both connected knowing and separate knowing. With respect to connected knowing, knowledge is gained by trying to understand others' ideas by sharing experiences that have led to the formation of the idea. In terms of separate knowing, whereas subjective knowers believe experts are correct, procedural knowers believe experts and themselves may be wrong.

Constructed knowers create knowledge through integration. These knowers represent a never-ending quest for truth and possess a high tolerance for internal contradiction.

Typological Theories

Kolb's learning styles (1984), the Myers-Briggs Type Indicator (Myers & McCaulley, 1985), and Holland's theory of vocational personalities and environments (1973, 1985, 1992) are three widely used tools to evaluate an individual's preferred style of learning and/or personality type. Many in higher education use these tools as base for assessing students' needs or in curriculum development.

Kolb (1984) describes learning as, "the process whereby knowledge is created through the transformation of experience" (p.38). Kolb (1984) indicates that learning is comprised of four stage/step cycle. The four stages/steps being: concrete experience (CE) (feeling); reflective observation (RO) (feeling); abstract conceptualization (AC) (thinking); and active experimentation (AE) (doing). Each of the steps acts as a basis for the succeeding one. Evans, et al., (1998) describe the four learning styles as follows.

- *Convergers* (AC and AE). People with this type of learning style are good problem solvers and decision makers. They are also good at applying ideas to practical situations. Convergers prefer technical tasks to social and interpersonal concerns.
- *Divergers* (CE and RO). Divergers appear to be the opposite of convergers. They possess the ability to view situations from many perspectives and come up with alternatives ideas and implications. Divergers are *feeling-oriented.*
- *Assimilators* (AC and RO). Assimilators excel at inductive reasoning and have the ability to create theories. They prefer to focus on ideas and concepts rather than people.
- *Accomodators* (CE and AE). People that possess this learning style implement plans, complete tasks, and are open to new experiences. They are risk takers and can adapt to change. They employ the trial by error approach as opposed to analysis.

Kolb (1984) indicated that learning styles contain weaknesses. Individuals too embedded in their styles are likely to display shortcomings such as premature decision making, indecisiveness, and be engaged in insignificant activities (Evans, et al. 1998). In conclusion, Kolb (1981) states, "How one learns becomes a major determinant of the course of personal development" (p.248).

The Myers-Briggs Type Indicator (Myers & McCaulley, 1985) is an adaptation of Carl Jung's theory of personality type (1971). Myers (1987) working with Kolb's (1923) theory, suggests that there are eight personality type preferences arranged along four bi-polar dimensions (Evans, et al., 1998): *extraversion-introversion* (EI), *sensing-intuition* (SN), *thinking-feeling* (TF), and *judging-perception* (JP). These preferences can be combined to form 16 different types. The Myers-Briggs Type Indicator is the most popular instrument for assessing personality type and is used to assess high school students and adults (Myers & McCaulley, 1985).

Holland (1966) describes six personality types defined by, "specific interests, behaviors, and attitudes" (Evans, et al., 1998, p. 228). The six types are: realistic, investigative, artistic, social, enterprising, and conventional. Evans, et al. (1998) describes each of the six types as follows.

- *Realistic* (R). People who fall into this type are interested in and prefer activities which involve objects, tools, machines, and animals. They display competence in manual, mechanical, agricultural, and technical areas.
- *Investigative* (I). Investigative types prefer activities that involve systematic investigation and are competent in scientific and mathematical areas. These types value science and are analytical, intellectual, precise, reserved, and cautious.
- *Artistic* (A). This group prefers spontaneous, creative, unregulated activities that lead to the creation of art. They are competent in areas such as language/writing, art, music, and drama.

- *Social* (S). Social types prefer activities that educate, inform, cure, or enlighten. They have interpersonal and educational competencies. They enjoy helping others and participating in social activities.
- *Enterprising* (E). These types enjoy working with other people to achieve organizational goals or material outcomes. They possess leadership skills and tend to be domineering, extraverted, self-confident, talkative, and adventurous.
- *Conventional* (C). Conventional types prefer working with data in systematic, orderly, and explicit ways and are competent at computational and clerical tasks. They are conforming, efficient, inflexible, practical, and unimaginative.

Initially, Holland (1966) suggested that a person can be described by one of the six types. Later, Holland (1985, 1992) indicated that a person may also be described with subtypes. Subtypes may consist of two to six types with one type indicated as the dominant type.

Computer Science Learning Styles

The aforementioned review of learning styles may leave little question as to which learning styles are represented by those in computing fields. Previous studies (Haliburton, Thweatt, & Wahl, 1998; Salter, 2003; Salter & Persaud, 2003) have looked at the learning styles of students and at times of computer science faculty. Researchers have also examined the chilly classroom environment in regards to personality types and learning styles.

In 1973, Holland gave the three letter code *IRC* (investigative, realistic, conventional) to computer programmers. In 1985, Hansen and Campbell studied a large number of computer professionals and found their code to be *IRA,* replacing conventional with artistic. Haliburton, Thweatt, & Wahl (1998) studied Holland's congruence hypothesis on 73 computer science students and 11 computer science faculty members. All study participants were given Holland's personality inventory, the *Self-Directed Search* (SDS) which determined the individual's three letter code. Faculty members of the study consisted of six males and five females. Male faculty members' code was *IRS*, whereas the female faculty members' codes were *ISA*, indicating artistic as opposed to realistic. Female students' codes were consistently *ICS* while there was no pattern to the male students' codes (*IRS, IRC,* and *ISC*). In addition, the study found that male student personalities were more similar to the faculty personalities than the female students. The computing environment at the time of Holland's (1973) code for computer programmers was much different than the current environment which now includes more teamwork, graphical user interfaces and web-based modes of communication. This could explain the emergence of the female code of *ISA* in the computer science area (Haliburton, et al., 1998).

Classroom "Fit"

Persaud and Salter (2003) examined the chilly classroom suggested by Hall and Sandler (1982) by utilizing Jungian constructs. The researchers examined classroom fit and self-reported levels of participation. Congruence between learning style and classroom climate was measured using the Myers-Briggs Type Indicator (Myers & Briggs, 1998) and the Salter Environmental Type Assessment (SETA) (Salter, 2000). Participants were 142 upperclass women majoring in either engineering or education. Women identified as "feeling", reported that feeling classrooms were a better fit for them and thinking classrooms were not. Women categorized as "thinking", showed no preference for either thinking or feeling classrooms (Persaud & Salter, 2003). Persaud and Salter (2003) also found that women are less likely to participate in thinking classrooms.

Salter (2003) studied "perceived" classroom fit for both men and women using the Myers-Briggs Type Indicator (Myers & McCaulley, 1985) and the SETA (Salter, 2000). Participants included 421 male and female undergraduate and graduate students. Students were asked to select a previous college course which they felt was a good fit for them or to select a course they felt was a poor fit for them. Students were asked to describe a classroom experience that reflected the type of fit. Of the 421 students, 253 students chose classes that they perceived to be a good fit and 168 students chose classes that were deemed a poor fit. Salter found the "largest determining factor to perceived fit was classroom climate" with "good fit being associated with feeling-oriented classes and poor fit with thinking-oriented classes" (p.116).

This section discussed the various types of learning styles individuals possess. In addition, information was provided which indicates women's ways of knowing differ from men's. Taking these various learning styles, along with the different ways of knowing into consideration, it becomes more evident that the traditional college classroom environment may not be the best fit for females. Is there alternative learning environment for women which will promote learning while at the same time eliminate some of the unwelcoming characteristics? The next section discusses distance learning, the characteristics of online learners, the learning styles present in an online environment, achievement, and communication patterns in online classes.

Distance Learning

Distance learning, as it is known today, has been in existence for more than 25 years. Prior to the current model of distance education, educational materials were distributed via the U. S. postal service to educate women in the 1870s (Nasseh, 1997). Later (1918-1946), broadcast licenses were granted to 202 colleges and universities to provide instructional radio; this attempt failed to attract enrollments and had its skeptics. This radio inspired method paved the way for educational programming on television, which fueled social acceptance of the distance education concept (Nasseh, 1997).

Today, distance learning, now sometimes referred to as online learning, is primarily delivered via the Internet or World Wide Web. A 2006 report by the Sloan Foundation indicated that nearly 3.2 million students were taking an online course in the fall of 2005, reflecting an increase over the previous year when 2.3 million students took an online course. This increase is more than twice the number added in any previous years.

Characteristics of Online Learners

A review of the reference literature reveals many studies that focus on the characteristics of online learners (Aman & Shirvani, 2005; Barrett & Lally, 1999; Dutton, Dutton, & Perry, 2002; Gal-Ezar, 2007) and how this unique group of learners differs from traditional learners.

In a 2005 report, Aman and Shirvani present results of a study focused on individual's characteristics and preferences with respect to online education. The researchers used an online survey tool to acquire a diverse sample of study participants. The survey netted 287 responses from 198 women and 97 men. Of the 287, 249 indicated being employed outside the home. Results of the study revealed that more women than men took more online courses. The typical age group of those taking online courses was between 40 and 50 years. The trend to take online courses fell after age 50 (Aman & Shirvani, 2005). Gal-Ezar (2007) indicate similar characteristics of online learners describing the majority as non-traditional students: older, part-time students with work and family responsibilities.

Dutton, Dutton, & Perry (2002) conducted a study using "survey responses and student records" (Dutton, et al., 2002, p. 4) of 283 male and female students enrolled in two course sections (one online and one FTF) of the fall 1999 Introduction to Programming course at North Carolina State University. One hundred ninety three usable surveys were collected; 104 from the FTF section and 83 from the online section. Dutton et al. (2002) found that gender did not appear to play a role in a student's choice to enroll in an online class but older, non-traditional aged students preferred the online environment. Many of the online students indicated class flexibility and a reduction of travel time as important factors that influenced their decision.

These studies report similar online student demographics. A 2007 paper by Dabbagh, suggests a change in the online learner, "The profile of the online learner population is changing from one that is older, mostly employed, place bound, goal oriented, and intrinsically motivated, to one that is diverse, dynamic, tentative, younger, and responsive to rapid technological changes" (Dabbagh, 2007, p.224).

Learning Styles in Online Education

Many studies have been conducted which focus on learning style differences between online students and FTF students (Mupinga, Nora, & Yaw, 2006; Neuhauser, 2002;) and in online students (Dewar & Whittington, 2000;). Using the MBTI, Dewar and Whittington studied both male and female graduate students and found MBTI and learning styles denoted by Lawrence (1979) were specific to FTF but were also valid for online students as well with the exception of a gender difference for the thinking/feeling preference.

Using the MBTI, Mupinga et al. (2006) conducted a study involving 131 undergraduate online students. Results showed the largest concentration of students fell into three common codes: 16% of the students were ISTJ (introvert, sensor, thinker, judger), 16% were ISFJ (introvert, sensor, feeler, judger), 14% ISTP (introvert, sensor, thinker, perceiver), and 8.4% ESFJ (extrovert, sensor, feeler, judger). The results did not identify a predominant learning style (Mupinga, et al., 2006). Additionally, Neuhauser (2002) found no significant difference in learning styles or preferences of undergraduates enrolled in a Principles of Management course either online or FTF.

Achievement

Achievement outcomes of online learning have been a concern for higher education institutions and accrediting agencies of higher education. The Sloan Foundation (2006) reports that a majority of Chief Academic Officers rated the outcomes of online classes as the same or superior to the outcomes of FTF classes.

McDonald, Dorn, and McDonald (2004) studied the success of students in online courses as compared to those in FTF courses. The researchers analyzed two years' worth of data which included 195 observations; 134 on-ground and 63 online of an upper-level Database Systems course. T-tests revealed that FTF students significantly outperformed the online students. Since computer skills are somewhat second nature to computer science students, the researchers suspect the model used for their online learning to be the cause of the poor performance by the online students.

Communication

One aspect of online learning that promotes classroom interaction is the use of discussion boards. Discussion boards allow students along with the instructor to ask questions and respond to others. Researchers who have studied communication in the online classroom including these discussion boards (Barratt & Lally, 1999; Guiller & Durndell, 2006; Sullivan, 2002) have found notable differences in males and female students.

Barrett and Lally (1999) found that men and women took different roles in the online classroom. With respect to communication, on average, men sent more messages than women. Men's messages were twice as long and made more socio-economic contributions than women. Women on the other hand, sent more interactive messages than the men (Barrett & Lally, 1999).

One study (Sullivan, 2002) sampled female students focused on issues of gender in online courses. The majority of the respondents had positive comments regarding their online experiences. Many of the female participants indicated "anonymity" as a key component of the online course, resulting in a comfortable learning environment (Sullivan, 2002). Overall, respondents indicated that they enjoyed the online classroom and were afforded learning opportunities that are not present in traditional classroom settings (Sullivan, 2002). The anonymity provided by the online classroom appeared to eliminate many of the common in-class gender issues women face in traditional computer science courses.

Distance learning has grown in popularity through the use of the internet. Course management tools make it easier for institutions to deliver instruction online to a variety of learners. Research has shown online courses to be as good as their FTF counterparts. The next section will discuss the delivery of undergraduate computer science programs online and the results of those attempts.

Online Computer Science Programs

Offering computer science courses through distance education is not a recent development. As early as 1976, there was evidence that the need existed to provide quality education to students in remote locations. Eccles and Gordon (1976) describe how television was used to provide a first semester computer science course to students who planned to major in the field. The impetus for this course delivery method was the lack of qualified faculty available to teach the growing number of students (Eccles & Gordon, 1976). This course utilized tapes containing lectures and laboratory exercises. Forty to sixty students experienced the course, for over two academic years, one semester at a time. Although no statistics exist from this experiment in distance learning, the authors noted that students who took the distance course seemed "to work harder in this course and have a greater drive to understand the material" (Eccles & Gordon, 1976, p. 55).

By 1990, the Open University was reporting that their distance learning course on the Fundamentals of Computing was attracting over 3000 students per year (Davies & Preece, 1990). This course and other courses at Open University utilized weekly printed texts called "work units" (Davies & Preece, 1990, p. 145), television, and audio-cassettes. The researchers indicate that this course had been successful, but the course did exhibit logistical and academic issues. For example, the requirement that students somehow possessed a computer and the loss of communication between the faculty and the student body were described to be the areas of concern.

Regardless of logistical and academic issues, studies of online learning in the computer science/technology field conclude that students who participated in online courses showed no significant difference in the learning outcomes than students in the traditional classroom (Kleinman & Entin, 2002; McCloud, 2004; Dutton, Dutton, & Perry, 2002). McCloud (2004) studied undergraduate students enrolled in an Introduction to Technology service course. During Fall 2001 and Fall 2002 semesters, 32 FTF sections and 2 online sections were taught. All participants were full-time students. Among other things, the study found that the online students did as well as the FTF students.

Chapter Summary

The literature presented identifies the conceptual framework of the study. Each area of the framework was researched and findings were reported. It is evident through a review of the literature that under-representation of females in computer science/technology fields is still an issue that needs resolution. Many factors influence females' perceptions. Investigating the importance that an online learning environment may have on these perceptions is the focus of this study. Chapter three provides information regarding the research design, research question, population, instruments, data collection, and data analysis necessary to understand these particular perceptions held by females regarding the computing field.

CHAPTER 3: METHODOLOGY

Introduction

This chapter describes the research design selected for this study including the methodology. The purpose of the study, the research question, and hypotheses are presented. The target population and sample for the study are described, including higher education institutions and the students at those institutions who met the study criteria. In addition, the data collection instruments and methods are discussed along with the data analysis processes. The chapter concludes with a summary of the methodology employed for this study.

Research Design

A mixed method design was implemented for this study. This design methodology was chosen because a combination of quantitative and qualitative methods provides a more detailed representation of the findings that one would receive utilizing one methodology alone (Creswell & Plano Clark, 2007, p.5). The design was chosen to provide a more thorough understanding of the perceptions held by females enrolled in online and traditional computer science/technology programs toward the field of computer science.

Most research in the field of computer science utilizes a quantitative research method, similar to the methods used in the natural sciences (Berglund, Daniels, & Pears, 2006). A review of computer science education (CSE) research also reveals studies based on quantitative methods (Hazzan, Dubinsky, Eidelman, Sakhnini, & Teif, 2006). In comparison, qualitative inquiry has been used for many years in educational research, including mathematical education research, and is also appropriate for use in CSE research (Hazzan, et al., 2006). The types of research questions that appear in the area of CSE are best studied using qualitative methods. Improving the quality of teaching and learning, measuring success of programs, and understanding how students learn computer science concepts are just a sampling of the areas investigated in CSE research. These appear to be consistent with other education-based research projects. In addition, qualitative inquiry allowed the investigator to explore the research question by talking directly with those associated with the phenomenon allowing them to communicate their experiences first-hand (Creswell, 2007). Implementing this type of research allowed the investigator to obtain an understanding not accessible using a quantitative approach (Berglund, Daniels, & Pears, 2006).

Purpose of the Study

The purpose of this study was to investigate the perceptions held by undergraduate female students' in computer science/technology programs enrolled at colleges and universities which offer either online or traditional program formats or in some cases both formats.

Research Question

Based on a careful review of the literature, the research question which guided this study was:

> How does a difference in course format influence female students' perceptions toward the field of computer science/technology?

Research Hypotheses

The purpose of the quantitative portion of this study was an attempt to support the five research hypotheses. Each hypothesis corresponds directly to one of the five survey subscales present in the CSAS (Weibe, Williams, Yang, & Miller, 2003); Confidence in Learning Computer Science and Programming, Attitude Towards Success in Computer Science, Computer Science as a Male Domain, Usefulness of Computer Science and Programming, and Effective Motivation in Computer Science and Programming. Therefore, the five research hypotheses that will guide this study are:

1. Face-to-face students will report less confidence in learning computer science and programming than the online students.
2. Face-to-face students will report a less positive attitude toward success in computer science than the online students.
3. Face-to-face students will describe computer science as a male domain more frequently than online students.
4. Face-to-face students will have a less positive attitude toward the usefulness of computer science and programming than the online students.
5. Face-to-face students will report less motivation in computer science and programming than online students.

Population

The target population for this study was undergraduate female students enrolled in computer science/technology programs. These programs could be an online program or a traditional face-to face (FTF) program. Potential participants enrolled in appropriate undergraduate programs were identified with the assistance of the institutions which also met the study criteria.

Participant Sample

Due to the nature of this study, a purposeful sampling technique was implemented. This technique allowed the researcher to gain knowledge from individuals currently experiencing the study phenomenon and its associated issues (Creswell, 2007; Gall, Gall, & Borg, 2007). Therefore, female students enrolled in undergraduate computer science/technology leading to a bachelor's, associates, and minor (certificate) degree comprised the sample.

Institution Sample

This study focused on computer science/technology programs offered by institutions which met the following criteria:

- at the time of selection, each were accredited by the Higher learning Commission (HLC)
- each was listed a “public” or “private not-for-profit” institution
- each offered either an associate’s, bachelor’s degree, or undergraduate certificate (minor) program in computer science/technology in an online format, traditional brick-and-mortar format or both.

There are many variations of computer science degree programs; therefore, for this study, a computer science/technology degree program refers to any program that offers a traditional computer science curriculum or a program offering that has a strong relationship to a traditional computer science degree program.

Degree programs were evaluated using the 14 “knowledge areas” defined by the Association of Computing Machinery (ACM) and the IEEE Computer Society (ACM, 2001). The 14 defined knowledge areas are:

- discrete structures (DS)
- programming fundamentals (PF)
- algorithms and complexity (AL)
- architecture and organization (AR)
- operating systems (OS)
- net-centric computing (NC)
- programming languages (PL)
- human-computer interaction (HC)

- graphics and visual computing (GV)
- intelligent systems (IS)
- information management (IM)
- professional issues (PI)
- software engineering (SE)
- computational science (CN)

Online and FTF programs that could be described by one or more of these knowledge areas were of interest to the researcher.

Online Program Selection

A list of institutions that met the study criteria was compiled by performing an exhaustive search of the HLC website. The HLC was chosen because of the geographical area it serves; the Midwest corridor of the United States. The 15 states affiliated with the HLC are: Arkansas, Arizona, Colorado, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, Oklahoma, New Mexico, South Dakota, Wisconsin, West Virginia, and Wyoming. At the time of selection, this 15 state region contained more than 1000 institutions that could possibly offer the degree program(s) of interest.

An initial list of candidate institutions for this study was generated. For each state, institutions listed as "currently active" by the HLC were reviewed to determine if the institution offered one or more undergraduate programs under the "Distance Learning" heading. Institutions that offered undergraduate online program(s) that were listed as computer science/technology and led to an associate's, bachelor's degree, or undergraduate certificate (minor) were added to the list of candidate schools.

An initial list of 70 institutions offering an online program(s) was compiled. The investigator then conducted a selection process to determine a final listing of institutions that met study criteria. The final selection process involved two phases; an "institutional phase" and a "program phase". The initial list of institutions can be found in Appendix B.

Institutional Phase. The website of each of the 70 institutions was visited to obtain information regarding the online program(s) of interest. Two codes were used to verify that the institution did in fact offer the program(s) listed on the HLC website; the code *N-OFF* (no offering) was used to indicate that an initial review of the school website did not report any online program meeting the study requirements, a code of *Y-OFF* (yes offering) was used to indicate that the institution did provide information on its website regarding the online program(s) listed on the HLC website.

Schools coded as N-OFF were further investigated to determine if the school did offer the online program(s). This was accomplished by a search of the institution's online undergraduate catalog, a search of the school's distance learning programs, and as a last effort, contacting via email the individual listed as the online program director. If it was found that a school did offer an online program(s) the coding for the school was updated from N-OFF to Y-OFF. For the final list, 48 institutions were found to offer one or more online programs of interest to the researcher.

Program Phase. For each of the schools coded as Y-OFF the course requirements for the program(s) were carefully examined to determine if the program met the study requirements by implementing one or more of the 14 knowledge areas defined by the ACM and IEEE.

Since the researcher possesses an undergraduate and graduate degree in computer science, the determination of a degree program fitting one of the 14 knowledge areas was made by the a review of the course titles, and if available, the course descriptions.

FTF Programs

Many of the schools that offered an online program(s) also offered the identical or similar program(s) in a FTF format. Therefore, the investigator again used the initial list of institutions that offered online programs to identify schools that offered FTF programs. The selection criteria used to identify the online programs also was used to verify the FTF programs. In an effort to minimize the number of study sites and streamline the research approval process, the investigator made an attempt to select schools that offered both types of program formats.

Study Site Descriptions

After analyzing the program offerings at various schools, the investigator selected four institutions that met the study criteria. Of these four sites, two were private not-for profit institutions and two were public state universities. In addition:

- three of the four sites offered online and FTF undergraduate computer science/technology program(s)
- one site offered only traditional FTF undergraduate computer science programs
- each of the sites selected is considered to be a small to mid-sized institution
- one site was a private Jesuit university
- one institution was a small private liberal arts school
- one of the two public state schools is considered an institution specializing in technical education

All of the four institutions offer graduate and undergraduate programs. Enrollment at each of the four schools ranges between 2,800 students to 14,000 students.

Study Participants

Student Recruitment. Each of the four institutions described above was contacted to determine if the school permitted outside researchers to study their undergraduate student population. After learning that each of the four schools permitted outside researchers the investigator obtained the Institutional Review Board (IRB) process from each study site and the required paperwork was completed and submitted. Once permission was granted from each site, the recruitment of study participants began. Of the four institutions that granted IRB approval, only three were willing to assist the investigator with the dissemination of recruitment materials to students. The researcher requested that information regarding the study be distributed electronically to female students enrolled in undergraduate online and/or FTF programs. This procedure differed for each of the three study sites. At one school, announcement of the study was sent to students via a faculty member. It is unknown how many students were contacted. At another school, the office of research queried their computer system for a list of undergraduates that met the study criteria and sent a mass email to 54 undergraduate females. The fourth institution allowed the investigator to email students directly. Overall, 35 females completed the online survey and 11 students volunteered for the telephone interview. It is unclear how many of the study participants were notified first-hand of the study and how many participants gained knowledge of the study from a fellow student.

Participation in the study was on a voluntary basis. No incentive was provided to those who chose to participate. Contact information for the researcher was provided to the potential participants. Students who elected to participate were notified that participation in the study included the completion of an online questionnaire and a voluntary 15-20 minute telephone interview.

Instrumentation

The mixed-method design used in this study required the use of two instruments to collect the quantitative and qualitative data needed to address the research question and study hypotheses. A description of these instruments follows.

Quantitative Instrument

The instrument chosen to collect the quantitative data was in the form of an online questionnaire. Study participants were provided the Universal Resource Locator (URL) for the survey in the study announcement sent out to students.

Survey. The perceptions and attitudes held by female students were measured by using the "Computer Science Attitude Survey" (CSAS) (Wiebe, et a., 2003). Eric Weibe, an author of the CSAS, was contacted and permission of use was granted to the investigator via e-mail correspondence. The CSAS was adapted from the Fennema-Sherman Mathematics Attitude Scales (Fennema, Sherman, 1976).

The Fennema-Sherman Mathematics Attitude Scales (1976) were developed as part of a grant from the National Science Foundation. The purpose of the grant was to develop an instrument that could be used to gather information regarding females' attitudes towards the learning of mathematics and also in females' selection of mathematics courses. Prior to the creation of the Fennema-Sherman (1976) scales, there existed no instrument to measure the learning of mathematics, but rather only devices designed to measure global attitudes of students (Fennema & Sherman, 1976).

The instrument created by Fennema and Sherman (1976) consists of nine scales related to the learning of mathematics by students, specifically females. The scales are:

1. *The Attitude toward Success in Mathematics Scale* (AS)

2. *The Mathematics as a Male Domain Scale* (MD)
3. *The Mother Scale* (M)
4. *Father Scale* (F)
5. *The Teacher Scale* (T)
6. *The Confidence in Learning Scale* (C)
7. *The Mathematics Anxiety Scale* (A)
8. *The Effectance Motivation Scale in Mathematics* (E)
9. *The Mathematics Usefulness Scale* (U)

The CSAS, developed in 2003, measures five of the nine sub-scales present in the Fennema-Sherman instrument. The sub-scales present in the CSAS are:

1. *Confidence in Learning Computer Science and Programming* (C)
2. *Attitude Toward Success in Computer Science* (AS)
3. *Computer Science as a Male Domain* (M)
4. *Usefulness of Computer Science and Programming* (U)
5. *Effective Motivation in Computer Science and Programming* (E)

The Cronbach's alpha for the five sub-scales ranges from 0.83 to 0.91 (Weibe, et al., 2003). The statements found in the five CSAS subscales are most representative of the research question that directs this study. Table 1 describes the association between the 57 survey statements and the five subscales. The investigator has not made any modifications to the CSAS for this study.

Table 1: Survey Subscales	
Subscale	**Survey Statement Numbers**
1. Confidence in learning computer science and programming	2-13
2. Attitude toward success in computer science	14-25
3. Computer science as a male domain	26-33
4. Usefulness of computer science and programming	34-45
5. Effective motivation in computer science and programming	46-57

The questionnaire for this study contained 57 close-ended statements which utilized a 5-point Likert scale ranging from strongly agree to strongly disagree (Weibe, et al., 2003). Statements were grouped according to the five scales, although participants had no indication that the survey questions were arranged in any particular order. The survey opened with a single statement which reflected the participant's intent to major in computer science. This question is not represented in any of the five subscales. In addition to the Likert scale questions, an area was provided at the end of the survey for participants to include any additional information or comments regarding the survey. Any information provided in this area was included in the qualitative analysis process. The questionnaire also contained an area to collect demographic information from participants. The demographic data collected included gender, academic year, age range, name of institution, enrollment in an online program, academic major, academic minor/certificate and type of degree program. Justification for the collection of demographic data is discussed in the data analysis portion of this study. At the end of the survey, a statement was provided to inform participants of the optional telephone interview. Included in this statement was the contact information (email address) for the investigator. The questionnaire was presented in English and was not translated to any other language.

Qualitative Instrument

Interviews. All survey respondents who indicated their willingness to participate in the qualitative phase (telephone interview) of the study were contacted by the investigator via email to arrange for an interview date and time. All interview participants were provided with a consent form outlining the interview procedure and informing them that all interview data would be digitally recorded for use in the analysis phase. All interview participants were asked a set of semi-structured questions via telephone. The investigator was initially prepared to limit ($N < 5$) the number of interviews conducted but increased the number of interviews ($N > 10$) to offset the low amount of quantitative data collected.

A set of interview questions was constructed by the investigator and reviewed by an expert panel of three scholars who have contributed research to the area of under-representation of women in STEM areas. The interview questions were derived from a review of the current literature and the research questions. The expert panel consisted of: T. Camp (personal communication, October 13, 2009), C. Frieze (personal communication, October 13, 2009), J.M. Cohoon (personal communication, October 12, 2009). Feedback from the expert panel was used to fine-tune the interview questions. A copy of the interview questions can be found in Appendix A.

Data Collection

To address the research questions, information regarding female student perceptions was collected. Quantitative and qualitative data was collected concurrently and sequentially (Creswell & Plano Clark, 2007). Data collection was performed in two phases: the first focusing on the collection of quantitative and qualitative data and the second phase focusing solely on the collection on qualitative data.

Quantitative Data Collection

The CSAS survey implemented for this study was administered via the internet. The questionnaire was anonymous and was hosted by SurveyMonkey.com. SurveyMonkey.com was chosen due to its ease of use and it provided a secure web server for the storage of data. Each participant was provided one opportunity to complete the survey. Once a participant completed the survey, it was submitted. Once submitted, the participant was not provided an opportunity to change responses or submit a second/replacement survey.

The survey collected quantitative data through a series of statements to which the participants provided responses using a five-point Likert scale. The statements on the survey were grouped into the CSAS five subscales, although, as mentioned, this was not evident to participants.

An internet-based survey was chosen to aid in the transferring of data into a software package that was used for analysis. This method minimizes the time needed for data entry and also eliminates the possibility of data entry errors. This internet-based method of data collection also eliminated the cost involved in a traditional survey delivery method through the U.S. mail.

Qualitative Data Collection

Qualitative data was collected using two methods: by providing additional "write-in" information on the survey and optional follow-up interviews. At the end of the survey, a section was provided for participants to include any additional information with respect to the survey questions or any information that they felt the investigator should know.

The majority of qualitative data was collected through interviews. After completion of the online survey, participants who indicated a willingness to be interviewed were contacted via email to arrange a 15 to 20 minute interview. Due to the unpredictable location of interview participants, interviews were conducted via telephone. Although the response rate for telephone interviews typically is not as high as for face-to-face interviews (Leedy & Ormrod, 2005), it was the only option due to the nature of this study and the location of the study participants. Each interview was digitally recorded using a Sony ICD-P520 recorder. After each interview, the data file was downloaded to the investigator's personal computer. Each recording was transcribed verbatim and stored as a word processing document.

Data Analysis

This section will describe the methods undertaken to analyze the quantitative and qualitative data collected through the online survey and participant interviews. Analysis of all data collected addressed the initial research question and allowed the researcher to respond to each of the five research hypotheses.

Quantitative Analysis

Demographic Data. The demographic data collected from the online surveys was used to ensure the validity and cleanliness of data. Data indicating gender, academic year, major, and degree program (major and minor) ensured that the survey data captured reflected the target population of the study; female students enrolled in undergraduate computer science/technology programs. In addition, demographic data such as academic year, age range, enrollment in an online program, major, and degree program was used during analysis to "describe" the demographics of the sample population.

Survey Data. The quantitative data collected from the online survey is reported using descriptive statistics. To address the five research hypotheses of this study, the five subscales of the CSAS were analyzed using independent t-tests and Mann-Whitney U tests. The independent t-test was initially selected to compare the means of the two groups. Since the sample size of the two groups was small, Mann-Whitney U tests were also conducted. Results of these two tests allowed the investigator to determine the significance of the findings between female students enrolled in the online environment and female students enrolled in the traditional FTF setting. These tests ensure that the findings describe "the situation as it is" (Leedy & Ormrod, 2005, p. 179). In addition, for each survey statement, the mean and standard deviation was computed for the two sample populations: online students and FTF students.

Qualitative Analysis

The qualitative analysis strategy implemented for this phenomenological study reflects a classical content analysis process consisting of preparing and organizing the data, reducing the data into themes through coding, and presenting the findings through figures, tables, or discussion (Creswell, 2007; Ryan & Bernard, 2000; Glesne, 2006). More specifically, the data collected from the participant interviews and from the write-in section of the online survey were analyzed using a phenomenological analysis approach defined by Creswell (2007). Creswell (2007) suggests a series of six steps (p. 156) including:

1. Data managing
2. Reading and memoing
3. Describing

4. Classifying
5. Interpreting
6. Representing and visualizing

The initial step in this process, data managing, consists of organizing the data in files. The researcher achieved this by creating separate files for participant interviews and any write-in comments from the online survey. During the second step, reading and memoing, the investigator reread the transcripts, while placing comments and codes in the margins.

To address the third step, Creswell (2007) suggests describing "personal experiences through epoche" (p.156) and also describing the essence of the phenomenon. Since the investigator has prior education in the field of computer science, all attempts were made to set aside personal experiences and allow the investigator to examine the phenomenon with an unbiased perspective.

The fourth step, classifying, required the investigator to identify significant statements and group the data into meaningful units. This step was achieved with the investigator utilizing a priori coding scheme (Creswell, 2077) by coding the transcripts using a set of setting/context codes (Bogdan & Biklen, 1992), also referred to as general domain codes (Creswell, 2007). "This term refers to codes under which the most general information on the setting, topic, or subjects can be sorted" (Bogdan & Biklen, 1992, p. 167). After this coding process was completed, the investigator arranged the statements into separate data files, where each file corresponded to a single code. This process resulted in 147 statements being extracted from the verbatim transcripts. An additional 17 comments were collected from the write-in portion of the online survey.

To address the research question that guided this study, after the initial coding was completed, content analysis was applied to the resulting set of 160 statements to determine any patterns or themes (Patton, 2002) present in the data. With respect to coding, classifying, and the theme-searching process, Glesne (2006) states suggests that this is the time the investigator can reflect on the coded data, and begin to discover commonalities across the data. After reviewing the data, the investigator recorded five themes that emerged from the data.

To obtain a further understanding of the t-test findings, a second coding technique was applied to the categorized statements using codes which reflected the five survey subscales: attitude toward success (SUC), attitude toward usefulness (USE), confidence (CON), male domain (MAD), and motivation (MOT). The investigator coded the participant's statements and recorded positive, neutral, and negative statements for each of the five codes. A listing of the general domain codes and sub codes may be found in Appendix C.

Internal Validity

Internal validity is defined as, the extent to which a research study's, "design and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data" (Leedy & Ormrod, 2005, p. 97). Various elements were present within this study which minimized any threat to internal validity. Since this study was not longitudinal, the attitudes and perceptions of females should remain steady during the data collection period. The multiple methods of data collection for this study not only addressed the issue of triangulation but also internal validity. The decision by the researcher to collect multiple forms of data was made to promote a convergence of data which addressed this study's research question and hypotheses. In conclusion, at no time during the study was the survey instrument modified in any way, causing irregularities in the quantitative data.

Triangulation Design

This study used a triangulation design which is used when the investigator would like to validate or describe quantitative findings with an explanation found in the qualitative data (Creswell & Plano Clark, 2007). This study reflects a "convergence model" which is typical of a mixed methods research design (Creswell & Plano Clark, 2007). The convergence model states how and when the researcher collects, analyzes, and interprets the data. Specifically, "the researcher collects and analyzes quantitative and qualitative data separately on the same phenomenon and then the different results are converged (by comparing and contrasting the different results) during the interpretation" (Creswell & Plano Clark, 2007, p.64).

In keeping with this model, data for this study was collected in two phases using quantitative and qualitative instruments. An online survey was used during the first phase and one-on-one interviews were conducted during the second phase. The survey also included an area where participants could provide additional information for the researcher. Data from this area was extracted and included with the interview data during the analysis process.

At the onset of the study, it was clear to the investigator that a very limited pool of potential study participants existed. The investigator was unable to determine if a sufficient amount of quantitative data could be collected to address the study hypotheses. The initial study design consisted of collecting a limited number of interviews ($N < 5$) to compliment the survey data. After it became evident that the survey response rate was low, a decision was made to increase the amount of qualitative data to augment the survey data.

Researcher Bias

It was the goal of this researcher to minimize the introduction of bias into this study. The survey chosen for this study was not developed by the researcher. Therefore, it is unlikely that the survey statements reflected any biases held by the researcher. In addition, since all participants of the study were female, the issue of gender bias was eliminated. Lastly, the set of interview questions reflected the themes which emerged from the literature review. The review of the interview questions by the expert panel did not result in any comments regarding bias.

Chapter Summary

The chapter described in detail the research design that was used in this study. This mixed-methods approach allowed the researcher to gain an in-depth understanding of female perceptions. Findings from the data collected are reported in chapter four. These findings describe the demographic data of the participants, a description of participants' responses to the questionnaire, and results of the analysis performed on the qualitative data. Patterns and relationships that have emerged during analysis of the qualitative data also are presented. A discussion of these findings is presented in chapter five along with recommendations for future research.

CHAPTER 4: ANALYSIS AND PRESENTATION OF DATA

Introduction

This chapter will present the findings of the quantitative and qualitative data collected for this study. These findings, presented in detail, will describe whether differences exist in the perceptions toward the field of computer science of undergraduate females enrolled in traditional in-class computer science/technology programs to those enrolled in online programs. The findings are a direct result of the data collected through the online survey and telephone interviews. Undergraduate female students from three Midwestern universities, one private and two public participated in the study. The data collection period spanned three academic semesters (Spring 2010, Fall, 2010, and Spring 2011). This chapter will conclude with a summary of these findings.

Quantitative Findings

The quantitative data collected from the online survey via SurveyMonkey.com was downloaded to the investigator's personal computer into Microsoft Office Excel 2007. The downloaded data were opened, reviewed, and cleaned by the investigator. A codebook was established for the demographic data preparing it for import into IBM SPSS Statistics 19 for analysis. The codes used in the conversion process may be found in Appendix D.

Survey Responses

During the three semesters the online survey was made available, a total of 39 undergraduate female students responded. Of these 39 survey responses, one individual disclosed they were trans-gendered; male to female. This information was provided in the open response area at the end of the survey. No other participant included any additional comments regarding gender. At the beginning of the data collection period it was not evident to the investigator the actual number of potential participants existing at each of the three study sites, therefore the actual response rate is not known. It is also unknown how many of the study participants received direct notice of the study and how many were informed of the study by a classmate or a friend.

Of the 39 initial surveys, three of the surveys contained only demographic data and no response to any of the survey questions. In addition, another survey was found to be incomplete. A total of four surveys were discarded by the investigator leaving 35 complete surveys for final analysis.

Demographic Data

The online survey for this study collected 11 pieces of demographic data from participants. Information regarding these responses can be found in Table 2.

Table 2: Demographic Data

Gender (Female)			**Type of Degree Program**		
	Yes	35 (100%)		Associate's	2 (5.7%)
	No	0 (0%)		Bachelor's	33 (94.3%)
	Total	35 (100%)		Total	35 (100%)
Academic Year			**Major Format (Online)**		
	Freshman	3 (8.6%)		Yes	6 (17.1%)
	Sophomore	8 (22.9%)		No	29 (82.9%)
	Junior	8 (22.9%)		Total	35 (100%)
	Senior	15 (42.9%)	**Minor/Certificate?**		
	Total	35 (100%)		Yes	6 (17.1%)
Age Range				No	29 (82.9%)
	18 – 22	15 (42.9%)		Total	35 (100%)
	23 – 29	8 (22.9%)	**Minor/Certificate Program**		
	30 – 39	4 (11.4%)	Computer Science		2 (5.7%)
	40 -49	6 (17.1%)	Web Design/Development		3 (8.6%)
	50+	2 (5.7%)	Computer Applications		1 (2.9%)
	Total	35 (100%)	N/A		29 (82.9%)
			Total		35 (100%)

Table 2: Demographic Data (continued)

Institution		**Minor/Certificate Format (Online)**	
Public	11 (31.4%)	Yes	6 (23.1%)
Private	24 (68.6%)	No	20 (76.9%)
Total	35 (100%)	Total	35 (100%)
Major Program		**Number of Online CS/Technology Classes**	
Computer Science	10 (28.6%)	None	0
Computer & Network Security	3 (8.6%)	1 – 5	16
Computer Infor. Systems	6 (17.1%)	6 – 10	2
Management Infor. Systems	1 (2.9%)	11 – 15	1
Game Design	1 (2.9%)	More than 15	1
Web Design/Development	3 (8.6%)	Total	20
Interactive Digital Media	2 (5.7%)	**Number of FTF CS/Technology Classes**	
Information Management	1 (2.9%)	None	4
Other	8 (22.9%)	1 – 5	16
Total	35 (100%)	6 – 10	7
		11 – 15	3
		More than 15	2
		Total	32

Descriptive Data for Survey Questions

For each of the 57 survey items, the frequency count, percentage, mean, and standard deviation was computed. This information is provided in Table 3. Responses for each of the survey items were based on a five point Likert type scale. Responses ranged from Strongly Agree to Strongly Disagree. For the positive statements Strongly Agree was coded with a value of one and Strongly Disagree was coded with a value of five. For the negative statements, the coded values were flipped; Strongly Agree was coded with a value of five and Strongly Disagree was coded with a value of one. For each positive and negative statement, the Neutral response was coded with a value of three.

Table 3: Frequency Count, Mean, and Standard Deviation of Survey Items

Survey Item #	Total Responses	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
1	35	19(54.3)	6(17.1)	5(14.3)	0(0.0)	5(14.3)	2.03	1.42
Subscale 1 – Confidence in Learning Computer Science and Programming								
Survey Item #	**Total Responses**	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Mean**	**SD**
2	35	15 (42.5)	14 (40.0)	3 (8.6)	1 (2.9)	2 (5.7)	1.89	1.078
3	35	12 (34.4)	15 (42.9)	5 (14.3)	1 (2.9)	2 (5.7)	2.03	1.071
4	35	19 (54.3)	12 (34.3)	3 (8.6)	0 (0.0)	0 (0.0)	1.49	.702
5	35	13(7.1)	15 (42.9)	4 (11.4)	3 (8.6)	0 (0.0)	1.91	.919
6	35	23 (65.7)	12 (34.3)	0 (0.0)	0 (0.0)	0 (0.0)	1.34	.482
7	35	10 (28.6)	16 (45.7)	5 (14.3)	4 (11.4)	0 (0.0)	2.09	.951
8	35	0 (0.0)	34 (11.4)	8 (22.9)	11 (31.4)	12 (34.3)	3.89	1.022
9	35	1 (2.9)	3 (8.6)	4 (11.4)	12 (34.3)	15 (42.9)	4.06	.1.083
10	35	0 (0.0)	1 (2.9)	9 (25.7)	8 (22.9)	17 (48.6)	4.17	.923
11	35	2 (5.7)	4 (11.4)	4 (11.4)	13 (37.1)	12 (34.3)	3.83	1.200
12	35	1 (2.9)	4 (11.4)	11 (31.4)	6 (17.1)	13 (37.1)	3.74	1.172
13	35	0 (0.0)	2 (5.7)	3 (8.6)	5 (14.3)	25 (71.4)	4.51	.887
14	35	22 (62.9)	8 (22.9)	5 (14.3)	0 (0.0)	0 (0.0)	1.51	.742
Subscale 2 – Attitude Toward Success in Computer Science								
Survey Item #	**Total Responses**	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Mean**	**SD**
15	35	27 (77.1)	6 (17.1)	2 (5.7)	0 (0.0)	0 (0.0)	1.29	.572
16	35	29 (82.9)	5 (14.3)	1 (2.9)	0 (0.0)	0 (0.0)	1.20	.473
17	35	16 (45.7)	6 (17.1)	13 (37.1)	0 (0.0)	0 (0.0)	1.91	.919
18	35	17 (48.6)	6 (17.1)	12 (34.3)	0 (0.0)	0 (0.0)	1.86	.912
19	35	28 (80.0)	5 (14.3)	2 (5.7)	0 (0.0)	0 (0.0)	1.26	.561
20	35	1 (2.9)	3 (8.6)	14 (40.0)	6 (17.1)	11 (31.4)	3.66	1.110
21	35	1 (2.9)	2 (5.7)	2 (5.7)	7 (20.0)	23 (65.7)	4.40	1.035
22	35	1 (2.9)	0 (0.0)	2 (5.7)	4 (11.4)	28 (80.0)	4.63	.973
23	35	0 (0.0)	2 (5.7)	4 (11.4)	8 (22.9)	21 (60.0)	4.37	.910
24	35	0 (0.0)	0 (0.0)	1 (2.9)	7 (20.0)	27 (77.1)	4.74	.505
25	35	0 (0.0)	1 (2.9)	3 (8.6)	7 (20.0)	24 (68.6)	4.54	.780

Table 3: Frequency Count, Mean, and Standard Deviation of Survey Items (continued)

Subscale 3 – Computer Science as a Male Domain								
Survey Item #	Total Responses	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
26	35	26 (74.3)	3 (14.3)	3 (8.6)	1 (2.9)	0 (0.0)	1.40	.775
27	35	33 (94.3)	2 (5.7)	0 (0.0)	0 (0.0)	0 (0.0)	1.06	.236
28	35	31 (88.6)	4 (11.4)	0 (0.0)	0 (0.0)	0 (0.0)	1.11	.323
29	35	31 (88.6)	3 (8.6)	0 (0.0)	0 (0.0)	1 (2.9)	1.20	.719
30	35	0 (0.0)	0 (0.0)	0 (0.0)	6 (17.1)	29 (82.9)	4.83	.382
31	35	1 (2.9)	12 (34.3)	3 (8.6)	7 (20.)	12 (34.3)	3.49	1.358
32	35	0 (0.0)	0 (0.0)	6 (17.1)	7 (20.0)	22 (62.9)	4.46	.780
33	34	1 (2.9)	2 (5.7)	7 (20.0)	3 (8.6)	21 (60.0)	4.09	1.337
Subscale 4 – Usefulness of Computer Science and Programming								
Survey Item #	**Total Responses**	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Mean**	**SD**
34	35	17 (48.6)	13 (37.1)	3 (8.6)	1 (2.9)	1 (2.9)	1.74	.950
35	35	17 (48.6)	13 (37.1)	3 (8.6)	2 (5.7)	0 (0.0)	1.71	.860
36	35	24 (68.6)	9 (2.7)	1 (2.9)	0 (0.0)	1 (2.9)	1.43	.815
37	35	25 (71.4)	7 (20.0)	3 (8.6)	0 (0.0)	0 (0.0)	1.37	.646
38	35	14 (40.0)	9 (5.7)	7 (20.0)	4 (11.4)	1 (2.9)	2.11	1.157
39	35	15 (42.9)	14 (40.0)	5 (14.3)	1 (2.9)	0 (0.0)	1.77	.808
40	35	0 (0.0)	1 (2.9)	1 (2.9)	15 (42.9)	18 (51.4)	4.43	.698
41	35	1 (2.9)	0 (0.0)	3 (8.6)	13 (37.1)	18 (51.4)	4.34	.698
42	35	0 (0.0)	4 (11.4)	4 (11.40	12 (34.30	15 (42.9)	4.09	1.011
43	34	0 (0.0)	0 (0.0)	0 (0.0)	5 (14.3)	29 (82.9)	4.71	.893
44	35	1 (2.9)	0 (0.0)	1 (2.9)	8 (22.9)	25 (71.4)	4.60	.812
45	35	1 (2.9)	1 (2.9)	3 (8.6)	13 (37.1)	17 (48.6)	4.26	.950
Subscale 5 – Effective Motivation in Computer Science and Programming								
Survey Item #	**Total Responses**	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Mean**	**SD**
46	35	12 (34.3)	11 (31.4)	5 (143)	4 (11.4)	3 (8.6)	2.29	1.296
47	34	13 (37.1)	13 (37.1)	4 (11.4)	2 (5.7)	2 (5.7)	1.97	.954
48	35	14 (40.0)	14 (40.0)	5 (14.3)	2 (5.7)	0 (0.0)	1.86	.879
49	35	14 (40.0)	10 (28.6)	9 (25.7)	2 (5.7)	0 (0.0)	1.97	.954
50	35	14 (40.0)	8 (22.9)	8 (22.9)	3 (8.6)	2 (5.7)	2.17	1.224
51	35	13 (37.1)	15 (42.9)	5 (14.3)	1 (2.9)	1 (2.9)	1.91	.951
52	35	1 (2.9)	3 (8.6)	6 (17.1)	14 (40.0)	11 (31.4)	3.89	1.051
53	35	1 (2.9)	4 (11.4)	6 (17.1)	12 (34.3)	12 (34.3)	3.86	1.115
54	35	2 (5.7)	3 (8.6)	10 (28.6)	9 (25.7)	11 (31.4)	3.69	1.183
55	35	1 (2.9)	4 (11.4)	6 (17.1)	11 (31.4)	13 (37.1)	3.89	1.132
56	35	0 (0.0)	3 (8.6)	9 (25.7)	11 (31.4)	12 (34.3)	3.91	.981
57	35	1 (2.9)	2 (5.7)	1 (2.9)	12 (34.3)	19 (54.3)	4.31	.993

Independent T-Test Findings

Independent T-tests were performed on each of the five survey subscales to address each of the five research hypotheses. The five subscales of the CSAS, are:

- Confidence in Learning Computer Science and Programming
- Attitude Toward Success in Computer Science
- Computer Science as a Male Domain
- Usefulness of Computer Science and Programming
- Effective Motivation in Computer Science and Programming

Results of the t-tests performed on each research hypothesis are outlined below.

Hypothesis One

- Face-to-face students will report less confidence in learning computer science and programming than the online students.

There was no significant difference in confidence scores for FTF students (M = 25.13, SD = 10.127) and online students, (M = 23.30, SD = 8.176); t(33) = -.593, p = .557. The magnitude of the differences in the means (mean difference = -1.833, 95% CI: -8.126 to 4.459) was very small (eta squared = 0.01). Therefore, hypothesis one is not supported.

Hypothesis Two

- Face-to-face students will report a less positive attitude toward success in computer science than the online students.

There was no significant difference in attitude scores with respect to success for FTF students (M = 16.73, SD = 5.189) and online students, (M = 17.20, SD = 4.372); t(33) = .288, p = .775. The magnitude of the differences in the means (mean difference = .467, 95% CI: -2.824 to 3.758) was very small (eta squared = 0.0025). Therefore, hypothesis two is not supported.

Hypothesis Three

- Face-to-face students will describe computer science as a male domain more frequently than online students.

There was no significant difference in computer science as a male domain scores for FTF students (M = 12.33, SD = 3.352) and online students, (M = 11.05, SD = 2.781); t (33) = -1.237, p = .225. The magnitude of the differences in the means (mean difference = -1.283, 95% CI: -3.393 to .827) was very small (eta squared = 0.04). Therefore, hypothesis three is not supported.

Hypothesis Four

- Face-to-face students will have a less positive attitude toward the usefulness of computer science and programming than the online students.

There was no significant difference in usefulness scores for FTF students (M = 17.06, SD = 4.837) and online students, (M = 18.05, SD = 8.023); t (31.77) = .206, p = .838. The magnitude of the differences in the means (mean difference = .450, 95% CI: -4.004 to 4.904) was very small (eta squared = 0.001). Therefore, hypothesis four is not supported.

Hypothesis Five

- Face-to-face students will indicate less motivation in computer science and programming than online students.

There was no significant difference in motivation scores for FTF students (M = 21.53, SD = 8.709) and online students, (M = 26.95, SD = 10.018); t(33) = 1.62, p = .104. The magnitude of the differences in the means (mean difference = 5.417, 95% CI: -1.174 to 12.008) was very small (eta squared = 0.074). Therefore, hypothesis five is not supported.

The results of the five t-tests conducted suggest no differences exist between online and FTF females for the five survey subscales. Due to the low survey response rate for this study, a non-parametric test was also conducted. To accurately test each of the five hypotheses, a Mann-Whitney U test was also performed on each of the five survey subscales. The results of these tests follow.

Mann-Whitney U Findings

Mann-Whitney U tests were also conducted for each of the five subscales to determine if differences exist between two groups; FTF and online. The results of these non-parametric tests are described below.

Hypothesis One

- Face-to-face students will report less confidence in learning computer science and programming than the online students.

A Mann-Whitney U test revealed that no significant difference in the confidence levels of FTF students (Md = 18.80, n = 15) and online students (Md = 17.40, n = 20), U = 138.00, z = -.401, p = .688, r = -0.07). Therefore, the results do not support hypothesis one.

Hypothesis Two

- Face-to-face students will report a less positive attitude toward success in computer science than the online students.

A Mann-Whitney U test revealed that no significant difference in the attitude levels toward success in computer science between FTF students (Md = 17.00, n = 15) and online students (Md = 18.75, n = 20), U = 135.00, z = -.502, p = .615, r = -0.08). Therefore, the results do not support hypothesis two.

Hypothesis Three

- Face-to-face students will describe computer science as a male domain more frequently than online students.

A Mann-Whitney U test revealed that no significant difference in the perception of computer science as a male domain between FTF students (Md = 20.43, n = 15) and online students (Md = 16.18, n = 20), U = 113.50, z = -1.228, p = .220, r = -0.21). Therefore, the results do not support hypothesis three.

Hypothesis Four

- Face-to-face students will have a less positive attitude toward the usefulness of computer science and programming than the online students.

A Mann-Whitney U test revealed that no significant difference in the attitude levels toward the usefulness of computer science and programming between FTF students (Md = 17.63, n = 15) and online students (Md = 18.27, n = 20), U = 144.50, z = -.184, p = .854, r = -0.03). Therefore, the results do not support hypothesis four.

Hypothesis Five

- Face-to-face students will indicate less motivation in computer science and programming than online students.

A Mann-Whitney U test revealed that no significant difference in the motivation levels between FTF students (Md = 14.90, n = 15) and online students (Md = 20.33, n = 20), U = 103.50, z = -1.553, p = .120, r = -0.26). Therefore, the results do not support hypothesis five.

Results for the non-parametric Mann-Whitney U tests found no difference between the two groups; FTF and online, for the five research hypotheses. Therefore, none of the five research hypotheses are supported with the data collected for this study. To understand the results of the survey data, follow-up interviews also were conducted. Results of the qualitative analysis are described next.

Qualitative Findings

Qualitative data collected through participant interviews and the write-in portion of the online survey were coded using general domain categories (Bogdan & Biklen, 1992). Seven general domain categories were selected: activities, events, definition of the situation, process, relationships and social structure, strategies, and ways of thinking about people and objects. The process was applied to the 11 verbatim transcripts and 17 survey comments. Overall, 160 statements were extracted for analysis. These statements reflect the comments of seven participants enrolled in traditional FTF programs and three enrolled in online programs.

After the statements were categorized, two separate coding techniques were employed; one to address the research question and another to gain a greater understanding of the qualitative findings. In each case, the statements were sub-coded and a traditional content analysis process was applied. Therefore, the qualitative findings of this study are organized into two sections, the essence of female perceptions toward computer science and theme-based findings.

The Essence of Female Perceptions Toward Computer Science

As mentioned, to expand on the findings of the independent t-tests and Mann-Whitney U tests, sub-coding was employed in an attempt to identify any comments associated the with five survey subscales: Attitude Toward Success in Computer Science*,* Attitude Toward Usefulness of Computer Science, Confidence in Learning Computer Science*,* Computer Science as a Male Domain*,* and Motivation to Learn Computer Science. After sub-coding, the number of comments relating to each sub-scale was tallied and is represented in Table 4. A summary of these comments follows.

Table 4: Qualitative Themes and Frequency Counts			
Subscale	**Number of Comments**		
	Positive	Neutral	Negative
Confidence in Learning Computer Science	5	1	2
Attitude Toward Success in Computer Science	3	0	0
Attitude Toward Usefulness of Computer Science	11	0	0
Computer Science as a Male Domain	5	12	8
Motivation to Learn Computer Science	19	0	0
Total	43	13	9

Confidence in Learning Computer Science

Confidence often was not discussed in any of the interviews. Only a few respondents actually mentioned the word confidence. Those that made positive comments did so saying that they felt more confident after taking a number of computer science/technology classes. The negative statements were associated with the respondent's lack of confidence in mathematics. Two females indicated that prior to enrolling in their current degree program that it was their lack of confidence in their mathematical ability that made them unsure of their degree decision. One female stated, "I definitely thought it was a lot of math, while there is some math involved it's not as highly mathematical as I thought. It's a lot more problem solving". But each of these females hinted that they eventually overcame this lack of confidence.

Attitude Toward Success in Computer Science

Very few interview participants mentioned success during conversation. Those that did indicated that they had learned tasks and concepts that allowed them to either advance in their current job or create a website or something similar that functioned properly. One respondent claimed that she was promoted to the position of database administrator due to her current degree program. She commented, "Actually, I just got the position of a database administrator and that is what I wanted and now that I have been into it for a while [I realize], there's a lot to learn, but I love it". Another indicated that she was able to successfully code an interactive website similar to one she previously had seen on the internet. Other than the three positive comments, success toward the field of computer science was not mentioned.

Computer Science as a Male Domain

One hundred percent (N = 11) of the interview participants in some way made reference to male domination in the field of computer science. Most comments were neutral, and based on the females' own classroom observations or their perceptions of the field. Participants commented that there were few females in their classes. Some indicated that they wished there were more females but did not a give reason why. Many of the positive comments centered around the concept of male influence in their decision to enter the field. Three of the negative comments came from two females who had worked closely to the field or had attended another institution prior to enrolling in their current program with one stating, "I think it is easier for guys in this field. I think it's getting better [for women] but I think we're not as recognized as being able to manage [things]. I think [we're] still viewed as [inferior]". Each of these females could be categorized as non-traditional aged students. A third female commented:

> I am the only girl in my major at my college. That makes me the only girl in basically all of my classes. It is somewhat uncomfortable to be the only female because all the male students think I shouldn't be in the classes. Either that or I am a target of unwanted attention because of my gender. I have some very good male friends in the same major/classes which makes dealing with these advances easier.

Attitude Toward Usefulness of Computer Science

With respect to the usefulness of computer science, all comments were positive. Many of the respondents indicated that they could relate what they were learning to their current or past work experiences. Comments also revealed that the respondents realized the connection between computer science and the internet, specifically the creation of web pages.

One respondent who is in the process of completing her degree remarked. “Well, I have an associate’s degree in business administration, so I took Information Management because of my business background. I wanted to select something that I could apply to what I already knew”.

Motivation to Learn Computer Science

Many of the respondents indicated that their main motivation to learn computer science was economic. Most said they felt like it was a good field to enter, with many job opportunities. Some suggested that salary was a main motivator and were confident of securing a well-paying position in the future. One female commented, “Well, I had done programming before, my [opinion] is that it is a good paying field and I enjoy programming and I wanted to get back into it”. One respondent who recently had been to a few computer science workshops and conferences stated she was motivated after listening to and interacting with females working in the field.

As described, there were no obvious differences found in the interview data that would contradict the qualitative findings. Overall, the FTF and online respondents were positive in the comments that directly related to the five survey subscales. Differences in attitude between traditional FTF students and the online students were non-existent. The only noticeable differences were the comments made by non-traditional aged students with respect to male domination of the field. One of these females was an online student and one a FTF student.

Theme Based Findings

Grown to Like Computer Science

Overwhelmingly, respondents were in agreement with the theme of *growing to like computer science* after experiencing time within the major. Many of these same females indicated that prior to enrolling in their degree program they knew very little about the field. Many attributed computer science as the act of programming a computer. One student revealed, "I thought it was more um, fixing things not so much writing programs. Learning C++ and the coding". Following, are comments given by respondents after being asked what their perception of the field was like prior to entering their degree program. One commented, "To be honest with you I had never actually heard of it before. I only thought computer science was more programming". Another student indicated that she was unsure of the true nature of computer science. "My perceptions were that it was a very technical field. I wasn't completely [aware of] how computer science and technology folded together". Others also commented on how their perceptions had changed over time.

> Well, I didn't really have much of a perception I guess kind of stereotypical of kind of guys in front of a computer. I really didn't know too much about it prior to enrolling other than I knew I had an interest in it.
>
> I thought it was highly involved with math. And I did not see myself as a computer science degree major because I hated math. But then I took my first class and I found it more like puzzle solving in a way.
>
> I guess I always thought that computer science was kind of boring. Because I like math and that was my original field. It was just one of those things where I was interested because of the financial gain.

When asked if their perceptions of the field had changed since enrolling in college, many agreed that the more they learned, the more they enjoyed it. One respondent commented, "I actually, I like it more. The more that I learn and the further into the program that I've gotten, I don't know, it's more fun now". Others had similar comments. "It seems more realistic. After I got into the program and started doing [the types of things] that I would be doing after I graduate it seemed more realistic and actually a lot more fun". Another stated,

> [I like it more now] because I understand it a little bit better. There are certain things I don't take for granted, there are certain things I understand better. I feel more comfortable. I definitely like it a lot more since I've gone through the program than when I first started out.

One student summarized her change in perception in the following way.

> I have gotten more into the program. I'm starting to go to more networking events and conferences and I've seen other women computer related positions. There's a lot more to computers than I think most people realize and just to be able to see how computers relate to every aspect of business and life [in interesting].

For females having some prior knowledge of the field through coursework or work-related activities, they indicated that their perception of the field had not changed and they were satisfied with their decision to remain in the field. Whereas those with little experience or knowledge indicated that growing to like computer science was a direct result of exposure to the field through classroom experiences.

It appears that many of these females would have benefited from exposure to the field prior to enrolling in their current degree program. The comments made by this group of females is consistent with the findings of Liu and Blanc (1996), who indicated that females were more comfortable with computer applications than with computer terminology and computer programming. These findings indicate the importance of girls experiencing the field in a variety of ways, not just as computer users.

Prior Computing Experience

Exposure to computing prior to entering college was suggested repeatedly by respondents and is consistent with other research (Fisher, Margolis & Miller, 1997; Greening, 1999; Morahan-Martin, Olinsky & Schumacher, 1992; Scragg & Smith, 1998). Some respondents indicated a lack of exposure while others indicated experiencing limited exposure during high school or at a place of employment. One respondent describes being introduced to computing in high school courses focused on computer applications. "I think my senior year of high school I took, a couple of computer courses, not anything technical. Just [using] Word and Excel and how those work". In addition, another stated, "[In] high school I had a couple of applications classes. [Classes focused] on keyboarding and [things like that]. Not programming classes but hands-on. I had a web design class in high school and I really was interested in that". These comments are consistent with the findings of Rodger and Walker (1996).

One female describes how she taught herself how to program at the age of thirteen. She is the only one who reveals a deep interest at an early age.

> I've been working with developing websites and web programs for about the last seven years or about since I've been thirteen. So I started out teaching myself basic HTML and so as soon as I learned something I wanted to learn how to do more with it. So then I went into CSS and I got into XML, also a little PHP and JavaScript work because I saw a website and I liked how something worked and so I would research it and basically how to replicate it for myself.

The following quotations were made by students will little to no prior computer experience. One student revealed that her father introduced her to computing. "I actually didn't have much experience, I took HTML classes but I really didn't consider [it] as programming. I learned computer [skills] from my dad". Another describes how her experience was limited to learning word processing in high school. "I really didn't have any [experience] prior to college. It was mainly just [learning about] Microsoft Suite". And one student stated that her previous job afforded her some experience. "Well, I worked as a biller for about ten years, so I've had a lot of experience with just basic computer [operation]".

Two of three non-traditional aged respondents indicated that prior to college their experience with computers occurred while enlisted in the U.S. Navy. Each of them described how working with computers was part of their assigned duties.

> I was in the military in the mid to late 90s and they had just [installed] computers into everybody's office and one of my colleagues and I were the only ones that were really familiar with any kind of computers at all. It became our job to set up the network and then from that point on I have been working with my own computer [and helping friends and family with theirs].

> Prior to college, I was in the Navy. We were given a computer and a manual [and were expected to learn how to use it]. I learned it all myself and then people in other departments would come to me for help and I thought it was pretty cool.

The third respondent reports that her job situation was motivation to learn computer programming.

> I actually started off an as auditor and I asked them if they would train me [to work with computers] and that's what they did. So basically I took some Visual Basic classes and some of it was self-taught. So, I have been programming for about 10 years before this [degree] program.

Prior computer experience was reported by some of the respondents. Those that did report prior experience did not always feel comfortable entering the field. Many hinted that the courses they had taken in high school were not in-depth enough to get a real understanding of computer science. Many of these females had taken courses focusing on computer usage and not on traditional computing concepts.

The importance of prior experience has been reported (Bunderson, Christensen, & Elizabeth, 1995; Sackrowitz & Parelius, 1996; Scragg & Smith, 1998). Although many of the females in this study did not experience "computer science like" courses early on, each was able to experience an adequate amount of knowledge early in their degree programs, allowing them to make the decision to remain in their current program.

Faculty Accessibility

Every respondent reported positively on the accessibility of faculty. When discussing the classroom environment, many stated that faculty members were available to students outside of the classroom. They remarked that instructors offered phone numbers, email addresses, and some indicated open-door policies when meeting with students. The most common method of contacting faculty was by email. Students indicated that they had no hesitations when contacting their instructors in this manner. One student remarked. "For the most part I usually email. Unless they prefer to talk on the phone, like if they're not getting the point across. It doesn't happen very often, rarely, does that happen so it is mostly email". Another stated, "Well, generally I ask them in class. But if it's out of class then I email them". One student indicated:

> I'd say probably a good 90% of the way we communicate is by email. Because they are computer professors and we are a technology school. Every student and faculty is issued a school computer, a laptop that we are required to keep with us at all times. And so the computer faculty more so as the other faculty on campus are always on their computer. Which means if you send an email you usually get a response within 5 minutes. I think the most I've waited is probably 12 to 15 hours for a response which is really good as far as getting feedback on questions. Otherwise, they all encourage you to stop by their office on campus at any time they all have open door policies where you can stop in and set up an appointment. They're very, very reachable and very willing to help with any questions or problems that you have regarding either class work or even for your own projects. They strongly encourage you to work on things [outside] of the classroom.

One student also had positive comments with respect to faculty contact in her online classes. "I've had three online instructors. Generally speaking, I found the professors to be very available. I had one instructor, [who] always got back to me even on weekends which I thought was pretty amazing. I thought it was great".

Overall, respondents were very satisfied with the communication patterns they had established with faculty, which for the most part was through email correspondence.

Respondents also indicated they would not hesitate to contact a faculty member by telephone or visit them during office hours.

Open communication with faculty appears to be an important aspect to these females. Access to faculty via email, telephone, or office visit allowed many to feel a sense of belonging.

Encouragement

Encouragement from others, specifically male family members and friends was a common theme among participants. This could be viewed as an extension of male domination, not from within the field but from outside the field. Many females indicated being encouraged by their fathers whether or not the parent worked in the field. When asked if they had any influences from friends or family members, one female whose father worked at her university stated: "[My dad] did a lot with computers on the business side. He talked to me about what I was going to get into and he put me in contact with the computer science department to talk with them". Another respondent commented, "My dad was an electrical engineer and he worked a lot with electronics and then I started developing an interest in technology from him".

In addition, encouragement at times also stemmed from a brother. Two respondents described how their father and brother offered encouragement and influence. "My brother is a computer programmer and my dad is highly into computers. So they both encouraged me". Another stated, "[My brother] was a computer science student at Penn State University, so I was exposed to [computer science] early on". This female continued to explain,

> [My brother] did really well in computer science. He did really well in school and immediately after graduating he actually got a very nice job so that was definitely a plus in my mind. My father also, he is a senior reactor operator in a nuclear power plant so he is involved with a lot of [technology] and I guess he did introduce [computer science] to me early on. Like we [my brother and I] saw also his work and we were kind of interested growing up.

Two respondents indicated that a male friend offered encouragement. One female comments on how a friend of her father offered encouragement.

> A friend of my dad's was the IT help at the local high school and he was a good friend of mine too. So, I helped him fix some computers and really enjoyed that so he suggested that I look into [the computer field].

Another discussed how her friend's husband suggested that she should, "… learn more about networking. Doing the Cisco certification".

Of the 11 interviews, only one respondent indicated that a female offered encouragement. She stated, "My mom really influenced me. She saw the technology increase and knew it would be a good way to have a career".

Obviously, encouragement from others does play a major part in a female's decision to enter or remain in the field. Encouragement from males appears common. Encouragement from fathers and brothers allowed these females an opportunity to openly discuss career opportunities in the field. These discussions may not have taken place had it not been for these family members.

Small Class Size

During the interview process, all respondents were prompted to comment on the classroom environment of their computer science/technology courses. This included traditional FTF courses and online courses. The topic of small class size being an advantage was reported by a number of females that had taken traditional FTF computer science/technology courses. A number of females indicated that they felt very comfortable in the classroom setting and that the small size allowed for more interaction with the instructor. With respect to classroom size and interaction, one respondent stated:

> I had great experiences. I love the classroom sizes. The teacher is able to give more one-on-one help with the smaller classrooms. Whereas I have friends that are like psych majors and all of their classes are almost 25 students.

Others made note of how the small class size promoted interaction between students and between students and the instructor. "I think it's a very nice environment. The class sometimes isn't too full or too empty. There are a lot of interactions between the student and professor". Many suggested that the small class size encouraged student-teacher interaction.

> It's mostly I guess lecture based but there's plenty of opportunity for questions. I have noticed that a lot of people in the class help each other before and after class. It seems pretty casual to me. It's a really nice learning environment.

A common response among respondents was that the small class size allowed them to get ot know their professors. "It's comfortable environment, more informal. We got to know our professors pretty well. [We did a lot of] group work, so we actually got to know our fellow really well".

It is interesting to note that on the topic of classroom environment, no comments were made with respect to the "chilly classroom" suggested by Gibb (1961). Many of the respondents indicated that small class size was important in establishing their comfort level in the classroom. Most indicated that the small class size allowed them to ask questions and get to know others in the class. They also indicated that classes that were held in a computer lab setting allowed them to experiment with code and real-world situations.

All the females in this study attended schools that would be considered fairly small. Classes at larger universities may only offer many of the introductory computer science classes in a lecture hall format or in classrooms that exceed 25 students. The small class sizes reported in this study encouraged communication, increased the female's comfort level, and created a welcoming environment needed for effective learning.

Chapter Summary

This chapter presented the quantitative and qualitative findings of this study. These findings do not suggest any difference exist between traditional FTF and online females enrolled in undergraduate computer science/technology programs. These females did report that over time, they learned to like computer science more. They also indicated that prior to enrolling in their current degree program they felt as if they had little knowledge of the field but that changed after learning more about the field through coursework. Respondents were very positive with respect to faculty accessibility and small class sizes. A lack of computer experience prior to college is one area in which many of the respondents said contributed to their lack of knowledge of the field prior to enrolling. Male encouragement from their fathers, brothers, and at times male friends was a common theme among respondents.

The final chapter provides further discussion of the findings including limitation of the study and recommendations for increasing female participation in the field of computer science/technology. Recommendations for future research also are discussed.

CHAPTER 5: CONCLUSION

Introduction

This final chapter will discuss the findings of this study, limitations, and recommendations for practice and future research. The chapter will conclude with a summary.

Discussion

The focus of this study was to determine how a difference in class format may affect the perceptions of undergraduate females enrolled in traditional FTF and online programs. Prior research has shown that classroom environment does play a part in forming a female's negative perception of the field including interaction with the instructor and the communication within the classroom. Outside of the classroom environment, there appears to be an array of events and/or issues that also may play a role in establishing females' attitudes and perceptions.

The investigator was unable to locate any prior research that attempted to study this specific phenomenon. Therefore, the findings of this study are significant, for these results could impact future research focusing on the under-representation of females in undergraduate computer science/technology programs. A discussion of this study's findings follow.

Quantitative Data Explanations

Data collected via the online survey was downloaded and reported using descriptive statistics and analyzed by conducting two separate quantitative tests to determine if significant differences exist in the perceptions of FTF and online students. Independent t-tests and Mann-Whitney U tests were performed on each of the five survey subscales. The results of these two tests are discussed.

Independent T-tests and Mann-Whitney U Discussion

The parametric and non-parametric tests for each of the five subscales suggested no significant difference in the perceptions of females in FTF programs and those in online programs toward the field of computer science. The number of participants for the online survey was small (N = 35). It is not certain if the survey responses of this study's group of females reflect the views of all females in similar programs at other institutions. The 11 students interviewed for this study were able to communicate information to the researcher that assisted in understanding the results of the quantitative results.

Confidence in Learning Computer Science

Lack of self-confidence is one barrier that females have reported as the reason they do not enter the field. There was no difference in the confidence levels of FTF and online students for this study. Only one participant mentioned the word "confidence" during the interview process. This word surfaced as the student was describing how her perceptions of the field had changed since beginning her degree program.

The only other comments that could be associated to self-confidence came from two females who indicated they did not like math. But overall, this group of females appeared confident in their ability to learning computer science concepts. A few did report that some classes were more difficult for them but they gave no indication that this was associated to a lack of self-confidence.

Attitude Toward Success in Computer Science

Every female that participated in the interview portion of this study communicated a positive attitude toward success in the field. During the interviews, each female's tone was that of excitement; looking forward to graduating and joining the workforce. When asked what area of computer science they would like to seek employment, approximately 60% knew exactly what they wanted to do. A few mentioned being involved with the creation and design of web sites. Others mentioned working with databases and some mentioned computer programming.

None of the females indicated that they would have a difficult time finding employment. All seemed quite confident that they would find a nice paying job soon after graduating. In addition, none of these females stated that they would be attending graduate school. These females were also confident that they would successfully complete their current degree program.

Computer Science as a Male Domain

One of the reoccurring themes in the literature review is the fact that the field of computer science is male dominated. While this appears to be true, the literature suggests that it is another reason why females are not attracted to the field. Some of the respondents of this study commented that there were definitely more males in their classes than females. But none of the respondents gave male domination as a reason to stop pursuing their degree. Many of the females hinted that they knew the field was comprised of males but it was not a deterrent. The comments given by one respondent in the write-in portion of the online survey stated, "I've never understood why this field is dominated by males. It's probably because men are supposed to good at math and science, and women at English and history". This statement may suggest that women today understand that the field is male dominated but this fact alone is not reason enough for them to retreat to another discipline.

Attitude Toward the Usefulness of Computer Science

As reported in the literature, women prefer the field of computer science when they feel they can utilize their computing knowledge to help others or relate it to a field outside of computer science. Some of the females in this study claimed that their current degree program was an extension of a previous associate's degree or courses taken outside of their major. Two females who were interviewed stated that they chose their current Information Management program because they could relate their knowledge of business concepts. Two other students indicated that their degree program would allow them to design and or create useful web sites for others.

As an extension of "liking computer science more", many respondents also indicated that they had a much better understanding of the field. They also suggested that they now had the ability to visualize how computers could be used to solve real-world problems in other disciplines.

Motivation to Learn Computer Science

Motivation to learn computer science was evident when interview participants began speaking about future employment. Ease of employment and the guarantee of a well-paying position appeared to be a strong motivator. Some of the females hinted that learning how to perform a specific computer task such as programming, was also a motivating factor.

While none of the females in this study indicated a strong desire to enter the field prior to high school, these females have come a long way. First, making the decision to major in the field while it not being their first choice, to now being close to graduation and realizing the opportunities that await them.

Summary

The quantitative findings of this study differ from information learned during the literature review with respect to female's attitudes and perceptions of the field. Prior research has shown that the computer science classroom has been a breeding ground for negative perceptions toward the field computing, especially for women. The findings of this study do not appear consistent with many of these negative perceptions.

Qualitative Data Explanations

Qualitative data collected through the telephone interviews and the write-in portion of the online survey were categorized, coded, and analyzed further to identify themes or patterns that existed in the data. The investigator identified five themes of importance. This section will discuss the each of these themes.

Grown to Like Computer Science

Many of the respondents indicated that when they first enrolled in their current academic program they were somewhat unsure what the field of computer science entailed. Many hinted that at the time, they did not know what they were getting into. Surprisingly, these females all agreed that after having taken a number of courses and experiencing the culture they had "grown to like it more". Many respondents suggested they felt more comfortable with their degree choice.

Respondents did not indicate if one specific event or activity influenced them to change their view. Many indicated that it was the process of navigating through the required coursework and realizing that they had the ability to do well in their current program of study. At the start of their degree program, many stated that they thought a degree in computer science would only prepare them to be future computer programmers. All have come to realize that the field offers an array of opportunities other than programming. The notion of computer science being only programming is most likely due to the fact that for most undergraduate degree programs, computer programming is one of the first required courses students take. Many change majors before realizing that they can specialize in other areas of the field.

It is not clear whether learning about computer science topics is enough to alter these females' opinion of the field and "like it more". Other factors such as classroom environment, diversity, and communication in and outside of the classroom may play a part in this change in viewpoint. Many females did state that they "like it more". But what about their degree program or the field do they actually like more? Outside of realizing career opportunities and being successful, none of the females in this study communicated why they like it more.

Prior Computer Experience

Forty percent of the respondent's indicated that they wish they would have had more computer experiences prior to enrolling in their current degree program. Some reported that they had attended a high school that did not offer very many courses related to computer science, only courses that focused on computer applications such as word processing. Even though respondents had taken some computer related courses in high school, many stated that they wish they would have taken more or been afforded the opportunity to take more. Some felt that exposure during the high school years would have given them a better understanding of the field and help them prepare for their undergraduate programs.

In addition to prior experience, very few of the respondents indicated having a computer in the household while growing up. Those that did have a computer said they used the computer for homework, mainly word processing and conducting research for papers. None of the females hinted that they were involved in building computers or were heavily into programming. Although, one respondent did say that she was able to teach herself programming after becoming very interested in learning how a few websites were implemented.

Today, many children have access to a computer in their home and many parents often bring their personal laptop computers home, allowing their children to witness how people use computers. So, one must wonder how this generation of children will respond to early exposure to computers and how this exposure may impact their career decisions. This generation of children also has access to a vast array of electronic devices including game machines, iPods, cell phones, and most recently tablet computers such as the iPad.

With the prevalence of social media and the number of computers in classrooms today, females will gain more exposure to computers than any previous generation. It is yet to be seen whether this type of exposure will be enough to encourage them to enter the field. Will they only view this technology as a tool for communication? Or will they look deeper and begin to wonder how these devices work and want to know more? It will take many years before anyone knows how this generation's access to technology will impact their career decisions.

Encouragement

Encouragement is one area that is not represented often in the literature. The interview participants for this study were specifically asked if they had any influence from family or friends to enter the field. Many of the respondents stated that their father or other male figure encouraged them to pursue their degree. Of those that indicated a father offered encouragement, many times the father was involved in the field or in a related field. The same holds true for those who had brothers that encouraged them. Only one respondent reported her mother offered encouragement. With the lack of females in the field it is not surprising that little or no encouragement was reported originating from females.

None of the females interviewed for this study indicated that a K thru12 teacher or college professor offered encouragement, although, one could view encouragement through performance on tests and assignments. But no one specifically stated that an instructor or school counselor encouraged or even suggested the computing field as a potential career path. This may be due to the fact that many teachers at the junior high and high school level are themselves not well informed of what the field has to offer students. It appears as if high schools offer courses that fall at either end of the computing spectrum. Courses focused on improving a student's ability to navigate and use a computer seem to be popular. On the other end of the spectrum are courses such as Advanced Placement (AP) computer programming. There seems to be few if any courses offered that teach students how computers are utilized in other disciplines such as healthcare.

Studies have shown that females in particular prefer computing careers where they can "help others". Exposing junior high and high school girls to these opportunities would allow them to see how a career in the computing industry can be just as rewarding as positions in other fields.

Small Class Size

Class size was reported consistently by respondents. Every female indicated that small class size was a great benefit for them. Some made comparisons to other disciplines, such as psychology were most classes are taught in a lecture hall with many more students.

Small class size appears to create a more comfortable learning environment. Most indicated that the small size allowed them to get to know others in the classroom. They also felt that fewer students in the class encouraged more classroom conversion and discussion. In addition to small class size, many indicated that courses taught in a hands-on lab format were also preferred. These types of courses allow the student to experience real-world working knowledge of concepts such as computer programming and networking.

It is not known whether this type of format is feasible for most undergraduate programs. It is suspected that many larger universities would not be able to accommodate this type of learning environment, except for courses that are taught at an upper level; junior or senior. Many of the larger schools tend to teach many introductory courses in the traditional lecture hall format which does not promote the type of learning environment preferred by this specific group of females.

The females who were online students did not mention class size as a factor. Although, many of them did suggest that the online environment was lacking the personal interaction present in FTF classes. These online students gave hints that they were willing to sacrifice this interaction for the convenience of online classes.

Faculty Accessibility

Along with small class sizes, respondents also remarked about faculty accessibility. Online and FTF students ranked the accessibility of faculty very high. Those in online programs felt their instructors offered timely feedback and were often available, answering emails, even during the weekend hours. Females in the FTF programs indicated that faculty made themselves available and encouraged students to contact them. Most instructors provided email addresses, telephone numbers, and open office hours to students. One of the study sites provided each of their undergraduates with a laptop computer and students were expected to keep in close contact with their faculty members. Students claimed that the laptops gave them the opportunity to interact with faculty via email even if they were outside of their dorm buildings.

None of the respondents reported that they were treated poorly by any faculty member. All stated that they felt they had a good relationship with their instructors and they had no reservations about contacting them with questions or to seek help. Online students, of course experience less one-on-one interaction with their instructors, but they all felt the instructor would respond to their questions in a reasonable amount of time. None of the online students reported difficulty in contacting their online instructors.

What Respondents Did Not Say

Although the survey response rate was low, the investigator augmented the data with a larger than expected number of participant interviews (N = 11). It is significant in this discussion to mention what the respondents of this study did not report with respect to the literature review for this study.

The terms "geeky" or "nerdy" was not mentioned except by one female who indicated that her friends would describe her this way. These two terms surface repeatedly when describing or researching the field. These terms, studied in depth by Anderegg (2007) are first learned by young school-aged children through various forms of media and are viewed as being bad. The literature suggests that many females shy away from the computing field because they do not want to be labeled with these terms.

During the interview process there was only one instance where a participant referred to the word, "stereotype" in her response. The computing industry is wrought with stereotypes. These stereotypes often portray any person associated with the industry as introverted, uninteresting, nerdy, and often a loner. None of the females mentioned any of these labels in their responses. It was common for the females in this study to describe themselves as hard working, focused, and funny. Many also thought that their friends would also describe them in a similar manner.

Another issue that was not reported by respondents was the existence of the "chilly classroom", which has been reported in many studies. The females in this study gave no indication that communication patterns in the classroom were unfair or made them feel inferior to their male counterparts. They also did not suggest that males were called on more often than females and that the instructor tended to call on students who had raised their hand.

One non-traditional aged respondent, who had experienced the chilly classroom first-hand in the 1980s indicated that the environment was anything but welcoming to women. This female reported many of the common complaints of women in studies focusing on computer science classrooms. She did state during the interview process that since taking online classes that she had not noticed many of the same negative behaviors she witnessed in previous years.

In summary, the females interviewed for this study did not report many of the issues that occur in the literature. This may stem from the actual questions that each participant was asked during the interview process even though respondents were afforded the opportunity to include any information they felt was important to the investigator.

Further Explanation of the Findings

The quantitative findings of this study suggest that no significant difference exist in the perceptions of FTF and online females enrolled in undergraduate computer science/technology programs toward the field of computer science. These results contradict the information learned from a review of the literature. Previous studies report on the many barriers women state as their reason not to enter or stay in the field. These barriers include the lack of self-confidence, male domination, classroom environment, and the lack of computing experience prior to college. The investigator believes that the online survey instrument utilized for this study did accurately measure these female's perceptions toward the field.

The research hypotheses for this study stated that females in traditional undergraduate programs would report similar perceptions to those mentioned throughout the literature. In addition, it was anticipated that these perceptions would differ from the perceptions of females in online programs. Any difference between the two groups of participants for this study was not found to be true.

To address the contradiction with respect to the FTF and online students, there are certain factors that may provide an explanation. Traditional-aged undergraduates today have more access to technology than any other female group in history. Access to the Internet, cell phones, touch devices, and personal computers may be providing some form of comfort in terms of using and experimenting with technology. Even though this type of access does not reflect pure computer science concepts, it does allow middle school and high school aged girls to interact with technology on their own.

It was anticipated that online students would not experience the "chilly classroom" environment mentioned in previous studies. Removal from the physical classroom eliminates many of the issues associated with a chilly classroom environment such as feeling a lack of self-confidence, a sense of being inferior with respect to technology, and experiencing defensive communication. It is worth mentioning that the online group did not indicate any hostility in the online discussions for the class. Literature has reported that sometimes discussions that take place in the online format can be unwelcoming to women. This type of communication pattern was not evident in this study.

For the FTF group of females, one would anticipate that they would report incidents consistent with the chilly classroom but it was not the case with this study. Class size and faculty accessibility also appears to eliminate some of the chilly classroom components for the FTF females. Lack of classroom interaction with faculty members and the inability to meet individually with instructors has been reported in the literature. Small class size allowed these students to become more connected socially and academically. Fewer students in the classroom also provides a learning environment that promotes interaction between students and between students and the instructor. All the FTF females in this study commented they preferred the small class sizes and exhibited no hesitation when contacting their instructors for help with course material or general questions.

Had this study solicited participation from institutions that are considered to be traditional engineering schools or have a strong focus on technological research, females may have responded differently to the online survey and the interview prompts. The typical class size of these larger institutions is unknown but it is suspected that they are larger and less comfortable toward women. Many of the introductory courses offered at larger schools may be taught by teaching assistants and not by actual faculty members. This situation would not allow this group of females to form the student-faculty relationship they deem necessary.

In addition, many institutions categorized as engineering or research schools most likely do not offer applied degree programs in computer science but rather degree programs focused on theory alone with very little opportunity to experience any “hands on” activities. All of the sites selected for this study appeared to offer applied programs since many of the females who participated were in programs indicated that they prefer the “hands on” component of their programs. This is not to say that applied programs offer no theory but these types of programs integrate theory with real-world situations.

Of the 11 interview participants, three were online students. As mentioned, the online student group did not indicate any differences with respect to the online survey. In addition, there were also no significant differences in the way the online students responded to many of the interview questions/prompts. The online class environment does eliminate the possibility of encountering the chilly classroom but overall, the online group communicated thoughts similar to the FTF group. The online students that participated in the interview process appeared very satisfied with their online courses. This group also communicated that faculty accessibility played a major role in their online class which is to be expected. None of them appeared to be questioning their academic ability or experiencing a lack of self-confidence.

Overall, it would be correct to suggest that some of the literature reviewed for this study may not be up-to-date. Even though the majority of literature reviewed for this study was conducted in the past decade, the pedagogy in academic programs has changed, reflecting technological advances, especially with student-to-student and student-to-student interaction.

Limitations

The following were limitations for the findings of this study's results:

1. The number of institutions offering undergraduate online computer science/technology programs may be difficult to identify, thus resulting in a small number of institutions that meet the study criteria.
2. This study focused on undergraduate women in computer science programs. The low numbers reported by the literature could result in a low number of females eligible to participate in this study.
3. The age of the females enrolled in the online programs may be older than traditional-aged college students, thus making it more difficult to generalize the findings regarding traditional-aged undergraduate females.
4. Since this study utilized a questionnaire, participants may not respond truthfully to the statements/questions.
5. The number of accredited not-for-profit institutions offering online programs in computer science/technology was very small. Very little information was available on the best way to locate these institutions.

6. The number of females enrolled in computer science/technology programs in FTF programs is low and the numbers are even lower in online programs.
7. Contacting potential participants at the study sites was difficult. Only one institution offered a streamlined process by querying their computer system.
8. The institutions that participated in this study were not considered to be engineering schools, therefore the online and FTF programs that were selected may be less rigorous in there pedagogy than a traditional engineering or technology school.
9. The IRB approval process at two of the study sites took approximately two months. This slowed the momentum of the study.

Recommendations for Practice and Future Research

Recommendations for Practice

The themes that emerged from the qualitative analysis, coupled with the quantitative findings were the basis for the investigator to suggest the following recommendations for future practice.

- Educate faculty and staff on the importance of providing an inclusive environment for females in computer science/technology programs, including communication.
- Provide outreach to junior high and/or high school females and educate them on the many aspects of computer science and the job market. This will provide valuable information to them when making future educational or vocational decisions.
- Create multi-disciplinary undergraduate courses or programs which demonstrate how computer science is utilized in other disciplines such as healthcare.
- Encourage undergraduate females to minor in computer science/technology programs so they can gain exposure to the field.
- Provide students with hands on real world experiences if possible. This could be accomplished by offering programs that combine theory with practice.
- Provide introductory computer course in small class settings to encourage classroom communication.

Recommendations for Research

This study provided significant data on the perceptions of undergraduate females enrolled in traditional FTF and online computer science/technology programs. The data from this study is just the beginning of understanding the role online education plays in a female's choice to enter into the computing field. Expanding this study to include females at larger institutions would be useful since this study focused on small to mid-sized schools. Research by a joint effort of individuals from various institutions offering online and FTF programs would assist with the issue of student access, especially for online students. Finally, continuing to explore if and how online learning environments shape the views of females and other minorities toward the field computer science would be beneficial.

Chapter Summary

The purpose of this phenomenological mixed-methods study was to determine if differences exists in the perceptions of undergraduate females in face-to-face and online programs toward the field of computer science/technology. The data collected for this survey was analyzed and it was found that no apparent difference exists between the participants of this study.

The findings of this study describe the essence of these female's perceptions of the field. Five themes emerged from the interview data and online survey; Grown to Like Computer Science, Prior Computer Experience, Encouragement, Small Class Size, and Faculty Accessibility. Overall, the females in this study reported very positive attitudes toward their current degree program and the computing industry.

Participants in this study did not comment on some reoccurring themes present in the literature. Participants did not discuss terms such as "geeky" or "nerdy" during the interview process. Outside of male domination, they did not make any stereotypical comments toward the field or other students in their degree program. In addition, they did not provide any evidence of a “chilly classroom” environment.

This group of females appeared confident, motivated, and certain that they will find success in a male dominated industry. As one student commented in the online survey, “It is disappointing how society has driven most of the women out the computer programming industry but that’s also what make it so much more appealing”.

APPENDIX A: INTERVIEW QUESTIONS

(15 – 20 minutes in length, telephone)

Collect demographic data: name, institution, degree program, type of program (online or traditional).

Pre-college:

1. Describe your perceptions of the field of computer science prior to enrolling in your undergraduate program.

2. When did you decide to major in computer science/technology?

3. Describe any influences from family, friends, or others to enter the field of computer science/technology.

4. Describe your programming experience or other experience with computers prior to college.

College:

5. Why did you choose your current program?

6. Describe the classroom climate of you current or past computer science/technology courses.

7. Tell me how you interact with your instructor(s)?

8. Have your perceptions of the field have changed since beginning college? If so, how?

9. Is there anything with regard to academics you wished you would have done prior to entering college?

10. Tell me how you would describe yourself. How do you think your friends would describe you?

11. In what area of computing would you like to work and why?

APPENDIX B: INSTITUTION LISTING

The following is a list of institutions that, according the Higher Learning Commission website, offer online and traditional FTF undergraduate programs in computer science or a closely related field.

State	School Info	Notes
ARKANSAS	**Southern Arkansas University Tech** P.O. Box 3499 Camden, AR 717111599 http://www.sautech.edu AAS Computer Information Technology (Internet)	No computer programming involved. N-OFF
ARIZONA	**Arizona State University** PO Box 2203 Tempe, AZ 852872203 http://www.asu.edu Bachelor of Applied Science (Internet)	Y-OFF Online and traditional
	Cochise College 4190 W. Highway 80 Douglas, AZ 85607-6190 http://www.cochise.edu/ Associate of Business - Computer Information Systems (ABUS CIS) (Internet)	Y-OFF Online and traditional
	Maricopa Community Colleges-Rio Salado Community College 2323 W. 14th Street Tempe, AZ 852816950 http://www.rio.maricopa.edu/ AAS in Computer Technology (Internet)	Y-OFF Online only
	Northern Arizona University P.O. Box 4092 Flagstaff, AZ 86011 http://www.nau.edu B.A.S. Computer Technology (Internet)	N-OFF Technology management degree
	University of Advancing Technology (candidate) 2625 W. Baseline Road Tempe, AZ 85283 www.uat.edu Associate of Science in Advancing Computer Science (Internet) Associate of Science in Network Security (Internet) Associate of Science in Technology Forensics	Y-OFF Online and traditional

	(Internet) Bachelor of Science in Advancing Computer Science (Internet) Bachelor of Science in Network Security (Internet) Bachelor of Science in Technology Forensics (Internet)	
COLORADO	**Colorado Technical University** 4435 N. Chestnut St. Colorado Springs, CO 80907 www.coloradotech.edu AS Information Technology (Internet) BS Information Technology (Internet)	N-OFF Business degree with emphasis
	Community College of Aurora **16000 E. CentreTech Parkway** **Aurora, CO 80011-9036** www.ccaurora.edu Associates of Applied Science in Computer Information Systems (Internet)	Y-OFF Traditional only
	Front Range Community College 3645 W. 112th Ave. Westminster, CO 80031 http://www.frontrange.edu AAS Computer Information Systems (Internet)	Y-OFF Online and traditional
	Lamar Community College 2401 S. Main Lamar, CO 81052 www.lamarcc.edu A.A.S. Computer Info. Systems (Internet)	Y-OFF
	Regis University 3333 Regis Blvd. Denver, CO 80221 http://www.regis.edu BS Computer Information Systems (Internet) BS Computer Networking (Internet) BS in Computer Science (Internet)	Y-OFF Online and traditional
ILLINOIS	**College of Lake County** 19351 W. Washington St. Grayslake, IL 60030-1198 www.clcillinois.edu AAS Computer Info Systems (Internet)	Y-OFF
	Ellis University 111 North Canal Street, Suite 380 Chicago, IL 606060000 http://www.ellis.edu/#headA	Y-OFF Online only (online university)

	BS in Computer Science (Internet) BS in Information Technology (Internet)	
	Joliet Junior College 1215 Houbolt Rd. Joliet, IL 604318938 http://www.jjc.edu Computer Programming Online Degree (Internet)	Y-OFF Online and traditional
	Lincoln Land Community College **5250 Shepherd Rd.** **P. O. Box 19256** **Springfield, IL 62794-9256** http://www.llcc.edu Associate of Applied Science (AAS) in Computer Information Systems Networking (Internet) Associate of Applied Science (AAS) in Microcomputer Applications and Systems (Internet) Associate of Applied Science (AAS) in Microcomputer Programming (Internet)	Y-OFF Online and traditional
	National-Louis University **122 S. Michigan Ave.** **Chicago, IL 60603** http://www.nl.edu B.S. in Management Information Systems (BSMIS) (Internet)	N-OFF Nothing found
	Southern Illinois University Carbondale Anthony Hall 116 Carbondale, IL 62901 http://www.siuc.edu B.S. in Information Systems Technologies (Internet)	Y-OFF
	University of Illinois at Springfield One University Plaza Springfield, IL 62703-5407 www.uis.edu B.S. in Computer Science (Internet)	Y-OFF Online and traditional
	William Rainey Harper College 1200 W. Algonquin Rd. Palatine, IL 60067-7398 http://www.harpercollege.edu AAS in Business: Management Information Systems (Internet) ASS in Business: Database Management (Internet)	Y-OFF Online and traditional

INDIANA	**Indiana Wesleyan University** 4201 S. Washington St. Marion, IN 469534974 http://www.indwes.edu/ Associate of Science in Computer Information Systems (Internet) Bachelor of Science - Business Information Systems (Internet)	Y-OFF Online and traditional
	Ivy Tech Community College of Indiana 50 West Fall Creek Pkwy, North Drive Indianapolis, IN 462085752 http://www.ivytech.edu AS/AAS in Computer Information Services (Internet)	Y-OFF Online and traditional
	Vincennes University **1002 N. First St.** **Vincennes, IN 47591-1504** http://www.vinu.edu AAS Computer Programming Technology (Internet) AS Information Technology (Internet)	Y-OFF Online and traditional
IOWA	**Iowa Central Community College** **One Triton Circle** **Fort Dodge, IA 50501** www.iowacentral.com AAS in Computer Networking Technology (Internet)	Y-OFF Online and traditional
	Upper Iowa University P.O. Box 1857 605 Washington St. Fayette, IA 52142 http://www.uiu.edu B.S. in Technology Information Management (Internet)	Y-OFF Online and traditional
	Western Iowa Tech Community College **P.O. Box 5199; 4647 Stone Ave.** **Sioux City, IA 51102-5199** www.witcc.edu AA in Computer Science (Internet)	N-OFF
KANSAS	**Baker University** 618 Eighth Street P.O. Box 65 Baldwin City, KS 660060065 http://www.bakeru.edu Bachelor of Business Information Systems (Internet)	Y-OFF Online and traditional

	Fort Hays State University 600 Park Street Hays, KS 67601 www.fhsu.edu BBA in Management Information Systems (Internet) BS in Information Networking and Telecommunications (Internet)	Y-OFF Online and traditional
	Southwestern College 100 College St. Winfield, KS 671562499 http://www.sckans.edu BS in Computer Programming Technology (Internet)	Y-OFF Online and traditional
MICHIGAN	**Baker College** 1050 W. Bristol Rd. Flint, MI 485075508 http://www.baker.edu Associate of Applied Science, CIS/Prog - JAVA (Internet) Associate of Applied Science, Computer Programming (Internet) Associate of Business, CIS/Programming (Internet) Bachelor of Computer Information Systems, Project Man. & Plan. (Internet) Bachelor of Computer Information Systems (Internet) Bachelor of Computer Science (Internet) Bachelor of Computer Science, Database Technology (Internet)	Y-OFF Online and traditional
	Davenport University 6191 Kraft Avenue S.E. Grand Rapids, MI 49512 http://www.davenport.edu AAS, Computer Info Systems (Internet) AAS, Information & Computer Security (Internet) BAS, CIS Database MGT Speciality (Internet) BAS, CIS Global Technology Spec (Internet) BAS, CIS Programing Speciality (Internet) BAS, Information & Computer Security (Internet)	Y-OFF Online and traditional
	Lansing Community College PO Box 40010	Y-OFF Online and traditional

	Lansing, MI 489017210 http://www.lcc.edu Associate Degree/Computer Database Specialist (Internet) Associate Degree/Computer Programmer/Analyst (Internet)	
	Lawrence Technological University 21000 W. Ten Mile Rd. Southfield, MI 48075-1058 http://www.ltu.edu Bachelor of Science in Information Technology completion programs (Internet)	No programming offered
	Macomb Community College 14500 E. 12 Mile Rd. Warren, MI 480883896 www.macomb.edu AAS - Programming (Internet)	N-OFF
MINNESOTA	**Alexandria Technical College** 1601 Jefferson St. Alexandria, MN 56308 www.alextech.edu AS in Computer Information Systems (Internet)	No programming offered
	Concordia University, St. Paul 275 Syndicate Street North St. Paul, MN 551045494 www.csp.edu BA in Information Technology Management (Internet)	Hybrid program
	Minnesota State College-Southeast Technical 1250 Homer Rd. P.O. Box 409 Winona, MN 55987 www.southeastmn.edu AAS: Computer Programming - Microcomputers (Internet) AAS: Computer Programming - Web Applications (Internet) AAS: Microcomputer Support Specialist (Internet) AAS: Web Design & Development (Internet)	Y-OFF Online and traditional
	Minnesota State Community and Technical College 1414 College Way Fergus Falls, MN 565371000	Y-OFF Online and traditional

	www.minnesota.edu AAS in Computer and Network Technology (Internet) AAS in Computer Help Desk Technician (Internet) AAS in Computer Programming (Internet)	
	North Hennepin Community College 7411 85th Ave. N. Brooklyn Park, MN 55445 http://www.nhcc.edu AAS in Business Computer Systems & Management (Internet) AS in Business Computer Systems & Management (Internet)	Y-OFF Online and traditional
	Rochester Community and Technical College 851 30th Avenue SE Rochester, MN 55904-4999 http://www.roch.edu AS in Web Design and Development (Internet)	Server not found
MISSOURI	**Culver-Stockton College** One College Hill Canton, MO 63435 www.culver.edu B.S. in Management Information Systems (Internet)	Y-Off degree completion online
	Moberly Area Community College 101 College Avenue Moberly, MO 65270-1304 http://www.macc.edu AAS in Computer Information Technology (Internet)	N-OFF Business degree
	Northwest Missouri State University 800 University Dr. Maryville, MO 644686001 http://www.nwmissouri.edu B.S. Computer Science (Internet) B.S. MIS (Internet) B.S. Office Information Systems (Internet) M.S. Applied Computer Science (Internet)	N-OFF
	Park University 8700 N.W. River Park Dr. Parkville, MO 6415 www.park.edu B.S. in Management/Computer Information	Y-OFF Online and traditional

	Systems (Internet)	
	Webster University 470 East Lockwood Ave. St. Louis, MO 63119 www.webster.edu B.S. Computer Science Minor in Web Site Development Minor in Web Site Design	Y-OFF Online and traditional
NEBRASKA	**Bellevue University** **1000 Galvin Road South** **Bellevue, NE 68005-3098** http://www.bellevue.edu BAS in Computer Information Systems in Business (Internet) BS in Business Information Systems (Internet) BS in Computer Information Systems (Internet) BS in Computer Information Systems - Business (Internet) BS in Software Development (Internet) BS in Systems Network Administration (Internet)	Y-OFF Online and traditional
	Metropolitan Community College P.O. Box 3777 Omaha, NE 68103-0777 www.mccneb.edu AAS in Information Technology - Database/Web Programming Option (Internet) AAS in Information Technology - E-Commerce Option (Internet) AAS in Information Technology - Helpdesk Option (Internet) AAS in Information Technology - Networking Option (Internet) AAS in Information Technology - Web Development (Internet)	Y-OFF Online and traditional
	Southeast Community College Area **301 S. 68th Street Place, 5th Floor** **Lincoln, NE 68510-2449** http://www.southeast.edu A.A.S. in Business Information Technology (Internet)	Y-OFF Online and traditional (some courses offered online)
NEW MEXICO	**(none)**	

NORTH DAKOTA	**Mayville State University** 330 Third St. NE Mayville, ND 582571299 http://www.mayvillestate.edu B.A.S. degree - Comp. Info. Systems (Internet)	N-OFF
	Minot State University 500 University Ave. W. Minot, ND 58707 http://www.minotstateu.edu B.S. Management Information Systems (Internet)	Y-OFF Online and traditional (for certain emphasis only)
	North Dakota State College of Science 800 6th Street North Wahpeton, ND 580760002 http://ndscs.edu A.A.S. in Computer Information Systems (Internet) A.A.S. in Computer Information Systems-Web Developer (Internet)	Y-OFF Online and traditional
OHIO	**Chancellor University** 3921 Chester Ave. Cleveland, OH 441144624 www.myers.edu BSBA in Management Information Systems (Internet)	N-OFF
	Franklin University 201 S. Grant Ave. Columbus, OH 43215-5399 www.franklin.edu A.S. in Computer Science (Internet) A.S. in Information Technology (Internet) B.S. in Computer Science (Internet) B.S. in Information Technology (Internet) B.S. in Management Information Sciences (Internet	Y-OFF Online and traditional
	Stark State College of Technology 6200 Frank Avenue NW North Canton, OH 44720 www.starkstate.edu AAB Computer Programming and Database--Database Management Option (Internet) AAB in Computer Programming and Database (Internet) AAB in Web Design and Development (Internet)	Y-OFF Online and traditional

	AAS in Computer Science and Engineering (Internet) AAS in Computer Science and Engineering--Video Game Design and Development Optio (Internet)	
	University of Northwestern Ohio 1441 N. Cable Rd. Lima, OH 458051498 http://www.unoh.edu AAB in Information Technology (Internet)	N-OFF
	University of Toledo 2801 W. Bancroft Toledo, OH 43606-3390 http://www.utoledo.edu Associate Degree in Computer Software Specialist (Internet) Associate Degree in Information Services and Support (Internet) Associate Degree in Programming and Software Development (Internet) BS in Information Technology (Internet)	Y-OFF Online and traditional
OKLAHOMA	**Rogers State University** 1701 W. Will Rogers Blvd. Claremore, OK 74017 http://www.rsu.edu AAS in Applied Technology (Internet) AS in Computer Science (Internet) BA in Liberal Arts (Internet) Bachelor of Technology in Applied Tech (Internet)	Y-OFF Online and traditional
	Rose State College 6420 SE 15th St. Midwest City, OK 73110-2799 www.rose.edu AAS in E-commerce & Webmaster Technology (Internet)	Y-OFF Online and traditional
	Tulsa Community College 6111 E. Skelly Drive Tulsa, OK 741356198 www.tulsa.cc.ok.us A.A.S in Technology (Internet) A.A.S. in CIS (Internet) A.A.S. in CIS Microsoft Office Specialist (Internet) A.A.S. in Electronics Technology (Internet) A.A.S. in Telecommunications (Internet)	Web page not found

SOUTH DAKOTA	**Dakota State University** 820 N. Washington Ave. Madison, SD 57042-1799 http://www.dsu.edu/ AS.HIT (Health Information Technology) (Internet) BBA.MIS (Management Information Systems) (Internet)	Y-OFF Online and traditional
WEST VIRGINIA	**Mountain State University** P. O. Box 9003 Beckley, WV 258029003 http://www.mountainstate.edu AS Computer Science (Internet) BS Computer Science (Internet) BS Information Technology (Internet)	Y-OFF Online and traditional
	New River Community and Technical College 221 George Street, Suite 2 Beckley, WV 25801 www.newriver.edu A.S.- Information Technology (Internet)	No information found
	University of Charleston, The 2300 MacCorkle Ave. SE Charleston, WV 25304 www.ucwv.edu Associate's degree in Informaton Technology (Internet)	No information founds
WISCONSIN	**Concordia University Wisconsin** 12800 N. Lake Shore Dr. Mequon, WI 530972402 www.cuw.edu Bachelor's programs in Computer Science (Internet)	N-OFF
	Lakeland College P.O. Box 359 Sheboygan, WI 53082-0359 http://www.lakeland.edu B.A. in Computer Science (Internet)	No information found
	Milwaukee Area Technical College 700 West State Street Milwaukee, WI 53233-1443 www.matc.edu AAS in eCommerce/Web Administration (Internet) AAS in IT-Programmer/Analyst (Internet)	No complete programs offered online
	Moraine Park Technical College	Y-OFF

	235 N. National Ave. Fond du Lac, WI 549361940 http://www.morainepark.edu A.A.S. in IT-Microprogrammer Specialist (Internet)	Online and traditional
	University of Wisconsin-Stout 1 Clock Tower Plaza Menomonie, WI 54751 www.uwstout.edu BS in Information and Communication Technologies (Internet)	Y-OFF Online and traditional
	Viterbo University 900 Viterbo Drive La Crosse, WI 546018804 www.viterbo.edu BBA in Management Information Systems (Internet)	Y-OFF Online and traditional
	Wisconsin Indianhead Technical College 505 Pine Ridge Drive Shell Lake, WI 548719300 www.witc.edu AAS in Information Technology - Web Analyst/Programmer (Internet)	Y-OFF Online and traditional
WYOMING	**Laramie County Community College** 1400 E. College Dr. Cheyenne, WY 82007-3299 www.lccc.wy.edu AAS in Information Technology (Internet) AAS in Internet Technology Web Designer (Internet) AAS in Programmer/Analyst (Internet)	Y-OFF Online and traditional

APPENDIX C: CODES FOR QUALITATIVE ANALYSIS

General domain Codes

Definition of the situation (SIT):	how people understand, define, or perceive the setting or the topics on which the study bears.
Ways of thinking about people and objects (TNK):	understandings of each other, of outsiders, or objects in their world
Process (PRO):	sequence of events, flow, transitions, and turning points, changes over time
Activities (ACT):	regularly occurring kinds of behavior
Events (EVT):	specific activities, especially ones occurring infrequently
Strategies (STR):	ways of accomplishing things; people tactics, methods, techniques for meeting their needs
Relationships and social structure (REL):	unofficially defined patterns such as cliques, coalitions, romances, friendships, enemies

Subcodes

CON	confidence
SUC	attitude toward success
DOM	male domain
USE	Usefulness

MOT motivation

APPENDIX D: CODES FOR QUANTITATIVE ANALYSIS

Female

1 Yes
0 No

Academic Year

1 Freshman
2 Sophomore
3 Junior
4 Senior

Age Range

1 18-22
2 23-29
3 30-39
4 40-49
5 50+

Institution

1 Institution 1
2 Institution 2
3 Institution 3
4 Institution 4

Major

1 Computer Science
2 Computer & Network Security
3 Computer Information Systems
4 Management Information Systems
5 Game Design
6 Web Design/Development
7 Interactive
8 Digital Media
9 Information Management
10 Other

Type of Degree Program

1 Associates
2 Bachelors

Online or Distance Program

1 Yes
2 No

Minor or Certificate

1 Yes

2 No

If yes, indicate minor

1 Computer Science

2 Web Design/Development

3 Computer Applications

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Vitus Auctoris

Ms. Smith was born and raised in St. Louis, Missouri. She received a BA in Computer Studies from Webster University in 1991. She also received a MS in Computer Science with an emphasis in Distributed Systems in 2000.

She began teaching at the college level as an adjunct professor at Webster University in 1997. She became a full-time faculty member in June 2001. She is currently an Associate Professor in the Department of Mathematics and Computer Science at Webster. Prior to her teaching career, Ms. Smith worked as a technical illustrator at the McDonnell Douglas Corporation in St. Louis. She also worked as an illustrator at Hunter Engineering Company in St. Louis before returning to college to complete her undergraduate degree in computing.

Ms. Smith's main area of teaching is in computer programming, database systems, and web design. She is currently the faculty director of the undergraduate Web Design Certificate program and is a member of the Faculty Senate.

Her research interests include the under-representation of women in computing and issues in human-computer interaction.