

BEYOND THE FIRST “CLICK:”  
WOMEN GRADUATE STUDENTS IN COMPUTER SCIENCE

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## ABSTRACT

Ellen Broido, Advisor

This dissertation explored the ways that constructions of gender shaped the choices and expectations of women doctoral students in computer science. Women who do graduate work in computer science still operate in an environment where they are in the minority. How much of women's underrepresentation in computer science fields results from a problem of imagining women as computer scientists? As long as women in these fields are seen as exceptions, they are exceptions that prove the "rule" that computing is a man's domain.

The following questions were the focus of this inquiry: What are the career aspirations of women doctoral students in computer science? How do they feel about their chances to succeed in their chosen career and field? How do women doctoral students in computer science construct womanhood? What are their constructions of what it means to be a computer scientist? In what ways, if any, do they believe their gender has affected their experience in their graduate programs? The goal was to examine how constructions of computer science and of gender – including participants' own understanding of what it meant to be a woman, as well as the messages they received from their environment – contributed to their success as graduate students in a field where women are still greatly outnumbered by men.

Ten women from four different institutions of higher education were recruited to participate in this study. These women varied in demographic characteristics like age, race, and ethnicity. Still, there were many common threads in their experiences. For example, their construction of womanhood did not limit their career prospects to traditionally female jobs. They had grown up with the expectation that they would be able to succeed in whatever field they

chose. Most also had very positive constructions of programming as something that was “fun,” rewarding, and intellectually stimulating. Their biggest obstacles were feelings of isolation and a resulting loss of confidence.

Implications for future research are provided. There are also several implications for practice, especially the recommendation that graduate schools provide more support for all of their students. The experiences of these women also suggest ways to more effectively recruit women students to computer science. The importance of women faculty in these students’ success also suggests that schools trying to counteract gender imbalances should actively recruit women faculty to teach in fields where women are underrepresented. These faculty serve as important role models and mentors to women students in their field.

For my family.

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## CHAPTER I: INTRODUCTION

## A Legacy of Inequity

When Lawrence Summers (2005) told a group gathered at Harvard that women’s scarcity in the ranks of professors in the sciences may be due to a lack of interest or of aptitude, he was repeating a commonly-held belief that the American system of higher education is a true meritocracy, in which people who have the most ability and drive naturally rise to the top. This reflects our overall American mythology that the good are rewarded and those who do not succeed fail through their own incompetence or laziness. In the United States, Title IX has made it illegal for schools at any level to keep women and girls from participating in education as fully as men and boys. But gender-blind policies do not guarantee equal opportunity for men and women.

In the U.S., women are scarcer than men in the upper levels of the academic hierarchy, in higher-status schools, and in higher-status fields like science, mathematics, and technology. Rosser (2002) wrote that though “the number of women majoring in scientific and technical fields has increased since the 1960s, reaching 49 percent in 1988 . . . the percentage of women in computing, the physical sciences, and engineering remains small” (p. 147). The American Association of University Women (AAUW, 2003) reported that “only 28 percent of women (compared to 41 percent of men) are studying in a field that will prepare them for work in science, engineering, or information technology” (p. 2). The science gap is an issue of real importance, especially as more and more jobs require advanced technology literacy. According to the AAUW (2000), “The majority of low-paying word processing and data processing jobs in the service, clerical, and retail industries are held by women....But women are dramatically underrepresented in the information technology (IT) jobs” (p. 19). Women learn to use



computers as tools, but “to be ‘technologically literate’ requires a set of critical skills, concepts, and problem-solving abilities that permit full citizenship in contemporary e-culture” (AAUW, 2000, p. x). Technical skills can open doors to higher-status, higher-paying jobs, but women are a smaller percentage of the graduate enrollment in computer science than in most other science fields. The National Science Foundation (NSF, 2004) found that women “made up 74 percent of the graduate students in psychology, 54 percent in biological sciences, and 52 percent in social sciences,” but only represented “20 percent of graduate students in engineering and 30 percent of graduate students in computer sciences in 2001” (p. 21).

These differences do not merely reflect existing interests in the women entering higher education. Astin (1993) noted that rather than encouraging existing career aspirations, college “seems to exaggerate many freshman gender differences: During college, women are more likely than men to remain in the fields of school teaching, nursing, and psychology and more likely to drop out of the fields of medicine, law, and engineering” (p. 405). This suggests that higher education could do a better job of supporting budding women scientists. As Cuny and Aspray (2001) wrote, underrepresentation of women in fields like computing represents “a loss of opportunity for individuals, a loss of talent to the workforce, and a loss of creativity in shaping the future of society” (p. 1).

### Women in Higher Education

This section will discuss women’s experiences in higher education, from the historical roots of gender inequity, to the significance of Title IX for women’s education, to the continued “chilly climate” for women in higher education, to women’s underrepresentation in the sciences. The concept and importance of social construction of gender will also be introduced.

*Early History*

Women’s entry into higher education was relatively late. Though Harvard, the first institution for higher education in the United States, was founded in 1636, it was not until the end of the following century that institutions of higher education for women began to appear. These academies or finishing schools were intended to prepare women, as future wives and mothers, to assist in the education of their children. The first true women’s colleges in the United States appeared in the eighteen-hundreds. Oberlin College, which opened its doors to women in 1833, was considered “a radical, even dangerous place,” for not only educating men and women together, but also admitting both Whites and racial minorities (Sadker & Sadker, 1994, p. 21). Other men’s colleges gradually began admitting women in response to financial and social pressures. Clifford (1983/1993) detailed the decision-making process behind coeducation, which was begun not for altruistic reasons of giving women access, but because of a need for “women students to do the ‘women’s work’ of cooking, serving meals, mending, and laundering” at these institutions, and because the Civil War put pressure on schools to supplement a dwindling supply of young men (p. 252).

Just because women were allowed to enroll did not mean they were welcomed. Clifford (1983/1993) noted that “it was common for institutions to impose higher entrance requirements and outright quotas on women applicants” (p. 138). Leaders at the time responded to the threat of coeducation alternately with anger, ridicule, and pseudo-scientific theories that suggested women’s brains were too small to handle rigorous intellectual work or that intense study would damage women’s reproductive capabilities. Sadker and Sadker (1994) wrote that women at coeducational institutions were routinely harassed by other students with the support of faculty. For example, shortly after the University of Michigan was forced by the courts to admit women,

a professor told students they could not remove a stray dog from his classroom because “The dog is a resident of Michigan. . . . we now recognize the right of every resident of the state to enjoy the privileges afforded the university” (p. 22).

In addition to policies that were overtly discriminatory, the first women students were given many other signals that they did not belong in higher education. Women students were caricatured in school newspapers as “overly serious and unattractive” or even “masculine,” and administrators made speeches and wrote articles warning that admitting women students would result in the “effeminization” of their institutions (Clifford, 1983/1993, pp. 161-163). Women were added to institutions, but there was no sense that the institutions would need to change to accommodate them.

Academically rigorous women’s colleges like the “seven sisters” of Smith, Mount Holyoke, Wellesley, Vassar, Barnard, Radcliffe, and Bryn Mawr, were founded as an alternative to coeducational schools. The missions and environments of these schools varied and some still tried to protect women from themselves with shorter classes and strict routines. Other women’s colleges were formed with various sizes, selectivity, and missions. Some of these schools continue as women’s colleges, but many others became coeducational. Though women’s colleges still educate a high-achieving minority of women, most women in the United States attend coeducational institutions. Langdon (2001) reported that though over half of students at institutions of higher education are women, only about 2% attend women’s colleges. Women who attend coeducational institutions of higher education still encounter an environment that is dominated by men’s history, men’s views, and men’s experience.

*Title IX and Higher Education Policy*

Though many people associate it with athletics, Title IX is part of the Education Amendments of 1972 and prohibits sex discrimination in “any education program or activity receiving Federal financial assistance” (Title IX, Education Amendments of 1972, Section 1681(a), paragraph 1). Some higher education activities covered include “recruitment, student admissions, scholarship awards, tuition assistance, other financial assistance, housing, access to courses and other academic offerings, counseling, employment assistance to students, health and insurance benefits and services, and athletics” (United States Government Accountability Office [USGAO], 2004, p. 4). Title IX allows for termination of federal assistance if an educational program is not in compliance with its requirements, but the law has been controversial since its inception. Enforcement was assigned to the Office of Civil Rights (OCR), the agency that also enforces complaints about race discrimination and discrimination against disabled people. Appropriations to this agency “have remained unmodified throughout the years,” and as a result, Stromquist (1993) wrote, there “is wide consensus that OCR has been a weak enforcer of Title IX since its inception” due to scarce resources, court challenges, and “its inability to conduct a significant number of compliance reviews” (pp. 382-394).

Still, Title IX provided legal standing for women to challenge instances of unequal treatment and discrimination. For example, in *Jackson v. Birmingham* (2005), the Supreme Court ruled that retaliation against those who complain of sex discrimination was a violation of Title IX. A 2004 report by the USGAO described its investigations of science funding agencies and campus visits and interviews at “seven research universities” and “six national laboratories and technology centers” and concluded that “more aggressive exercise of oversight on the part of agencies that wield enormous influence in the world of science funding – Energy, NASA

[National Aeronautics and Space Administration], and NSF [National Science Foundation] – would provide an opportunity to strengthen the goal of Title IX” (pp. 2, 28). As a result, *Inside Higher Ed* reported, the U.S. Department of Education planned “to conduct in-depth investigations of whether selected colleges and universities are complying with federal anti-bias laws in their treatment of women in math and science” beginning in the summer of 2006 (“Federal Inquiry,” 2006).

### *Climate: Still Chilly for Women*

Decades after Title IX made outright discrimination against women in educational environments illegal, Pascarella et al. (1997) found “the climates of a large number of coeducational postsecondary institutions may not be conducive to, or supportive of, women students’ learning” (p. 110). Though some faculty members and fellow students may be overtly sexist, women may also be affected by “faculty calling on men more than women, faculty and students making stereotypical comments about women’s intellectual abilities, and faculty taking men’s contributions more seriously than women’s” (Pascarella et al., 1997, p. 110). Hall and Sandler (1982) found that faculty often treated women differently than men without realizing it, for example, setting up laboratory experiments so that women were “likely to be observers rather than participants,” or “allowing women to be physically ‘squeezed out’ from viewing a laboratory assignment or demonstration,” factors that contribute to what they called a “chilly climate” for women (p. 7).

### *Women in Science*

This chilly climate may be one reason for the scarcity of women in the sciences, and especially computer science. Women are underrepresented at all levels, as students and as faculty, and increasingly underrepresented at higher levels of the academic hierarchy. Cuny and

Aspray (2001) noted that without explicit attention to diversity considerations, decisions by graduate admissions committees are shaped by “a natural tendency, often subconscious, for faculty to want to recruit students much like themselves, putting a premium on White males “with backgrounds similar to their own” (p. 6). According to the NSF (2004), though women earned 27.6% of bachelor’s degrees in computer science, they only represented 18.8% of graduating Ph.D.s: In 2001, only 155 women earned doctoral degrees in computer science, compared with 716 men (p. 55, pp. 146-147). If women are underrepresented as science students, they are even more underrepresented among the faculty. Though “in every field students see mainly male professors,” the biggest disparities are in the sciences (Sadker & Sadker, 1994, p. 167).

Women are even scarcer in the higher ranks of the faculty and among decision-makers. NSF (2004) data show that women represented fewer than 13% of science and engineering “doctorate holders employed in universities and 4-year colleges” and just over 5% of full professors in information science (p. 259). The NSF reported that women “are less likely than their male colleagues to be found in the highest faculty ranks” (p. 304). Niemeier and González (2004) studied Association of American Universities (AAU) data on chairs and department heads and found that academic departments “in traditionally male-dominated fields such as engineering and the mathematical and physical sciences are almost exclusively chaired by men” (p. 160). The situation for women of color is even worse. The Committee on Science, Engineering, and Public Policy (COSEPUP, 2007) reported that a 2002 survey found that “there were no African American, Hispanic, or Native American women in tenured or tenure-track faculty positions in the nation’s ‘top 50’ computer science departments” (p. 19). Women “are disproportionately

selected out at each level” of the educational hierarchy, especially in the sciences (Pattatucci, 1998, p. 11).

As Sonnert and Holton (1995) wrote, most attempts to explain this underrepresentation can be summed up in one of two ways: “Women are treated differently in science (we call this the *deficit model*), and women act differently in science (we call this the *difference model*)” [italics original] (p. 1). Most of the interventions attempted to equalize representation have been aimed to counteract one of these two factors. Margolis and Fisher (2003) described the interventions attempted during a time when Carnegie Mellon increased women’s undergraduate enrollment in computer science from 7% in 1995 to 42% in 2000: They included changes to the admissions process, efforts to change the “‘boy hacker’ culture,” and outreach to high schools (pp. 129-134). Other interventions have included mentoring programs, additional research opportunities for women students, changes to introductory courses that attempt to recruit students with a variety of interests, and bridge programs to help students without significant computing experience to meet program entrance requirements (Margolis & Fisher; Roberts, Kassiniidou, & Irani, 2002).

### Social Constructions of Gender

A key assumption of this study is that gender is socially constructed. Social construction of gender means that the experience of being a man or a woman is largely determined by our ideas, and the ideas of people around us, about what those genders mean. Lincoln and Guba (1985), in their description of the naturalist paradigm, cited Schutz’s (1967) description of reality as “rooted in the meanings that are constructed and attached to everyday life by individuals” (p. 77). There is no single objective meaning to being a man or a woman, but we have plenty of social meanings attached to gender, most of which are so unconscious that we have trouble

articulating them. This idea of gender as socially constructed is what de Beauvoir (1949/2003) meant when she wrote in her book *The Second Sex* that women are defined by inferiority to men.

Johnson (2000) said that when we deal with a social construction of a category like race or gender, “we forget the social process that created it and start treating it as ‘real’ in and of itself,” making the construction all the more powerful because of its invisibility (p. 23). Valian (1999) used the term “gender schemas” to explain how even though we are not aware of it, “implicit ideas about men and women as a whole condition our reactions to men and women as individuals” (p. 3). These unconscious ideas shape our lives, including what we imagine as possibilities for ourselves, what our relationships are like, and what others expect of us. Often gender norms are most visible when they are transgressed, for example, when a little girl is told by her mother to stop running around and “act like a lady,” or a young boy is discouraged from playing with his sister’s dolls. Not only gender but also the meanings of disciplines, like education and computer science, can be seen as socially constructed, because there is some more or less shared notion of what it means to be a person studying in one of those disciplines. When we think about someone studying in one of those fields, the mental picture we see is largely determined by social constructions.

Fuss (1989) argued that there is a fundamental tension between social constructionism and essentialism that is one of the central debates of the discourse of feminism. Social constructionists reject the idea that there is a “female essence,” though Fuss pointed out that there must be some “minimal point of commonality and continuity” in women’s experiences for gender to be a useful point of study (pp. 2-4). Feminism “presumes upon the unity of its object of inquiry (women) *even* when it is at pains to demonstrate the differences within this admittedly generalizing and imprecise category” (p. 2). I assume that there is some commonality among



women’s experiences, but that even if some kernel of female essence exists, socially constructed gender norms and women’s own interpretations of their experiences are a key factor in the possibilities they imagine for themselves.

### Study Design

The purpose of this study is to explore the ways that constructions of womanhood affect the experiences of women doctoral students in computer science. Women who do graduate work in computer science still operate in an environment where they are in the minority. This study focuses on how constructions of gender – including participants’ own understanding of what it means to be a woman, as well as the messages they receive from their environment – shaped the choices these women made and their career goals and expectations. The following questions were the focus of this inquiry: What are the career aspirations of women doctoral students in computer science? How do they feel about their chances to succeed in their chosen career and field? How do women doctoral students in computer science construct womanhood? What are their constructions of what it means to be a computer scientist? In what ways, if any, do they believe their gender has affected their experience in their graduate programs?

These questions were chosen in an attempt to examine some of the perceptions and experiences that might affect women’s abilities to succeed in the sciences. I chose computer science both because it is one of the disciplines where women are most underrepresented, and because it is a field that has the potential to become increasingly important as our society becomes more and more reliant on information technology.

### *Significance of the Study*

The continuing differential representation of women in the sciences has been a topic of intense interest for researchers. However, Pattatucci (1998) asserted, “The scientific

establishment has addressed the issue of women in science in a very *unscientific* manner, choosing to rely on speculation rather than on a systematic gathering of data” (p. 5).

Graduate school seems to be a turning point where women leave academic computer science. Statistics from Damarin (1992) and the U.S. Department of Education (1994) show that “although the proportion of women in the U.S. who take MAs in computer science is similar to the proportion taking BAs, females still account for only 10-14% of doctoral candidates in this field” (as cited in Woodfield, 2000, p. 5). It would follow, then, that a study of the experiences of doctoral students may be able to provide some insight about what experiences may contribute to this phenomenon. Much of the existing research seems to focus on high school students, undergraduates, or professionals who have already entered careers in computer science. A study of graduate students could be a useful addition to the literature.

### *Terms and Definitions*

An understanding of several key terms is critical to an understanding of this study. These terms are defined below:

**Higher Education Institution:** An institution of postsecondary education. In this study, only institutions granting doctoral degrees were included as research sites.

**Gender:** As used in this study, gender is a person’s definition of his or herself, or society’s definition of that person, as a man or a woman. Gender is what is apparent to observers. A person’s gender may or may not correspond with a person’s biological sex.

**Social construction:** A shared understanding of what a particular characteristic, like gender or race, means in a social context. Social constructions often operate on an unconscious or commonsense level.

**Computer science:** An academic discipline that may encompass the study of computer hardware and software, programming, artificial intelligence, networking, and human-computer interaction. Computer science departments are generally located in the college of arts and science or the college of engineering at a university. Management Information Systems (MIS) departments are not included in the field of computer science, since the focus is on the business application of computers and not on the theory and study of the machines themselves.

### *Limitations and Delimitations of the Study*

I have chosen to focus this study on doctoral students in computer science because women are more underrepresented at this level than at the bachelor’s or master’s degree level. This choice means that I was limited to institutions offering doctoral degree programs in computer science, and to institutions with a large enough population of women doctoral students to provide information-rich cases.

### *Organization of This Document*

In Chapter Two, I review the literature on women in science, and specifically women in computer science. The chapter begins with an historical perspective on women and computing in the United States, and continues with the implications of women’s current underrepresentation in computing. Then, there is an in-depth examination of the “difference” and “deficit” models. The chapter concludes with a discussion of the literature in light of the ideas of social constructions of gender.

In Chapter Three, I reintroduce the research questions, my background, and the research framework. I also define the assumptions that underlie this study. I explain the ontological, epistemological, and methodological foundations of the study and include a discussion of the

assumptions and methods of phenomenology. I then outline the methods used for participant selection, data collection, and data analysis. I conclude the chapter with indicators of quality.

In Chapter Four, I include brief profiles of each of the participants to introduce the demographic characteristics of the participants and their history. These profiles provide context for the quotations used later in the document.

In Chapter Five I present the findings of the study, organized by research question. The findings include a general description of the aspirations and constructions of the participants.

In Chapter Six I present a model for understanding the experiences and constructions of the participants and discuss themes that emerged from the data.

In Chapter Seven, I compare the findings of this study to the literature and discuss implications for practice and for future research.

## CHAPTER II: A REVIEW OF THE LITERATURE

## Women’s Underrepresentation in Computer Science

Though it is often invisible in computer classrooms, women were pioneers in the history of computer science. As Carlson (2006) reminded readers, “Ada Byron Lovelace, a 19<sup>th</sup> century mathematician, is credited with writing the first computer program. Grace Murray Hopper is credited with finding the first computer ‘bug’” (p. 35).

The story of the Electronic Numerical Integrator and Computer (ENIAC), the first American electronic computer, is a good illustration of gender issues in computing. Light (1999) explained, “A ‘computer’ was a human being until approximately 1945,” when the ENIAC was developed to take over the job that was previously done by two hundred or so women, who performed complex non-linear equations by hand to calculate the trajectory of rockets and shells (p. 465). This “computing” had been performed by men until World War II, when college-educated women were recruited and trained for the job. The hundreds of calculations involved meant the work was slow and tedious, so a machine was invented to automate the calculations. Six of the best women were hired to program the ENIAC.

Programming was perceived as mostly clerical work and therefore an appropriate occupation for women. Contrary to this perception, though, Light (1999) described the work as complex engineering, with the women studying wiring diagrams and actually “crawling around inside the massive frame” of the ENIAC to figure out its inner workings and troubleshoot problems (p. 470). After the war, when the success of the ENIAC was publicized, Light described how women’s contributions were minimized. In publicity photographs, women were literally cropped out of the picture. Women were also encouraged to leave their jobs in computing to make room for men returning from the war. As men entered the field, computer

programming was redefined not as a clerical job, but as a technical profession with the associated prestige and importance.

Though women like Grace Hopper and Betty Snyder Holberton made crucial contributions to modern computing, including developing programming languages like COBOL and FORTRAN, history is not often a focus of the classes where those languages are taught. The importance of contributions by women to computer science, Light (1999) concluded, was diminished by the “unintentionally ‘male-centered terms’ of history” (pp. 482-483).

### Women on the Margins

The American Association of University Women (2000) reported that women’s participation in computer science “has declined over time” as measured by the percentage of women students graduating with bachelor’s degrees, “from a peak of 37 percent in 1984 to 28 percent in 1995” (p. 41). There is now, wrote Tillberg and Cohoon (2005), a “pervasive belief that computing is a male activity” (p. 130). Margolis and Fisher (2003) were adamant that decisions about the role and use of technology “should not be isolated to all-boy clubhouses; women’s voices and perspectives should be part of this conversation” (p. 3). Institutions of higher education, and specifically computer science departments, are the training ground where women can acquire the skills necessary to be power players in the computer culture.

As discussed in Chapter One, Sonnert and Holton (1995) summarized most research on women in science as variations on two models, the *difference* model and the *deficit* model: “women are treated differently in science (we call this the *deficit model*), and women act differently in science (we call this the *difference model*)” (p. 1). The deficit model refers to problems in computer science that make it an unfriendly discipline for women; the deficit is in the discipline. The difference model focuses on differences between men and women that affect

their ability to succeed in computer science. In the next sections, I will discuss the research in terms of these two models.

### *The Difference Model*

In higher education in general, and the sciences in particular, the mythology of the academy as a meritocracy, combined with women’s relative lack of success in reaching the upper levels of the academic hierarchy, has led some to believe that women lack drive, talent, or ability. This belief is reflected in former Harvard president Summers’ (2005) explanation of women’s underrepresentation in the sciences when he speculated that “in the special case of science and engineering, there are issues of intrinsic aptitude, and particularly of the variability of aptitude, and these considerations are reinforced by what are in fact lesser factors involving socialization and continuing discrimination” (p. 4). He asserted that gender differences in ability and interest were the primary explanation for the small percentage of women faculty in the sciences, and that environmental factors were of minor importance.

Many of these assumptions about natural difference between men and women are based on unchallenged commonsense beliefs that have little basis in fact. For example, Zuckerman (2000/2001) found that “To the extent that [ability or competence] can be measured by intelligence tests or academic performance, abilities of women scientists equal or surpass those of men” (p. 70). Hyde, Fennema, and Lamon (1990) debunked the widely-held belief that men outperform women in math. Overall, there were more differences within the genders than between them. They found “the gender difference was close to zero (favoring females slightly) for general samples; a larger gender difference favoring males was found for each successive level of selection for higher ability” but lower-skilled men also seemed less likely to pursue higher education (p. 148). There were, however, gender differences in how people explain their

success or failure in math: “Males, more than females, attribute their successes in mathematics to ability, while females (more than males) attribute their success to effort. More than males, females attribute their failures to lack of ability or task difficulty” (Harris & Schau, 1999, p. 201). When women succeed, they do not take it as an indication of their skill, but they take their failures as proof of low ability or think that math is just too difficult for them. This can lead to low self-confidence in math-related skills like computing.

Some social scientists minimize the influences of gender and culture, and see gender differences as inherent and inborn. Birke (1998/2003), wrote, “biological determinism has, for example, been adduced to argue that women are, say, genetically predisposed toward nurturing behavior while men are inclined toward adventures and fights” (p. 42). Bleier (1984/2001) criticized this sociobiology as flawed, including only data that reflect the biases of the researchers, mostly men. Bleier wrote that these researchers might be surprised to hear that “many American women, because of *their* experiences, would include in their list of male characteristics helplessness, impracticality, and dependence” (p. 183). Hubbard (1988/2001) extended the criticism to theories based on studies of lab rats that imply fetal hormones have important lasting effects on men and women, saying that scientists “claim not only that these (unproved) differences in fetal hormones exist, but imply (without evidence) that they predispose men and women *as groups* to exhibit innate differences in our abilities to localize objects in space, in our verbal and mathematical aptitudes,” and in other areas (p. 156). In its report on women in the sciences, COSEPUP (2007), after an extensive meta-analysis of existing studies of gender differences in abilities, concluded:

In summary, studies of brain structure and function, of hormonal influences on cognitive performance, of psychological development in infancy, and of human



evolution provide no clear evidence that men are biologically advantaged in learning and performing mathematics and science...Because men and women do not differ in their average abilities and because they have now achieved equal academic success in science through the college level, there is no sex performance difference for the biological studies and theories to explain. (pp. 41-42)

It is interesting that researchers continue to attempt to use science to explain and justify the status quo by looking at differences in ability and minimizing the influence of privilege. Hubbard (1988/2001) wrote that it is common “at times of tension and upheaval” for there to be research that seeks to “prove that differences in the political, social, and economic status of women and men, blacks and whites, or poor people and rich people, are inevitable because they are the results of people’s inborn qualities and traits” (p. 154). Using the aura of science helps to hide the vested interest these would-be theorists have in proving themselves right. But when women object to these kinds of characterizations, they can often be seen as simply promoting their own “special interests” in the face of an infallible scientific neutrality.

In reality, though, untangling what is “innate” or “natural” from socialization is difficult because socialization happens so early and unconsciously that both parents and their children can fail to notice it. For example, Margolis and Fisher (2003) cited a 1968 study of four-year-olds and their mothers by Newson and Newson, who found that mothers allowed their boys to roam further away from them before calling them and expressing concern for their safety than girls, and speculated that the cumulative result of subtle influences like these may be one reason that “hesitancy and risk avoidance appears more ‘innate’ in girls than in boys” (p. 29). Ferreira (2003) cited research (Oakes, 1990; Tracy 1987) that showed that parents “are more likely to buy

scientific games for boys than for girls, and boys are more likely to play with toys that encourage manipulation or construction” (p. 970). These kinds of experiences are likely to affect the skills and career goals that children develop.

Since no child ever grows up without environmental influences, then, we can never have a complete picture of which differences are truly the result of “nature” and which are the result of “nurture.” It is clear, though, that boys and girls are socialized differently, and this can result in different behavior and priorities in adults.

Some researchers and their informants focused on differences in style between men and women in the sciences. Sonnert and Holton (1995) said “women are more cautious and careful in their methods and pay more attention to detail,” and “aim to see the broader picture and do more comprehensive work” (p. 152). They speculated that perfectionism combined with the tendency to select larger projects might result in differences in research productivity between men and women. Woodfield (2000) wrote that men and women had different interaction styles with computers. Men said they were “attracted to the disruptive powers of the computer, which they likened to play, where the majority of women were neutral on this issue or actively disregarded it” (p. 176). Her study suggested that men enjoyed experimenting with and testing the limits of computers but that women were primarily interested in the potential of computers as tools to help them accomplish their tasks.

Cuny and Aspray (2001) instructed faculty in graduate computer science programs to be aware that women “are often less aggressive than male students in promoting themselves, attempting new or challenging activities, and pursuing awards and fellowships” (p. 2). Margolis and Fisher (2003) said that many of the women in their study were intimidated by the single-mindedness of men in their computer science programs. “I’m just not like that at all,” one

informant told them, “I don’t dream in code like they do” (p. 5). Whether these differences in style, if they are truly widespread and important, are a result of natural tendency, socialization, or the result of women’s experiences in science is difficult to untangle.

Another area of difference cited is the importance placed on expectations about relationships and family life. Chickering and Reisser (1993) wrote of college students’ quest to “construct a plan that balances life-style considerations, vocational aspirations, and avocational interests” as they develop a sense of life purpose (p. 229). Some research suggested that college women considered these factors more when thinking about their future careers than men did. Eisenhart and Holland (1992/2001) said that peer influences helped underscore the importance of relationships with men to women’s social standing. If she wanted to fit in with her friends, “A desire for heterosexual intimacy also was considered ‘natural.’ A woman could not singly declare a lack of interest in men that she could for, say, mathematics, history, or any or all of her courses” (p. 29). Steinham (1983) wrote, “I’ve yet to be on a campus where most women weren’t worrying about some aspect of combining marriage, children, and a career. I’ve yet to find one where many men were worrying about the same thing” (p. 214).

The idea of balance may be more of a factor for women than for men if women put more importance on personal relationships. Women may also expect to have more responsibilities at home than men do. Valian (2000) reported that women generally shoulder more domestic duties than men no matter what their work situations:

Almost all employed women in heterosexual relationships live in households where the division of labor is grossly and visibly inequitable...Married women who work for pay average about thirty-three hours of housework per week – about two-thirds of the total household work...Questioned independently, the

wives and husbands agreed that the wives carried out more of all child care tasks but one – playing with the children. In that one area, the partners were equally involved. Yet when they rated themselves as parents, the women expressed more guilt than men about not being a better parent. (p. 39)

In his speech, Summers (2005) said that the intensity required of faculty members in the sciences at top institutions in the U.S. often conflicted with family commitments and acknowledged the unfairness of “familial arrangements in which women are asked to make that choice and asked more to make that choice than men,” (p. 2) even though he downplayed the importance of these arrangements in the gender disparities in the sciences.

Miller (1976) believed that “women’s sense of self becomes very much organized around being able to make and then to maintain affiliations and relationships” (quoted in Chickering & Reisser, 1993, p. 149). Pattatucci (1998) wrote that the culture of science, which emphasized single-minded devotion to a career, worked to exclude women, because “men are far more likely to succeed by virtue of the fact that they can typically assign family obligations to women in their lives” (p. 132).

The desire for a family may discourage women from considering a science major. Xie and Shauman (2003) speculated that because of “the perception that an S/E [science or engineering] career may conflict with family life,” women may be less likely to choose a career in these fields (p. 48). Women may have different priorities, or they may be realistic about what their obligations are likely to be. One of Pattatucci’s informants wrote of her experiences as a graduate student in the sciences living with her partner, a man who was a graduate student in the same program: “The cleaning, shopping, cooking, and laundry still needed to be done – so I did them. After all, he was so much busier than I was, and I rationalized that I could do these things

more quickly and efficiently” (p. 120). This informant sacrificed her career interests for her relationship, only to have both the career and relationship fall apart.

Sonnert and Holton (1995) noted that “a much higher proportion of women scientists than men scientists are married to another scientist, very often in the same field,” resulting in more women having to settle the “two-body problem” of finding two positions in the same area, most often by putting the man’s career first (p. 11). van Anders (2004) found that, though women and men had similar interest in research and teaching, “more women than men indicate that mobility, plans for parenthood, and the academic environment and lifestyle are a negative influence on their intention to become professors” (p. 518). Fox and Stephan (2001) reported that women who do stay in computer science are more likely to plan for careers in teaching universities rather than working in research schools or high-paying jobs in industry, an aspiration which might, the authors speculated, “reflect their ‘expectation’ that this is the option open to them,” since “women obtain employment ‘left-overs’” (p. 119) while the high-status, high-paying jobs are still more likely to go to men.

### *The Deficit Model*

Pattatucci (1998) did not accept these arguments about women’s differential priorities. She disagreed with the assessment that women scientists with families necessarily left their fields because of conflicts with family, “although this has sometimes been expressed as an afterthought” (p. 6). Instead, she said, “these colleagues abandoned science careers because they had finally reached their level of tolerance for what I call the *extra stuff* – a blanket term encompassing all gender-related challenges and boundaries faced by women in science *over and above* those inherent to the field” (p. 6). This “extra stuff” reflects Sonnert and Holton’s (1995) “deficit model,” the idea that science, including computer science, is not attractive to women

because women within the field are not treated fairly, or because the culture is not friendly to women.

Brine (1999) distinguished between “formal equality,” or equal access to education, and “material equality,” or truly equal access to resources and power (pp. 67-68). Because of Title IX, women have formal equality with men in higher education. It is illegal to discriminate in education solely based on sex. But they still do not have material equality. This means that women do not receive the encouragement and support they need to succeed in science. As Johnson (2000) wrote, oppression operates through “paths of least resistance” (p. 85). Because people tend to follow these paths of least resistance, “the patterns of White dominance and male dominance in the system as a whole are perpetuated, regardless of what people consciously feel or intend” (p. 88). Sonnert and Holton’s (1995) deficit model refers to all the ways that the culture of science is unfriendly to women. These include Hall and Sandler’s (1982) notion of a “chilly climate” for women, a climate composed of all the small moments of neglect or exclusion that are harder to point out than highly visible incidents of overt discrimination. These might include being left out of informal study groups or noticing that professors provide less feedback for women’s work than for men’s. Rowe (1990) wrote that discrimination operated “within the dominant culture and within the person discriminated against” in a series of “tiny, damaging” events she called “micro-inequities” (p. 154). These micro-inequities may each seem insignificant on their own, but they have a cumulative effect of making women feel unwelcome.

Because this kind of inequality is invisible, it tends to make the failure of people from oppressed groups to succeed in large numbers look like a collection of personal failures or choices rather than the result of oppression. Luke (2001) presented a picture of higher education as a system of glass “walls and ceilings” (p.10). Women are progressively less represented at

each level higher in the academic hierarchy. There is also horizontal stratification, both between fields and within disciplines. For example, there are more women in education than computer science, but even within computer science, there are some niches where women have made inroads, while in others, women are less represented. Not coincidentally, there is a sense that some fields of computing are more prestigious or important than others. For example, when Woodfield (2000) studied the culture of a computing firm, she found that more women were represented in the Human-Computer Interaction (HCI) field than in other divisions of the firm, but the division was also perceived as less technical, and she found a widespread belief that HCI’s “less strictly technical focus allowed it to ‘recruit from a range of technically more mediocre individuals’” (p. 110).

Some of the barriers to women’s participation in computing may be messages to women, explicit or implicit, implying that they do not belong. The AAUW (2000) reported that when “male and female students received similarly high marks on exams, teachers attributed girls’ success to their diligence and methodical work, whereas even underachieving boys were thought to have an intuitive interest or ‘flair’ for computers” (p. 24). Though this study involved grade-school teachers, it is possible that professors have similar biases.

Women in computer science may also get messages from their peers that they do not belong in computer science. Pascarella et al. (1997) found that women students who perceived the classroom as a chilly climate (Hall & Sandler, 1982) felt less prepared for their future careers, reflecting, the authors speculated, the powerful effects of subtle factors like “the extent to which [women’s] contributions in class are sought and valued, the extent to which their intellectual and career potential is taken seriously by faculty and male classmates, and the extent to which men are given preferential treatment” (p. 122).

Margolis and Fisher (2003) found that as computer science departments tried to become more woman-friendly, there was a backlash among men in the programs. Their research participants reported comments from peers “implying that the only reason they were admitted was because of their gender” or otherwise suggesting they were not really qualified or competent (p. 84). These messages can be disheartening and put more stress on women who already feel like they do not fit in. Pattatucci (1998) wrote that as she studied women in science, “they all had the common theme of burnout, not with science itself, but with the extra stuff” (p. 6). This “extra stuff” has to be handled in addition to a rigorous course of study.

Wulff, Austin, Nyquist, and Sprague (2004) found, in a study of graduate students as teachers, that “finding balance in their scholarly, professional, and personal lives emerged as an important issue for the students” (p. 63). Their informants were both men and women, but some research suggests that this issue of balance is more important to women students. Cuny and Aspray (2001) wrote that a major obstacle to retaining women graduate students in computer science was a culture that encouraged “a fierce single-mindedness of purpose, competitiveness, and aggressive assertiveness in technical discussions,” behaviors that many women students found “uncomfortable” (p. 12). Torres, Howard-Hamilton, and Cooper (2003) spoke of the importance of culture in making diverse groups feel comfortable in an environment, saying that in a culture where there is a clear majority, that majority “may not realize how prevalent their culture is articulated and how little diversity is expressed, which is how privilege is maintained” (p. 84). Men in computing may wonder why women cannot just fit in.

Ali and Kohun (2006) estimated that “one out of every two students who start a doctoral program do not finish it” (p. 23). Though faculty in doctoral programs tend to attribute this high attrition rate to student background characteristics and tighten admissions criteria as a result,



these strategies have not worked. “The best and brightest are among those who drop” (p. 24). They found that feelings of isolation among doctoral students was an important factor in these high attrition rates, and wrote that many factors could contribute to feelings of isolation, including confusion about program requirements, difficulty in choosing a research focus, and the “complicated, long, and daunting” dissertation process (pp. 23-26). Doctoral programs that made an effort to combat these isolation feelings were able to increase the percentage of their students who graduated.

Margolis and Fisher (2003) wrote that women in computer science need extra support to persist, because their “interest in and attachment to computing are considered outside the norm and their abilities are never taken for granted.” This constant need to prove themselves, in addition to their resistance to becoming “myopically focused” on computing, places them at “high risk in the discipline” (p. 75). As one psychologist who studies women and girls in computer science put it, they “don’t want to be perceived as geeks and nerds” (Carlson, 2006). The AAUW (2000) reported that students found computer science classes “frustrating and poorly taught, or that they are structured to weed students out rather than to encourage students to come into the field” (p. 41).

Computer science courses typically involve group projects, and gender stereotypes can influence how likely a student is to be sought out as a partner. As one woman reported, “The guys wanted to be my partner when it came to writing papers, but no one wanted to be my partner when it came to lab time” and another said, “The guys don’t want to listen to the girls” (Carlson, p. 35). If there is a sink or swim attitude, women may be left out of informal social support structures like study groups.

Others point to women’s lack of role models and mentoring in science departments as a reason that these fields have trouble recruiting and retaining women. Abraham (1997) cited Bryn Mawr’s innovative and comprehensive mentoring program for women in science and mathematics as a model of what schools could do to encourage women to enter scientific study: “To mentor the whole life of a student, one must stay in contact with each student in an individual setting during the critical first year of college experience” (p. 215). Active recruitment is key. Abraham found that “waiting to talk to those who spontaneously enroll in the second-year course reduces potential majors to a third or less of those who might have continued successfully” (p. 215). Just adding women to a math or science program is not enough. Supporting those who enroll and actively seeking out gifted students can help narrow the gender gap.

*Beyond Differences and Deficits: Constructions of Gender*

Feminist theory gives us an alternate way of looking at both difference and deficit issues using the lens of social expectations associated with gender. Safarik (2003) wrote, “basic assumptions that gender is socially constructed and a central category of analysis underlie feminist epistemology” (p. 427). This means that most feminists assume that women are not inherently inferior and reject the idea of women’s subordinate status as something natural or innate.

In her introduction to *The Second Sex* (1949/2003), de Beauvoir introduced the idea of the second sex when she wrote that the invisibility of men’s gender sets women up as not only inferior to men, but defined by inferiority:

The terms *masculine* and *feminine* are used symmetrically only as a matter of form, as on legal papers. In actuality the relation of the two sexes is not quite like

that of two electrical poles, for man represents both the positive and the neutral, as is indicated by the common use of *man* to designate human beings in general; whereas woman represents only the negative, defined by limiting criteria, without reciprocity. (p. 33)

In higher education, as in other arenas, “women are everywhere within civilization the second sex, but everywhere differently so” (Mitchell [1975], quoted in Thornham, 2000, p. 75). Because of the “maleness” of gender neutrality, attempts at gender-blindness may contribute to continuing inequality between the sexes. “‘Equal’ is...appended to choice, opportunity, and rights. The power of the equality discourse is that in focusing on individual freedom of choice it often masks the social and economic inequalities inherent in the discourse of economic growth” (Brine, 1999, pp. 65-66). This allows privilege and power to go unnoticed by those who enjoy them.

Bias can happen even without a conscious attempt to exclude women, because of the unconscious tendency to underestimate women’s accomplishments and abilities. Kolodny (2000) wrote that “even in our supposedly most ‘advanced’ societies, women’s capacities are still judged as somehow inherently inferior to the capacities of men; and women’s work, however necessary or innovative, is assessed as less valuable than men’s work” (p. 133).

Woodfield (2000) found in the software development department she studied, “two of the most dominant themes which shaped the informal assessments of women’s skills in the unit seemed to be, first, the assumption that men were more likely to be technically oriented than women, and second, the assumption that men’s skills, whether social or technical, were more useful and valuable than the women’s” (p. 126). Woodfield borrowed Bordieu’s (1990) concept of “habitus,” or the “dispositions and practices that distinguish groups from each other” to

describe the way certain “intangibles” associated with gender became wrapped up with the notion of what makes someone a valuable member of a group when men and women have similar qualifications, especially in fields like academics and information technology where “part of the occupational profile is fluid and indeterminate” (pp. 152-155). Consciously or unconsciously, the demand for qualifications like “style” and “flair” can be used as a very effective way to “exclude non-standard or undesirable entrants” to the culture. In the software firm she studied, Woodfield found:

Whatever the objective levels of skill a female developer was acknowledged to possess, no woman was described as ever having sufficient ‘flair’ or as demonstrating the right kind of ‘style’ for really fitting in at the unit, and none were identified as exemplary members of the group. It seemed that to be so identified...one had to fulfil the additional tacit criterion of actually being male.  
(p. 161)

The influence of these intangibles is subtle and unconscious. People may not mean to discriminate, but the influence of habitus means that “the best person for the job” can really mean “the best man for the job” without anyone realizing it. This means that higher education’s lack of formal structures and explicit written policies can work against women. For example, informal networking, often referred to as the “old boys’ network,” can help to set up a system where it is easier for men to be admitted to programs or hired and promoted in higher education. Niemeier and Gonzalez (2004) speculated that chairs of academic departments in the U.S. remained mostly men because of “recruitment in one’s own image,” especially because of the subjectivity of the selection process. The mysteriousness of tenure and promotion processes can allow unconscious biases to flourish that can be harmful to women faculty.

Women probably would do better under a more objective promotion and tenure system that did not place so much importance on intangibles that may hide gender biases. Similarly, Woodfield (2000) found that in a software company that prided itself on its informality and lack of a hierarchy, the result was:

not, as was intended, an organisational structure which distributed power and opportunity more equally and liberated creativity, but the creation of a series of unregulated social spaces within which the most likely outcome was a default to the established cultural and social hierarchies of the pre-existing computer culture and its practices. (p. 191)

Similarly, Cuny and Aspray (2001) suggested that computer science departments that failed to spell out their admissions criteria might exclude qualified women because they “might well have backgrounds that look quite different from those of their male counterparts” and faculty who were not consciously seeking to increase the diversity of the department would have a natural tendency to favor “students much like themselves” (p. 6). They may also still be inclined to see women who are interested in computer science as unusual.

Boys and girls, and later, men and women, learn to downplay traits that they perceive to be inappropriate to their gender. Bordo (1993/1999), in her discussion of Foucault, wrote that in modern societies, “prevailing forms of selfhood and subjectivity are maintained not through physical restraint and coercion, but through individual self-surveillance and self-correction to norms” (p. 253). This means that people adjust their behavior according to their perceptions of what others expect from them.

Margolis and Fisher (2003) discussed the differences between men and women’s intensity of interest in computers, with men more likely to report enthusiasm and single-minded

interest in computing than women. However, this may be partly due to perceived expectations. One of their study participants, Sally, after describing her early love for computers, was quick to qualify her statements by saying “I didn’t spend all my waking hours on it the way some budding hackers might have” (p. 18). “Studies generally agree that computer scientists are stereotyped as male, very smart, antisocial, and content to sit in front of a computer for long hours,” wrote Dryburgh (2000), in her summary of 1990s research. Women computer scientists may feel a conflict between fitting into the culture of computing, a field perceived as the domain of geeky men, and fitting into the expectations of the larger culture for women.

Just as in the early days of higher education when women who were serious about their studies were labeled as masculine, gender norms are often enforced with name-calling. Butler (1997/2003) saw gender as a socially-constructed performance intended to produce an effect of “necessity and naturalness,” and noted that “those who fail to do their gender right are regularly punished” (p. 417). Heterosexism plays a role in this, because as Johnson (2000) wrote, calling women who transgress gender norms lesbians is one way to “keep women in line” (p. 65). Wilson (2003) found that men in one computer science program protested the offering of a women-only course by “suggesting it was an option for ‘lesbians’” (p. 130). In Woodfield’s (2000) study of computer software professionals, “women reported a double bind whereby they were either deemed adequately feminine but deficient according to the standards of intelligence and skill set by the stereotype, and therefore inadequate computer scientists, or inadequately feminine if they realised the standards,” to the point where one male employee said, “To be quite honest, if there are no raised eyebrows about a woman doing this job, it’s usually because people have already assumed that she’s very odd or gay” (p. 95). Calling someone a lesbian in this context is not meant to convey anything about the woman in question’s actual sexual orientation;

rather, it is an attempt to force her back into her proper gender role. Valian (1999) explained the double-edged sword gender roles represent for women:

A woman who is very feminine runs the risk of seeming incompetent; the more she typifies the schema for women, the less she matches the schema for the successful professional. On the other hand, a woman with masculine traits runs the risk of appearing unnatural and deviant. The more she typifies the schema for the successful professional, the less she matches the schema for a woman. (p. 15)

For college women, the message that computing is unfeminine may be a major obstacle to recruitment and retention of women to the field. Margolis and Fisher (2003) quoted a research participant who said that when she was growing up, she “found it difficult trying to be a girl and be technical at the same time” and reported feeling lonely and conflicted about whether she should do the things the other girls wanted to do or “go with the guys and pull apart a computer” (p. 30). Eisenhart and Holland (1992/2001) found that women’s peer culture was central to their experiences, and those cultures “play an important—and relatively unrecognized—role in guiding women toward traditional positions in the work force” by emphasizing social activities over academics and making a focus on rigorous courses of study “difficult to preserve or expand” (p. 27).

Sebrechts (1999) wrote that “unlike their male counterparts, who are valued and rewarded for academic, athletic, and leadership prowess by their male and female peers, women derive their prestige from their attractiveness to men” (p. 39). This tension may help steer women out of science and toward “softer” specialties when the demands of keeping up socially conflict with schoolwork. Even highly committed and capable women in computer science may be likely to downplay their accomplishments to avoid threatening or alienating their peers. One

of Pattatucci's (1998) informants called herself an “honorary male” because of a style of interaction with her classmates she consciously adopted but said she felt conflicted between her desire to succeed in computer science and her need to feel like a “nice lady” (p. 106). Sonnert and Holton (1995) found that their research participants agreed that women were faced with a double standard for behavior, with one participant saying, “We’d always have to be more conciliatory, more mainstream, more normal” than men, whose temper tantrums and grandstanding was often seen as a side effect of their brilliance (p. 143).

The role that gender constructions and the construction of science may play in determining women's success in the sciences presents a way to unite difference and deficit and see the problem in another way: How much of women's underrepresentation in computer science results from a problem of imagining women as computer scientists? As long as women in these fields are seen as exceptions, they are the exceptions that prove the “rule” that computing is a man's domain. This rule then presents computing and womanhood as competing choices and asks women to decide between being successful as computer scientists or successful as women. Some women will then feel the need to minimize the idea of themselves as women in order to feel successful as computer scientists.

Women who choose computer science as a career field must have a way to reconcile the role of woman and computer scientist to themselves. Some of these students may see themselves in ways that fit the notion of the computer culture or may be confident enough to challenge gender stereotypes. Tillberg and Cohoon (2005) found that several of the women in their focus groups “expressed the need to challenge society's views about gender-appropriate roles” (p. 136). Dryburgh (2000) wrote that “women in [computer science] accept the masculine culture and adjust their expectations and aspirations accordingly, whereas women outside [computer



science] are deterred from entering by anticipation of male hostility toward women who do non-traditional work” (p. 194). It may be that they see computing differently than women who are not interested in computer science. For example, Tillberg and Cohoon found that women in computing “believed that their work would involve lots of human interaction” and “recognized computing as a form of communication, a means of creative self-expression, or as a path to a helping occupation,” (p. 137) ideas that counter stereotypical ideas about computer culture as solitary and computing professionals as geeky loners. Any or all of these factors may affect the ability of women in computer science to feel at home in their chosen field.

### Summary

This literature review has covered both the extent of, and various explanations for, women’s underrepresentation in computer science. As long as academic fields and specialties remain mostly segregated by gender, women do not truly have access to the full range of possibilities available to them. In this study, I attempt to shift the focus from a false dichotomy of difference and deficiency to a view that encompasses both by taking into account the ways in which gender, and the range of possibilities available to each gender, are shaped by social constructions. This view suggests that gender operates as a category, often without our consent or even conscious knowledge, to shape and define what our proper roles are. Though this theory might prove useful for suggesting paths for remediation, it might or might not reflect the lived experience of women who are actually studying computer science. To access this experience, it was necessary to consult the students themselves.

## CHAPTER III: METHODOLOGY

As discussed in Chapter One, the purpose of this study was to explore the ways that constructions of womanhood shape the choices and expectations of women graduate students in computer science. Women who do graduate work in computer science still operate in an environment where they are in the minority. The goal of this research was to study how participants’ own understanding of what it means to be a woman and the messages they receive from their environment shape the choices these women make and their career goals and expectations. The following questions were the focus of this inquiry:

What are the career aspirations of women doctoral students in computer science?

How do they feel about their chances to succeed in their chosen career and field?

How do women doctoral students in computer science construct womanhood?

What are their constructions of what it means to be a computer scientist?

In what ways, if any, do they believe their gender has affected their experience in their graduate programs?

These questions are an attempt to tilt the kaleidoscope and shift the focus from a problem of deficiency or difference to a question of shaping constructions of identity and career aspirations. Women graduate students were chosen because they had already, by being accepted to graduate programs, demonstrated some success in the field of computer science. All of the women in this study were in doctoral programs, though three were in their first two years of a Direct Ph.D. program, meaning they had been admitted into a doctoral program after completing their undergraduate work and had not yet earned a separate master’s degree. Computer science was chosen both because it is one of the disciplines where women are most underrepresented,

and because it is a field that has the potential to become increasingly important as our society becomes more and more reliant on information technology.

### Researcher’s Background and Research Framework

Another reason for the focus on computer science is my own personal interest and experience in the field. As van Manen (1990) wrote, “research does not start or proceed in a disembodied fashion. It is always a project of someone: a real person, who in the context of particular individual, social, and historical life circumstances, sets out to make sense of a certain aspect of human existence” (p. 31). In the following paragraphs, I discuss the assumptions and background that informed my research.

#### *Assumptions of the Researcher*

A primary assumption of this research, and this researcher, is that “innate” or “natural” differences between men and women, other than certain physical traits and tendencies, if they exist at all, cannot be ascertained by any practical research model. Because of sonograms and other technologies, expectant parents can ask “is it a boy or a girl?” even before their child is born. Everything about the way that children are treated, including their nursery décor, the clothes they wear, the stories they are read, and the toys they play with, is informed by the answer to that question.

Children learn, as they are growing up, through cues like these and through constant messages from peers, adults, and the world around them, what it means to be a boy or a girl and what it means to grow up to be a man or a woman. This means that gender is *socially constructed*, that we are not born a boy or a girl so much as we learn how to be one, and we learn as we grow how to become a man or a woman. Even progressive-minded parents cannot avoid

this socialization process, and even if it were possible, a child who was brought up to be genderless could never fit in comfortably in a gendered world.

Any discussion of innate or natural differences between men and women, then, whether the causes are attributed to genetics or hormones or any other unalterable factor, ignores the power of these pervasive cues of proper gendered behavior. It is very difficult to tease out which of these differences are truly inborn and which are created by subtle social conditioning.

Whatever the origin of differences in intelligence, behavior, and interests, there is obviously as much variation within the genders as between them, so even where there is a tendency for one gender to outperform the other, those descriptions of populations cannot tell much about the relative abilities of an individual man and an individual woman. Because this research concerns doctoral students, who have been preselected for high levels of ability and interest in computer science by the graduate admissions process, it is assumed that all the participants would have all the ability and intelligence necessary to be successful in their chosen field.

This study concerns *women* doctoral students and their experiences as women. In undertaking this research, I made an assumption that women share common experiences that can be usefully studied. There is also still plenty of evidence, as demonstrated in my review of the literature, that women face obstacles and limitations in higher education because of their gender and because of commonsense, unexamined notions of what women can achieve. Women in computer science, a field almost completely dominated by men, are likely to face some of these barriers, even if, or possibly even especially if, a department or program attempts to be “gender-blind.”

Another assumption of this research is that gender-blindness is a misnomer. Policies that ignore gender are likely to favor men, because of men’s longer history in higher education and

their greater representation in the upper levels of the institutional hierarchy. As a feminist, I do not believe that complete gender-blindness is possible or desirable, and that a conscious effort to promote women’s interests in higher education is necessary if women are to make progress toward real equality in higher education. This research was undertaken to discover what experiences may help women to feel at home in a field where they are currently underrepresented.

### *Personal and Professional Background*

Computing has been an interest of mine since I was given my first computer at 10 years old and taught myself to program in BASIC. Though I had little formal training in computing, I was an enthusiastic self-taught computer user.

I worked in higher education for 11 years as an instructor and an information technology professional. I earned my master’s degree in creative writing in 1996 and worked for three years as a part-time instructor in general studies writing. I taught many of my classes in a computer-mediated environment and designed and taught a writing class online.

I worked for eight years in Bowling Green State University’s Information Technology Services department, first as a help desk consultant, and later as an email systems administrator and a trainer. Though my background seems unusual, even to me, I have found that many people in the information technology field have found opportunities to learn on-the-job because of the shortage of people with computer science backgrounds. I have also found that at times, my status as a woman and an information technology professional has put me in the uncomfortable position of having to explain or prove myself. For example, near the time when I submitted my dissertation proposal, I had a conversation with a woman who works in student affairs when we met at an on-campus event. I had to repeat several times that I was, in fact, working in

information technology, because she did not seem to believe me. This experience was not unique. Other people outside the information technology field have a hard time understanding that technical work can be creative and fulfilling.

At other times, I had the experience of feeling that my ideas or requests were not taken seriously by my coworkers, who were mostly men, even though I had several years of successful experience and glowing performance reviews. Not sure whether this was because of my gender or my lack of training in computer science, I took professional training courses and programming classes in languages like Java and C++ to improve my skills. I found much about technology work satisfying, especially the thrill of the chase when I was trying to solve a particularly sticky problem. Unfortunately, the bureaucratic nature of a large information technology department was often frustrating, and the opportunities for advancement were limited. I decided to pursue a doctoral degree in Higher Education Administration in 2001 as a chance to expand my career options, though I continued to work full-time or nearly full-time while doing most of my coursework.

Recently I was hired by the National Institute for Technology in Liberal Education (NITLE), an organization that supports small colleges in using technology to serve their pedagogical goals. This organization seems like it will be a good place for me to combine my interest in higher education with my enthusiasm for technology.

#### *Interest in Studying Women Graduate Students in Computer Science*

In some ways, studying graduate students in computer science gave me a look at the “road not taken.” I had many interests in high school and found it hard to choose a college major. Despite my interest in computing, I never seriously considered computer science, I think in part because it seemed to be a field for men. I felt that I would be more comfortable in the English

department. I am interested in finding out how these women made the choice I was not able to make to pursue a course of study where they would find few other women in their classes.

I have chosen to focus on doctoral students because they had already made a serious commitment to computing and have been successfully admitted to a competitive graduate field. Many majored in computer science as undergraduates. This allowed me to learn from the experiences of people who have already had some success and experience in the field of computer science.

### *Research Background*

My coursework has included classes in quantitative and qualitative research methods and their applications. I have also taken some courses in women’s studies, including Feminist Theory. Until this point, I had only done research as part of my coursework. I was fascinated by the idea of qualitative research when I took my first class on the topic because I was attracted by the idea of a research methodology that, in the words of Guba and Lincoln (1989), “rejects the controlling, manipulative (experimental) approach that characterizes science,” and instead involved a process of working with research participants to come to a common understanding (p. 44). I happened to be taking a Women in Higher Education course at the same time, and the appropriateness of this kind of a method to a feminist study seemed immediately apparent, especially when I read in Ely (1991) that “whether we like it or not, consciousness raising – our own and our participants’ – is an inevitable piece of the process” (p. 225). Because of my literature and creative writing background, I also was attracted to the narrative and metaphor-making elements of qualitative research.

*Perspective on the Nature of Inquiry*

As is evident from my research questions, my particular interest in this study was the way that women make sense of their lives through their construction of gender and their perceptions of what it means to be a computer scientist. Central to questions like these is the assumption of a relativist ontology, that is, a belief that reality does not exist as a neutral entity “out there” to be discovered but that “multiple, socially constructed realities” are created by groups or individuals as they attempt to make meaning of their experiences (Guba & Lincoln, 1989, p. 86). The idea of “objective” research, then, is in direct conflict with this ontology.

Underlying this research, then, is an epistemology, or belief about the nature of knowing, that is subjectivist. As van Manen (1990) wrote, there is an “epistemology of experience and perception” and “an epistemology of language and text” (p. 38). We cannot see things without the filter of our own experiences and beliefs, or know them without the language to describe and understand them. Instead of striving to be rational and detached from our research participants, then, the goal is to “see through the eyes of others in order to understand and accurately describe their experience” (Ely, 1991, p. 122). Rather than distancing us from the world, van Manen wrote, researching lived experience is an “intentional act of attaching ourselves to the world, to become more fully part of it, or better, to *become* the world” (p. 5).

Because this was a qualitative study, this research did not ask “how many,” as in a quantitative study. The fundamental question for this study was, “what,” as in, “what is the nature of the experience of being a woman graduate student in computer science?” The intention was to create a description that is as true as possible to the participants’ experience. Because of the nature of qualitative data, the large sample sizes typical for quantitative research are not reasonable or appropriate for qualitative research, wrote Patton (2002), who deferred on the



question of sample size with “It depends,” and said that appropriate sample size for qualitative studies “depends on what you want to find out, why you want to find it out, how the findings will be used, and what resources (including time) you have for the study” (p. 244).

### Methodology and Methods

The decision to use qualitative research methodology was a natural result of my desire to know more about the experiences of women graduate students in computer science. Because the question concerns social constructions, the study seemed to be most appropriately framed as a phenomenological study, which Patton (2002) described as an approach that focuses “on exploring how human beings make sense of experience and transform experience into consciousness” and seeks to find the essence of that experience, “the core meanings mutually understood through a phenomenon commonly experienced” (p. 106).

#### *Assumptions of Phenomenology*

Phenomenology does not attempt to problem-solve, van Manen (1990) wrote, as much as it seeks to illuminate and illustrate experience to promote better understanding to allow us “to act more thoughtfully and tactfully in certain situations” (p. 23). Data are gathered in a phenomenological study not just for the sake of understanding one particular person’s situation, but to understand the essence of the phenomenon being studied. “Varying the examples” is then done so that “the ‘invariant’ aspect(s) of the phenomenon itself comes into view” (p. 122). Moustakas (1994) wrote that “From the individual descriptions general or universal meanings are derived, in other words the essences or structures of the experience” (p. 13).

The act of phenomenological research is a political act. van Manen (1990) said that human science, and phenomenology in particular, is “concerned with action” and designed to “bring us to the edge of speaking up, speaking out, or decisively acting in social situations that

call for such action” by making us more deeply aware of things that might have formerly been ignored or unexamined (p. 154). Moustakas (1994) also saw phenomenology as a radical act, writing, “my natural bent was to avoid people who tried to instruct me with their facts and knowings, and to approach things for the first time alone” (p. 41). Ely (1991) described qualitative research as “continuous circles within circles of action, reflection, feeling and meaning making” (p. 7). As Guba and Lincoln (1989) wrote, the goal is an experience that “leaves *everyone* more informed and sophisticated than before. It is an educative experience for all [emphasis original]” (p. 258).

### *Methods of Phenomenology*

There are multiple approaches to phenomenology. Patton (2002) wrote: “transcendental, existential, and hermeneutic phenomenology offer different nuances of focus” (p. 104). Still, they share the common focus of searching for the essence of experience through varied examples (van Manen, 1990; Moustakas, 1994). Both suggest that researchers understand their “biases, assumptions, presuppositions, and theories” and attempt “to hold them deliberately at bay” (van Manen, p. 47) or in the words of Moustakas, placing “the world in the bracket” as a fresh and new thing to be observed, in a state of clear consciousness he called the “Epoche” (p. 85). Both called for varying the viewpoints from which we see a phenomenon in order to arrive at its essence. Moustakas wrote that “each angle of perception adds something to one’s knowing of the horizons of the phenomenon. The process involves a prereflective description of the things just as they appear and a reduction to what is horizontal and thematic” (p. 91).

### *Participant Selection*

In the interests of finding the essential elements of the experience of women graduate students in computer science, then, it was important for me to select participants who represented

a variety of perspectives on this experience within my framework for study. Though it is difficult for a researcher to know what kinds of variations she might encounter ahead of time, Patton (2002) suggested that in building a research plan, “for planning and budgetary purposes, one specifies a minimum expected sample size and builds a rationale for that minimum, as well as criteria that would alert the researcher to inadequacies in the original sampling” (p. 246). My goal was to find eight to ten participants to allow for a reasonable level of variation between cases. As much as possible, I wanted to include women of different ages, races, and backgrounds to assure that the phenomenon, the experience of being a woman doctoral student in computer science, was described from different vantage points.

These participants were selected from four schools with varying structures and missions. Varying the institutions meant more variation of participant characteristics. It also helped assure that the themes that emerged were not just the result of the culture at one particular school or type of school. One important variation among schools was institution size and type. Another variation was how the program is located within the organizational structure of the school. At some institutions, computer science is located in the School or College of Engineering. Other schools locate computer science in the College of Arts and Science. The schools chosen had to be large enough to have a doctoral program in computer science, which means that including historically Black colleges and universities (HBCUs) or women’s colleges, as interesting variations as those schools might have presented, was impractical because most are liberal arts colleges and few have graduate programs.

### *Sites Selected*

Before starting to recruit participants, I selected the research sites. Initially, I researched schools through searches of their websites and calls to computer science departments. I chose

four schools that seemed quite different from each other in size, structure of the computer science department, and apparent efforts to recruit and retain women students. Because of the very small numbers of women graduate students in computer science, to protect anonymity, I not only used pseudonyms for the participants, but also for the institutions selected as research sites and the locations of those institutions.

The first, Large State University, was one of the biggest research institutions in the nation, with more than 55,000 students and several campuses, including a main campus located in the heart of a sprawling city. The “Computer Science and Engineering” department was part of the College of Engineering. Out of 178 graduate students in the program, 31 were women. From its website, it seemed that the institution was making a concerted effort to increase the number of women studying computer science. Out of 33 tenured and tenure-track faculty members, the only women were 2 assistant professors. The department’s efforts to recruit and support women seemed to be primarily the work of one woman, a lecturer in the department.

The second school selected as a research site was Regional State University, a public institution in a rural area near a large city. The school had slightly more than 23,000 students, including those at 7 branch campuses. Computer science was located in the College of Arts and Sciences. Out of more than 150 graduate students in the department, 30 were women. There did not seem to be a specific group on campus for women computer science students and gender equity efforts were not mentioned on the website. Only 1 of the 18 faculty members in this department was a woman.

The third school, Brighton Institute of Technology (BIT), was, as its name suggests, a school whose mission focused on the sciences and technology. BIT is located in the large metropolitan city whose pseudonym is Brighton. The BIT website listed an enrollment of slightly

more than 6,300 students, approximately 43% in its graduate college. According to the BIT institutional research website, 34% of students on campus were women, 17% were racial/ethnic minorities, and 37% were international students. There was a campus Women’s Services office located in BIT’s Multicultural Affairs office. My initial research suggested that out of 30 faculty in computer science, 8 were women. When I talked with one of the women faculty in the department, she said that there was only one other woman who was on the tenure track, so the other women faculty may have been adjuncts. The computer science department was the largest department in the College of Science and Letters. Out of more than 460 graduate students in computer science, 92 were women.

Finally, Rosary University was a large private Catholic institution, also located in Brighton. The school’s enrollment was slightly more than 23,000 students. The computer science department was part of a larger school that also included telecommunications. Because of the idiosyncratic structure of the school, it was difficult to determine how many of the faculty were actually teaching in computer science or how many were tenured or tenure-track. Out of almost 2,000 graduate students in computer science, slightly less than 500 were women. Most classes for computer science were held in a modern building in the middle of Brighton’s downtown, though the main campus was in a residential area and there was also a branch campus near the city’s airport. The doctoral program welcomed part-time students as well as full-time students, and two of the participants in this study were studying at Rosary part-time while working full-time.

### *Recruiting Participants*

Variations in student characteristics, including age, race, and educational background were important, in order include a range of perspectives on the phenomenon being studied.

Moustakas (1994) wrote that the essential criteria for participation in a phenomenological study included that the participants had experienced the phenomenon, were “intensely interested” in exploring the nature of the experience, and were willing to participate and consent to taped interviews and the publication of the findings (p. 107). Patton (2002) stressed the importance of choosing “information-rich cases – cases from which one can learn a great deal” (p. 242). Ideal participants would not only have experiences that were varied and interesting, but would also be able to reflect on and express these experiences. I contacted faculty at the institutions selected by email, asking them to refer potential participants who would be willing and able to discuss their experiences (Appendix A). I then contacted nominated students by email with a letter of invitation (Appendix B), introducing them to the purpose of the study and the expected time commitment required of them if they chose to participate. Participants sometimes were able to suggest other students at their school who would be interested in participating in the study. I also recruited some participants when I attended small regional conferences for women in computer science. Other participants were recruited through personal contacts I already had at the students’ schools. The resulting sample was, therefore, a combination of a convenience sample and a snowball sample. Interestingly, not a single woman refused my request to participate in the study.

This study was conducted in accordance with general ethical principles of qualitative research, as well as the procedures established by the Human Subjects Review Board (HSRB) at Bowling Green State University. Graduate students who choose to participate were fully informed of the nature of their participation in the study, the intended use of the data collected, their rights to confidentiality, and their option to leave the study at any time with no penalty to them (Appendix C). Identifying details and any other information that the researcher determined

may be a threat to participants’ anonymity and confidentiality were obscured, and every attempt was made to minimize risk to the participants (Ely, 1991; Guba & Lincoln, 1989).

### *Data Collection*

Interviews were the primary data collection method. An interview protocol (Appendix D) was used to give structure to the interview, though additional questions were used to probe for more detail if more clarity or explanation was required. Alternately, questions were deleted if the participant had already answered them in responding to a previous question. The interview process was complicated by the fact that I was dealing with concepts, like social constructions, that may not be “understandable and part of the frame of reference” of all my participants (Patton, 2002, p. 362). I tried to arrange my questions in ways that explored this phenomenon but that would also make sense to the interview participant. The interview protocol was piloted with a volunteer who had studied in the sciences as an undergraduate. Her responses helped me to refine the protocol and anticipate what kinds of probing questions might be required for follow-up.

Interviews lasted approximately 60 to 90 minutes and focused on participants’ experiences as women doctoral students in computer science. All interviews were digitally recorded. I transcribed each interview personally and sent transcripts to participants by email to verify the accuracy of the transcription and to clarify their meanings where necessary. I remained in contact with participants by telephone and email. I had several follow-up conversations and email exchanges with participants to check details or sharpen the focus on their experiences.

Conducting the interviews in person also allowed for participant observation to be used as another source for information. These observations included descriptions of the physical characteristics of the participant, the campuses under study, and the surroundings for the

interview. These descriptions were recorded in my research log after each interview to provide additional contextual information. I also recorded my early impressions of what major themes seemed to suggest themselves from the interview.

### *Data Analysis*

Coding reduced the collected data into manageable and meaningful sets. I used a qualitative research software package called NVivo to aid in coding the data collected. In a quick “first pass” through each corrected transcript, I selected elements of data that seemed relevant and created a code to describe the data, for example, “advisor issues.” I reused existing codes if the fit seemed natural, but at this stage, I did not worry about trying to keep the number of codes small. At times, I would be reminded of something in an earlier transcript by something in the transcript in which I was working, and would go back to code another part of the earlier transcript. This data coding was, therefore, an iterative process and was the most challenging part of the whole research project. Often I felt, “adrift in a sea of data,” as Auerbach and Silverstein (2003) so aptly described the early coding phase (p. 34). I took notes not only on the mechanical steps of data coding but also on my frustrations and other difficulties. After several cycles through the data, the rough codes that were created in the first pass through the data were refined to combine like codes until it seemed that further attempts to create smaller number of codes would obscure the meanings contained in the data. Related codes were then arranged hierarchically into “trees” of broader categories.

At this step in the analysis, I began looking at the data contained in each case, code, and tree to “question the record and add to it, to comment on it and to look for ideas that [led me] up from the particular data to themes in the project” (Richards, 2005, p. 69). These notes went into the research journal and became the seeds of my data model. At this stage I spent a lot of time



thinking about the data while walking or running in Wintergarden Park. This passive processing may have helped formulate my first data model, which occurred to me one morning when I woke up. I had an image of the women in the study as participants in an obstacle course, with family influences as the start line and women faculty members cheering them on. I quickly sketched it and then scanned it to save with my other research notes. This data model helped to suggest the themes that were most important to the participants’ experiences. This data model eventually evolved into a slightly different metaphor, the one displayed as Figure 1 in Chapter Six.

In a method that van Manen (1994) called “Transcendental Phenomenological Reduction,” themes were used to show what is essential to the phenomenon under study (p. 91). van Manen wrote that “Themes are the stars that make up the universes of meaning we live through. By the light of these themes we can navigate and explore such universes” (p. 90). The themes that emerged from the data helped provide structure for a narrative attempt to capture the essence of what it means to be a woman graduate student in computer science.

Direct quotations from the participants were used to give the description richness and depth, or, as van Manen wrote, to avoid a facile theory that “distorts and shallows-out life” by reducing it to only examples of the thing being studied (p. 152). Because the purpose is to understand the lived experiences of these women graduate students, wherever practical, I used their own words to help the reader see their experiences from their own viewpoint. As Ely (1991) wrote, an important strength of qualitative research is that it allows us to honor participants by “seeking to tell their stories rather than imposing our own, to report their meanings, to involve them powerfully in the research process, to describe their social context, not as separate but as it is lived and understood by them” (p. 229). This insight from the graduate students’ own perspective is the greatest potential for an original contribution by this study.

*Indicators of Quality*

Social scientists seek to do work that meets standards of quality and rigor. However, traditional measures of quality and rigor may be inappropriate for a phenomenological study, wrote van Manen (1990), if they encompass the idea that research should be “methodologically hard-nosed, strict, and uncompromised by ‘subjective’ and qualitative distinctions” (p. 17). Instead, the rigor in phenomenology comes from the difficulty involved in attempting “to eliminate everything that represents a prejudgment, setting aside presuppositions, and reaching a transcendental state of freshness and openness, a readiness to see in an unfettered way” (Moustakas, 1994, p. 41). There is also the difficulty of stripping a phenomenon to its bare essence in a way that does not compromise the integrity of the participants’ experiences. van Manen wrote, “a good phenomenological description is something we can nod to, recognizing it as an experience that we have had or could have had,” or, to put it another way, “*is validated by lived experience and it validates lived experience*” [emphasis original] (p. 27).

The primary measure of credibility was the study participants’ approval and confirmation of the results, a process known as member checking (Lincoln & Guba, 1985; Patton, 2002). During the interview, I made every attempt to verify that I correctly understood each participant’s meaning. I also provided transcripts of the interview to each research participant to allow her to check for accuracy and also to delete any material she did not want included in the study results. I created an online community to share my preliminary findings with participants and potentially spark discussion among them. Though this discussion among participants never materialized and I received only a few comments on the items I posted there, the comments I did receive helped guide my further analysis. I sent each participant her profile by email and asked for feedback. I further refined the profiles according to their responses. One participant did not

respond to my requests for feedback on her profile, but all the others approved their profiles, with some requesting changes. Once I had completed drafts of the results, findings, and conclusion sections, those were also sent to participants for review. I received only a few responses, but they were thoughtful. The final product reflects all of this input, and in fact, I completely changed a section of my findings in response to a particularly insightful comment from one of the participants.

Though this study may not have fully satisfied the qualitative ideal of “prolonged engagement” (Lincoln & Guba, 1985, p. 301) in the field, the additional contact by phone and electronic media helped me to develop a better understanding of the participants and check my constructions of their experiences. Patton (2002) wrote: “There are always trade-offs. Limited resources, limited time, and limits on the human ability to grasp the complex nature of social reality necessitate trade-offs” (p. 223). The costs and logistical challenges that resulted from my decision to conduct a multiple-site study limited the time I could spend with each participant. Despite this limitation, varying the schools was a good way to help ensure variation among cases and this seemed like a worthwhile trade-off. Graduate students are busy people and it may have been even more difficult to recruit participants if a larger investment of their time had been required.

Peer debriefing, described by Lincoln and Guba (1985) as a process by which the researcher’s “biases are probed, meanings explored, the basis for interpretations clarified” by a peer who is not involved in the study, was also used in the data analysis (p. 308). This helped to assure that I had not unduly imposed my own preconceptions and values on the participants’ words. My faculty advisor and three of my colleagues in the higher education administration

program served as peer debriefers, and their contributions during these sessions were valuable to my evolving constructions and final text.

Triangulation (Lincoln & Guba, 1985) requires that information gathered “be verified by at least one other source (for example a second interview) and/or a second method (for example, an observation in addition to an interview)” (p. 283). Themes were created only around ideas that fit this criterion. Sharing my preliminary findings with computer science faculty and students at two regional conferences also helped to verify the trustworthiness of my themes. I conducted a “Birds of a Feather” session at one of these conferences. This informal discussion was quite lively, and though most of the participants were undergraduates or faculty members and not graduate students, their comments also helped to provide confirmation of the themes that were emerging from interview data. The transcription of this session was included in my research log.

The research log served as an audit trail of the research process and a record of the decisions made over the course of the study (Ely, 1991; Lincoln & Guba, 1985). It also helped to provide raw material for the final text. Documents and related materials collected during the study, including transcripts, sketches, and personal observations, were collected in this log. This served both as a record of the decisions made during the research process and helped me in analysis and reflection as I was working through the data. This provided a method by which these decisions could be reviewed, as Ely (1991) suggested, to help me become aware of my “self beginning to ask questions, to observe, to share with a support network, to take time, to try something out, to err, to study that again, and to become increasingly courageous and reflective” (p. 105). This was important not only as a check on the trustworthiness of my observations, but as a learning tool as I served an apprenticeship as a researcher during the dissertation process.

## CHAPTER IV: PARTICIPANT PROFILES

This chapter is composed of profiles of each of the participants. These profiles are intended to give a brief introduction to each participant, including her demographic characteristics, her progress in her graduate program, and some of the events that led her to pursue a doctorate in computer science. Physical descriptions of the participants are included because, as Patton (2002) wrote: “Qualitative data describe. They take us, as readers, into the time and place of the observation” (p. 47). The goal of the profiles is to help readers get to know the participants and empathize with them, so descriptive details are included as one more entry point into these women’s experience. The profiles are arranged in alphabetical order by the participants’ pseudonyms.

All ten participants were enrolled in doctoral programs in computer science at the time of the first interview, but three participants were in a Direct Ph.D. program, meaning they were admitted immediately after completing their undergraduate program and had not yet earned a master’s degree. The participants ranged in age from their early twenties to their late fifties, and included two students from Asia, two who had been born in the Caribbean and came to the U.S. at an early age, and six American students. Two participants were Asian, three were Black, and five were White. Participants were at various points in the degree process, from their first semester of graduate school to late in the dissertation stage. Two students were attending school part-time while working full-time. The rest were full-time students.

## Adelaide

Adelaide was the first participant I interviewed. A mutual friend introduced us. Adelaide was gregarious and laughed a lot. She was White and in her twenties, with glasses and curly,

chin-length red hair. She wore a red polo shirt and khaki shorts when I interviewed her. Her clothes were casual, but everything looked crisp, like it had been ironed.

We talked in her apartment, and I was struck by the combination of order and playfulness of her surroundings. She showed me a pen that said “geek” that she had gotten at the Microsoft world headquarters. During our interview, she sat in a chair that dangled from the ceiling like a swing. Her bathroom was decorated with a toilet seat with a British flag on it, and she had stenciled the Tower of London all over the walls.

Adelaide grew up in a blue-collar family that valued education. “We were always at the library, and always learning, and homework was always first, no matter what.” She had early exposure to computing through a program called the Explorers that was run through the Boy Scouts. The group did internships at a NASA research center. Her group worked in computer engineering, and Adelaide said that even though she had “no idea what I was doing with computers at the time and hated programming,” she found that she learned quickly. She also held a job while in high school that was primarily secretarial, but she ended up helping the office with computer maintenance.

Adelaide attended college at a small liberal arts school. Her choice of major was partly based on chance. “I really thought I was going into chemistry, but didn’t really like the chemistry guys that gave the qualifying placement tests. And the books were cheaper for computer science!” She found that she enjoyed computer science and was even given a chance to be a computer science teaching assistant her first year in school.

Adelaide did well in her classes, and her professors encouraged her to go on to graduate school. “I liked the teaching . . . and a lot of people at NASA had Ph.D.s or master’s, so it was natural to want to go on.” After she finished her master’s degree, she decided to go on for her

doctorate at the same school. She had recently passed her doctoral candidacy exams when we talked.

When asked how women’s experiences in computer science might be different from men’s, Adelaide said that she did not notice professors treating her differently in classes, but socially “there’s sort of that aspect where you can get treated a little bit, like on the outside.” She also discussed the issue of appearance. Adelaide mentioned that she had a breast reduction for medical reasons in the middle of her graduate career. It was not until after the surgery that she realized “the emotional, or sort of societal things that were there.” Adelaide thought that students, especially male students, treated her like more of a professional after the surgery. “People treat me less like I’m a dumb person with smaller breasts.”

Adelaide believed that appearance was very important in the classroom. She said women teaching assistants had to make more of an effort to look professional than men in order to be taken seriously:

I will see male graduate assistants wear sandals, junky beater sandals, a pair of shorts, and a t-shirt to go teach. If I wore that kind of clothing, I don’t think that I’d get the respect that I feel I deserve.

In her experience, wearing professional clothes and getting a shorter haircut contributed to her getting less “sass” from the undergraduates she taught. Adelaide seemed to work hard at being a good teacher, and her career goal was to become a computer science faculty member. “I really like to teach. That’s why I wanted to do this.”

Becky

Becky, a second-year doctoral student, was a White student in her mid twenties who looked younger. She was thin with pale, freckled skin. She wore her hair pulled up in a short,

high, fuzzy ponytail and wore jeans and a cap-sleeved blue t-shirt. There was nothing casual about her other than her clothes. She smiled and was friendly but a little reserved. I would not describe her as shy, just confident and self-contained.

We met in Becky’s office, a computer lab where she worked. She had pictures of her two cats on the wall. She talked about feeling isolated in the program, but she said she had close friends from her hometown and in other departments, so it did not bother her that she did not socialize with her fellow students.

Becky’s parents are both professors at the small, Christian, liberal arts college she attended. Her father teaches in biology, and her mother teaches math to education majors and earned a Ph.D. in education while Becky was in college. Becky says that her mother’s decision to pursue her education while raising a family gave her a sense of what was possible for her as a woman:

She was balancing a full-time teaching job, taking care of my brother and me, and working on her master’s and then later her Ph.D.... her experiences, I guess, taught me that she could do all of those things, and that she could go on to get her Ph.D. and still manage the family. Now she looks back at it and wishes she had more time to spend with my brother and me, but yet, I guess I don’t see it that way.

Becky started college as a biology major, but she had done some programming on her graphing calculator when she was in high school. She thought it might be fun to take a computer science course in college. “As I got into the computer science program, I really enjoyed it, so I picked it up as another major, so I had a double major, biology and computer science.” The computer science department at her undergraduate institution was small and close-knit. It had



only two professors, both men. “I did well in the classes and stuff so I never felt like there was any difference between me and the other students, really.”

Becky said that her parents encouraged her to explore her academic interests. “It had always kind of been assumed that I would go on for graduate school.” She decided to go on to study computer science partly because she was a “nervous test-taker” and she thought the entrance exams for computer science would be easier than those for biology.

Becky had some difficulties in her graduate admissions process. Her mother suggested that Becky take a course at Regional State University just to fulfill some requirements that she had missed in her undergraduate career as she was doing her second round of graduate applications. After taking these classes at RSU, Becky decided to apply to the master’s program and then stay on for her doctoral degree, because she was already familiar with the school.

Becky identified very strongly with her subspecialty, bioinformatics, an application of computer technology to study biological problems in areas like protein structure and genetics. One of her undergraduate biology professors said that as a double major in biology and computer science, this was a perfect field for her. “Every time I saw him, he would always say, ‘Bioinformatics! You have to go into bioinformatics.’” When Dr. Hamlin, a woman faculty member with a specialty in bioinformatics, joined the faculty at RSU, Becky decided to talk with her and find out more. Becky said Dr. Hamlin’s first question was “Why aren’t you in my bioinformatics class?” Becky took the class and Dr. Hamlin became her advisor:

And it definitely helped that she was female, at least from my perspective. She was easier to go and approach at first. And then it just kind of fell into place that she was female in the computer science department and working in an area that I had been told for several years was the perfect area for me to go into.

Becky said she was most interested in a career in bioinformatics research, but that she would also consider a faculty position if she had the opportunity to do interdisciplinary work. “I would definitely want to work with both departments, especially since my background is in both areas and I understand both areas. I would definitely want to be able to have that opportunity and not just be strictly computer science.”

### Camille

Camille met me at my hotel for our talk. She was wearing a hat with an abstract art pin on it and an African-print top. Her hair was gathered in a braided bun. She was a fun woman, very warm, and talked expressively about her experiences and her plans for the future. She said she was going to be the first African American woman to graduate from Rosary University with a Ph.D. She earned her undergraduate degree in the late 1970s, which would probably put her in her early 50s, but was hard to guess her age. She said, “Being a little bit more mature, I have a whole different outlook on life than if [I was] 30. I’m not trying to have kids, did that. Was married, got divorced, did that.”

Camille received her bachelor’s degree in math from a large private research institution. She said that she wanted to go on to get a master’s degree at a prestigious business school, but, she laughed, “my dad decided he didn’t want to pay any more money. So, I kind of changed my plans there.” She was recruited by a telecommunications company and was trained as a computer programmer. As she advanced in her career, she decided to go back to school for a degree in finance:

I was moving up the technical ladder, and I decided I wanted to be a manager...

So I got my MBA. Why I got it in finance I don’t know. I don’t even think they had MBAs in MIS at that point in time.

Camille had a mentor in her company who helped her along in her career:

I had one Black woman who was over me that kind of just kept pulling me up with her. Because there weren't a lot of women, nor were there a lot of Blacks, minorities, when I was moving up. So every two years, I got promoted, and she kind of got promoted.

Camille was in a high-powered management position when, after 22 years in the information technology industry, she decided to go back to graduate school in 1999:

It was a great adjustment, because I was a director then. So I was getting, like, stock options, and bonuses, you know, \$13-15,000 bonuses. So to go from over six figures, a nice amount over six figures, to zero, you know, going back to school, was a huge adjustment and a huge sacrifice. But, my quality of life now is so much better. Because, back then, it was just the hours that I worked. You know, I worked many, many hours and got called in a lot, when my programmers got called in and my managers. So, it really gave me kind of my life back.

Camille had some setbacks in graduate admissions. As she expected, she did not do well on the entrance exams. “I just don't test well. I don't know what it is about me and testing, standardized tests, never have. Only in math. Math, it's off the charts.” Her scores kept her from being accepted into the doctoral program of her choice. She chose to take this setback as a chance to upgrade her skills. She started a master's degree program, met the faculty, and excelled in her classes. When she applied for the doctoral program again, she had no trouble getting in. “My stuff was not all just great and rosy and cheery. But I was resilient. I made sure that I went over those obstacles.” She was even able to teach as an adjunct faculty member while working on her degree.

Camille was working on her dissertation when we talked. She planned to seek an academic position so that she could help recruit more women and minorities to the computer science field.

### Ginger

Ginger was a Black woman in her thirties who was “born and raised, at least in part” in the Caribbean. She met me in my hotel room for the interview and was wearing a red wool hooded sweater, black jeans, and a black corduroy cap when we talked. She was lively and optimistic about her future and talked very animatedly about her plans.

Ginger had three or four different careers in mind, ranging from designing expert systems for the healthcare industry to going back to the Caribbean to help create a better technology infrastructure to help improve economic and educational opportunities for people living there.

Ginger earned a bachelor’s degree and a master’s degree in health policy and administration and began her career in the health care field. Because of the volumes of data involved in healthcare, she found herself more and more interested in technology solutions to some of the problems she was encountering in her work:

We were making really big, important decisions without any good information.

So I initially thought about database management systems, but then I started to think about the Internet because I started to really like what I was seeing from the standpoint of communication.

She said she was also intrigued by the commercial potential of the Internet.

In 2000, she went back for a master’s in computer information systems at Rosary. Once she got involved in the degree program, her interest in computing increased, and she decided to go on for a doctorate:

I would not say that initially that I had the thought of pursuing a Ph.D. in anything. But my interest really, really peaked once I actually started the program. It just started to show me everything that was possible.

Ginger chose a doctoral program that welcomes part-time students. It was important to her to be able to work full-time while attending classes. “I just did not want to be in a program where I had to give up absolutely everything in order to do this. I’m married now; I just have plenty of other life things going on.”

When we talked, Ginger was in her second year of the doctoral program. She said she had found a good support group of other women in the program. She had expected to be isolated because of the reputation of computer science as a male-dominated field, but that had not been her experience so far, and, “there actually are also more minority women than I thought, too. So that’s also a nice boost.”

### Hazel

Hazel was a second-year student in a combined master’s and Ph.D. program at Large State University. She was a White woman in her twenties, pale and delicate-looking, with mid-length red hair and freckles. She wore a green v-necked sweater and jeans.

This fragile appearance contrasted with Hazel’s determined, self-sufficient persona. I noticed right away that her conversational style was a little blunt. When I asked her if she wanted to choose the pseudonym I would use for her in my research, she laughed and asked, “Why would I possibly care about that?” She seemed to have a sharp mind and a dry sense of humor.

We met in her apartment, which was in a mostly-student residential area within walking distance of campus. Her apartment seemed very normal — not messy but not overly neat either, just lived in. On a bookshelf near the table where we talked, I noticed a huge zip-top bag full of

all different kinds of dice, something I recognized from playing Dungeons and Dragons and other similar games when I was in college. She said she got them at a gaming conference.

Hazel said she had always been interested in computers. “I programmed from the time I was ten, basically, little things.” She earned her undergraduate degree at a highly-regarded state school, with a major in linguistics and a minor in computer science. She said her interests were “wide and varied,” and she changed her major a few times, starting with education and “and also music at one point.” She considered switching her major to computer science after her first class, but decided against it because she would have had to make up too many prerequisites.

Hazel was interested in computational linguistics, so when she applied to graduate schools, she applied to computer science programs and also applied to some linguistics programs as a fallback option. She said she chose her school because it was “the best computer science program that offered me money.”

Hazel said she enjoyed the immediacy and practicality of computer science. “I like the fact that it’s really science, you’re doing scientific things, but you’re immediately making things that do something.” She enjoyed doing computer science research and was confident in her abilities. “I’m willing to work, and do the stuff I need to do, and I work lots of hours, so I fit there. I’m good at the theory.”

Hazel said that as an undergraduate, she sometimes got the sense that her classmates were challenging her to see if she really belonged in computer science. She said that once she got to graduate school, people assumed that she had what it took to be there. “It’s really intimidating a lot of times. But, I like that. That’s sort of fun for me.”

## Ishvani

Ishvani was a third-year doctoral student at Brighton Institute of Technology. We met in the library on campus and used a small conference room for our interview. Looking for an Indian woman you have never met on a technical campus is tricky. When I told her this she laughed and said, “I should have told you I wasn’t one of the twenty-somethings.”

Ishvani was a thin woman, probably in her late forties, and wore her salt-and-pepper hair pulled back in a long braid. It was a cold day and she wore a heavy turtleneck sweater. It was difficult to hear her at times during the interview, because she has a very quiet voice and there was a hum from the heating system that sometimes drowned her out. She answered my questions thoughtfully and was the only person who requested a copy of the interview questions before we met. She seemed a little melancholy when we talked but was very kind. After our talk, she offered to drive me to the train station because she was worried about me walking around on campus in the dark.

Ishvani studied physics and science in India and earned a master’s degree in physics. She said she grew up in a conservative family in India, and was expected to focus on marriage and family. “You do get an education, but it’s just something to keep you occupied until you get married.” Her father was an engineer, and she said her interest in computers started because “he used to talk to me about transistor circuits and logic circuits.” One of her friends, a woman close to her own age, was a science talent scholar, and Ishvani said she was “pretty fascinated” when her friend came home from summer camp at the Indian Institute of Technology.

Ishvani said that she and her husband “always had pretty much of an equal relationship.” When they moved to Australia in the late 1980s, they “didn’t come out of the country with much

money,” so she started looking for a job. She had a chance to take part in a “Technical Jobs for Women” program that provided training and employment for women in technology fields.

Ishvani completed a bachelor’s in computer science while living in Australia. When she and her husband moved to the U.S., she got a master’s degree at Brighton Institute of Technology. She worked for a while in industry, and then her husband got very sick and she had to quit her job to take care of him:

A year later, he didn’t survive. I had to do something to come out from that, and that’s one of the, it may not be the greatest of reasons, but that was one of the prime motives to get into a Ph.D. program, just to get me back on the rails again, so to speak. This has helped me tremendously, I have no doubt. I didn’t plan on a career at that point.... There was recession and the job market was depressed with, a lot of jobs going away from this country, so I hadn’t planned a lot on how I was going to use my qualification. At that time I wasn’t even clear if I would be able to handle this or not. The more you do it, you find that it’s a lot of commitment as far as time, you don’t even know if you’re good enough. But slowly you realize that you’re learning a lot and it’s becoming more interesting. So I’m enjoying it now.

Ishvani said that at her school, “I find all the time I’m listening to more of languages spoken in India than English,” and that other Indian students are surprised to see someone her age in their classes. “It takes a while, but once they get used to me, we’re okay.”

#### Linn

Linn was a tall, very thin woman from Southeast Asia. A first-year student at Large State University, Linn was in her early twenties, with short hair and crisp clothes. She carried a large,



heavy-looking backpack. She seemed shy and spoke a little haltingly, though she smiled a lot. I got the sense that she still was not completely comfortable communicating in English. We talked in a conference room at the library. Her answers were mostly short and seemed a little guarded.

Linn said that she grew up in a very conservative family where “my mom and my grandma, they always gave priority to my brother.” She also had an older sister. Her father left her mother after Linn was born, and as a result, “my mom had to work a lot, because she got separated from my dad, so she couldn’t really pay attention to me. I was just by myself all the time, alone.” She went to a public all-girls’ school in her home country and was one of the top students there. “Even coming here, I just applied for schools and said, ‘I’m going,’ and she said, ‘Okay.’”

Linn attended a very selective women’s college in the Northeast United States as a computer science and economics major. She took a year off while she applied to graduate schools:

I applied to a lot of grad schools. I applied to [this school] because my fiancé is here, he’s going to [this school], but he’s still doing undergrad. He took some years off so he’s only graduating this spring, whereas I graduated earlier. So that’s one of the reasons I applied to [this school]. If I got in to another school I wanted to go to, I was going to go anyway, but what happened is that I didn’t get into other schools with funding, but I got into [this school] with funding, so I came.

Linn said she would not have chosen her current school if it was not for her fiancé. She said that because her undergraduate school was so small, even though she was shy and “my

English was not good,” her professors knew her and were able to help her. “Whereas here, sometimes you can get lost.”

Linn said her graduate classes are harder than she anticipated, “I feel like I’m losing confidence, because I’m not doing well in some of my classes, and sometimes I’m afraid that I might not be able to do it even though I want to.” Her goal is to become a computer science professor at a small school like the one she attended as an undergraduate.

Linn seemed a little wary of my dissertation topic of women in computer science. At the end of the interview, when I asked if there was anything else, she said,

People always talk about being a women and then men, and being successful in the CS field or whatever field. For me, at least, I think it doesn’t matter which gender, whether you are a man or a woman, it just depends on the person. I came from [an all-women’s college] and I’ve seen a lot of strong women. I don’t think it’s just because you’re a woman that you won’t be able to do it. It’s just because of who you are, or your personality, your mentality, your intelligence. That’s what I think, at least.

#### Olivia

Olivia was a doctoral candidate at Rosary. She was a pretty woman who looked about 25, but told me she was 42. She said that she and her parents moved to the U.S. from the Caribbean when she was 3 or 4 years old. When we met on one of the coldest days of the year, she was all bundled up with hat, scarves, gloves, big puffy coat. Underneath she had a light blue v-neck sweater with a t-shirt and jeans. She wore her hair long and relaxed.

Olivia said her parents were interested in her education when she was growing up. Because her parents did not speak English, they sent Olivia to nursery school so that she could

learn the language faster. Olivia did well in school, but when her teachers suggested she skip a grade, her parents did not want her to, because they were not going to be able to help her with her homework if her studies got too difficult. Olivia attended an all-girls’ Catholic high school in Brighton and earned a scholarship that paid for most of her undergraduate education at Brighton Institute of Technology:

We had really good counselors. Being from [a predominantly minority neighborhood in Brighton], being a minority, a lot of the schools sent materials to our high school to get girls interested in engineering. A lot of the colleges had Saturday and summer programs to get us interested. [My undergraduate institution] had a summer program, and that’s how I started getting interested.

Olivia began at BIT as an electrical engineering major, but “physics was not my friend.” She was doing a work-study job in the computer science department, and a woman professor in the department suggested that Olivia take a computer science course to see if she might want to switch majors. “It ended up being the perfect match. Not that it was all easy, not all the classes were easy, but it was something that I was good at.” She found more peer support in the program, and “to me, programming has always been about translating languages,” something that came naturally to her after growing up bilingual.

Olivia said her interest in computers was also partially financially motivated:

I wanted to get a degree in something that would be a good career, would have a lot of choices, but would also have a good pay scale, so that I could help out at home, because I was the oldest of three.

She worked in industry for a while and then went back for a master’s degree in management information systems. Olivia said that Affirmative Action helped “put my foot in the

door” for her first few jobs, but she was concerned that as a minority and a woman, she would need to work harder to get ahead:

I went back to get the first degree because that’s the only way you’ll get promoted as a female...I wanted to be ready for whatever the next level would be. So this way, when I would say, “How come I didn’t get promoted,” people couldn’t say, “You don’t have....” I could be, “Whoops, I got one of those.” I’ve been working hard. So I think that’s kind of why I went back. And I think sometimes for guys, it’s different. They just expect this will happen, whereas I have to be conscious of the fact that, no, I have to be ready for whatever kind of situation arises.

Olivia earned her master’s degree while working full-time. She also did some part-time teaching in computer science after she graduated with her master’s.

Olivia did not have a specific career goal in mind when she started working on a doctorate, “I’ve always wanted to get my Ph.D. Like I said, I’ve always liked school, so studying is just something I guess I enjoy doing.” She said she sees academia “as a back-up career, depending on what happens with the economy,” though she is drawn to teaching as a way to be a role model and mentor to others.

Olivia said that before entering each degree program, she checked in with her husband, a mechanical engineer she met at her undergraduate institution, “So, before I went back for my master’s, I asked my husband, ‘Okay, so where do we stand with the kid thing, are you ready?’” She did not want to interrupt a degree program to have a baby. “If I had a couple of kids, I would stop working. Or, fortunately, my mom would move in and take care of the kids, and I could continue working.”

When we talked, Olivia had completed all her course requirements and was working on her dissertation. She had to change projects, because working on her degree part-time in a field that changes so fast meant that some of her research became less relevant. “Starting in January, I’m hoping to cut back and work 30 hours a week, four days a week, so I can have more time to finish. I’ve been doing this for six years. It’s time to complete the degree.”

#### Susan

Susan was a doctoral student at Brighton Institute of Technology, and was in the process of writing her dissertation proposal when we talked. I met her in the hall that houses the computer science department, a run-down 60s-style building with drab, peeling paint. As a 50-year-old White woman with wild graying hair and glasses, Susan might have passed for a professor instead of a student if it were not for the navy blue sweat suit she was wearing. The faculty member who had referred Susan to me as a possible participant told me Susan had a disability but was not specific about it. Susan also mentioned being disabled but did not elaborate. She answered most of my questions with short, clipped phrases, and did not go into much detail, even when I attempted to probe with follow-up questions.

Susan graduated with an undergraduate degree in sociology from a regional public university in 1975. She worked in the not-for-profit sector for a while after graduating. In 1990, she decided to go back for a master’s degree in computer science. She said, “I wanted to go to graduate school all along, but I didn’t know what to major in.” Her parents supported her through most of her education, and her father’s expectations were an influence on her choice of majors:

I kind of regret that I didn’t go into social work, but my father wouldn’t pay for it.

He was willing to pay for everything, all my schooling, but he said he wouldn’t

pay for [social work] because you get paid peanuts. So that’s what kind of, set it back. I should have really gone into social work and switched to a different field from there. At least I would have had something, instead of working in offices as a clerk and things like that.

Computer science attracted Susan because it seemed like a field where she could make a good income, and because “I was very good in math. I had three semesters of calculus, one semester of differential equations.” She tutored students in math while she made up prerequisites required for a master’s in computer science. Susan completed a master’s degree in computer science at her current school in 1992, and started her doctoral program in 1993. Her father had been paying for her education, and his death triggered a series of financial and personal setbacks that slowed her progress toward her degree.

Susan stood out from the other students because her graduate career was interrupted so many times by financial and health problems. Because she had been working on her degree for 13 years when we talked, she was required to make up many of the courses she took early in her graduate career. Those issues, and her feelings of being older than the other students, were more dominant for her than the gender issues. Her campus is in an urban area, and seemed to pay more attention to security than some of the other schools I have visited. Susan said she had been stopped several times by campus police, who asked to see her identification and remarked that an “elderly” woman like herself did not look like a student.

Out of all the participants, Susan seemed to have the least interest in computer science. She was very uncertain when we talked about whether she would actually be able to graduate from the program, and if she did, whether she would be able to find good employment.

## Valerie

Valerie was a first-year student in a combined master’s/Ph.D. program at Large State University. She was White and in early 20s, with short, curly hair and glasses. She wore jeans and a sweatshirt from her undergraduate institution. We met in her office, which was a small, dingy white room in a corner of a high-rise building.

Valerie said that had varied interests in high school:

I was bent on being a music major. So I took all the music classes, but we had a computer science requirement. So I put that off until my senior year, took ‘Introduction to Programming,’ and discovered that it was interesting and challenging and I was pretty good at it.

She still did not want to consider computer science as a career because “I had all these other things I wanted to do.”

In her first year of college at a small state university, Valerie took another programming class and decided to major in computer science. “I suppose it was just because it was something that I felt I was good at and I kind of enjoyed.” She applied for master’s programs, but the only place she got accepted with funding was her current school. LSU accepted her on the condition that she enter their Direct Ph.D. program. Valerie had wanted to do a separate master’s program so that she could explore the field before jumping into research. She wanted to be a professor, though, so she decided that the opportunity was too good to pass up. When we talked, she was feeling worried and a little demoralized:

I think there’s a lot of pressure to hurry up and find a research project, because you have to have something published by the end of your, second year, I think.

I’m just, that’s really freaking me out! I just, I don’t know what to do. I’m

coming in here saying I wanted to go to grad school, not because I want to get involved in research right away, but because I want to, like you said, kind of explore what’s out there first. I’m thinking, with these crunch time requirements, that’s not really a chance to do that.

Valerie was keeping herself motivated by to focusing on her vision for the future. She said she wanted to teach at a college similar to the one she attended as an undergraduate.

Valerie’s undergraduate advisor, the only woman in the computer science department, helped shape her career goals:

She’s the chair of the department, and she just has endless energy, it seems. She devotes her time to the faculty senates and the volunteer activities, and you can always see her out on her bike around campus. It was neat to see her and run into her sometimes accidentally. She knows how to deal with people, which makes her a great department chair. She knows when to be firm with people, but she doesn’t go over the line of actually being rude, but she knows how to be firm with people. She’s just nice to everybody. She just knows how to deal with people; I don’t know how to put that into words. She’s a great teacher too.

The interview process seemed cathartic for her, because graduate school has proved more challenging than she expected and she had always been used to being a top student. Her undergraduate program was small and close-knit, and she seemed to find the larger university program to be alienating and isolating.

### Summary

Though the participants varied greatly in personal characteristics and the details of their stories, there were some common threads among their experiences. In Chapter Five, I address



their answers to the research questions introduced in Chapter One. In Chapter Six, I present a data model that highlights the common themes important to their experiences. This model is my construction of the phenomenon being studied, the gender constructions and experiences of women graduate students in computer science. Finally, in Chapter Seven, I discuss these findings more in depth in the context of the literature base presented in Chapter Two.

## CHAPTER V: RESULTS

The profiles in Chapter Four gave a brief sketch of each participant and an introduction to her story. In this chapter, I present the results of my research, organized by research question. I set out to learn about women graduate students’ career aspirations, how they feel about their chances to succeed in their chosen career and field, how they construct their concept of womanhood, their constructions of the discipline of computer science, and in what ways they believe their gender has affected their experience in their graduate programs. Major themes that emerged in response to each question are discussed and illustrated with quotations from participants.

#### How Do Women Graduate Students in Computer Science Construct Womanhood?

The participants had varying ideas about what it meant to be a woman. Three expressed the idea that their positive view of themselves grew out of their very positive views about women in general. The other seven saw themselves as different from most of the women they knew because they were more willing to challenge traditional gender roles. The distinction is the degree to which the participants saw themselves as similar to other women they knew.

Seven participants discussed what they saw as differences between the genders in communication and working styles. All participants were asked what they imagined when they thought of a happy or satisfied woman and most of them expressed similar ideas. Additionally, six women talked about motherhood during the interview, whether or not they were mothers. This seemed to be an important part of how they defined womanhood.

#### *Positive Views of Women*

Three of the women said that they had very positive views of women in general and saw themselves in a similarly positive light. Linn said that she thinks people overemphasize gender.

“For me, at least, I think it doesn’t matter which gender, whether you are a man or a woman, it just depends on the person. I came from [an all-women’s college] and I’ve seen a lot of strong women.” Ginger said that she is grateful for the positive media images of women she saw when she was growing up that helped open her up to a wide range of possibilities:

I saw enough positive female role models to help me determine that being a woman isn’t just one thing. Which is nice, because we do have many dimensions.

I think if I were growing up in the 60s or the 70s, I might have had a totally different experience. I was a teenager in the 80s, and at that point, I saw lots of good, positive images.

Valerie mentioned that her women’s Bible study group used their studies to empower them to take on strong roles, because, “there are examples of very strong women in the Bible, and we tried to take our examples from descriptions of those women, or descriptions of women in general that we would find.”

### *I’m Different From Other Women*

Seven of the participants saw themselves as different from other women they knew because of their willingness to challenge gender roles. Olivia said, “I’m different from other women that I know because I’m not wishy-washy. I really don’t care what other people think. I don’t know if that’s only different from other women. That’s [also] different from some other men.” Camille was not about to let other people’s expectations limit her:

I think other women let people define them. And I refuse to do that, to a certain extent...sometimes I push those little borders a little bit, and sometimes I decide it’s not worth it, it’s too much of a fight. But I think more women collapse, and

say, ‘Okay, So-and-So has said that I’m like this,’ and they become like that and they don’t push.

When she got to college Susan was surprised to discover that her parents, who had raised her as “an equal, like a man,” were unusual. “I found I was different. Because at that time, back in the early seventies, women weren’t allowed to do this, they weren’t allowed to do this; they weren’t allowed to do this.” For Ishvani, leaving her home country opened up new possibilities not available in a culture that expected women to be primarily homemakers:

You do get an education but it’s just something to keep you occupied until you get married. That’s the kind of basic message, that’s how it was. . . . Coming out [of that country] has helped me to bridge that, and has given me an opportunity to do something with a life.

Adelaide, Hazel, and Becky all said they spent more time with boys than girls growing up. Adelaide and Becky both used the word “tomboy” to describe themselves, and Hazel said, “I always felt like, from everyone else’s perspective, even though physically I’m obviously female, I shouldn’t be a woman. I’m not, from their perspective.” She said that she sometimes feels a disconnect between herself and other women. “I always felt like I had trouble talking to other women. And my mom also says the same thing.” When asked to elaborate, she said:

I feel like there’s almost a disconnect between the way we talk. Not necessarily what we’re thinking and feeling, but other women will often say things and I’ll be confused as to what their point is, or why they’re upset. It’s not because I wouldn’t be upset in their position, it’s probably because I would say it some other way... And so, it’s weird. I don’t get that talking to men, and I do with

women, so that’s a very definite difference. Although maybe men get it when they talk to me, so I don’t know.

Adelaide said that at her internship, she felt she tended to spend more time with the men in the group than the other women:

The people that were more competent, and more intelligent, just honestly, that were just more sort of go-getters were the males. The group of males that I hung out with. So, there were some females, but I never aligned myself, funny enough, with women.

Becky said, “I liked climbing trees and playing in the mud and all of that kind of stuff, what the guys did. So I guess that still kind shows through a little bit.” Becky thought that her tomboy experiences growing up prepared her for working in computer science:

The fact that there are few females in it is not going to hinder me from working in the area. And I guess maybe there’s a little bit of that, you know, kind of, “ha, ha,” to the guys. Of, “I can do this too. And in some cases I can do it better.”

Three of the participants who focused on differences between themselves and other women mentioned the importance of appearance to other women as one example of these differences. These women were attractive and well put-together, so it was not that they totally disregarded appearance. It was just less important than other things. Adelaide said that though now she sometimes enjoys getting dressed up and “being sort of girly,” when she was younger, paying too much attention to those things seemed silly. “When I got to high school and then college, women who always looked nice weren’t always interested in academics. So I associated, for too long, that looking nice and being smart didn’t go together.” Olivia said, “I’ve always been, like I said, the nerdy type, the glasses, the librarian, the bun, whatever. Late bloomer. And

it never bothered me.” Becky said, “My cousin Marie was more of a girl, who was into clothes, makeup and stuff. And I really could [not] care less! And some days now I really could [not] care less.” Hazel also expressed the idea that sometimes, it was important to focus on practicality:

I was talking to a girl who works in my lab the other day, we have a big conference. And she was organizing the conference, so she was completely frazzled from this huge experience, and we were walking back at like midnight or something, and she looks down, and she’s like, “Why did I wear sneakers today?” I said, “Because you had to walk around all day.” But she’s like, “But all these girls are dressed so nicely.” And it’s like, why would you care about that? So I feel like a lot of times, I care less about that stuff [than other women]. It doesn’t mean that I always don’t care about it.

It was not that appearance was never important, it was just that there were times when other things should be more important.

The common thread between these stories was the participants’ sense that they were different from other women they knew. In some ways, they identified more with men than with women. They saw themselves as exceptions to traditional gender constructions, rather than rejecting negative constructions of women in general.

#### *Differences Between Men and Women*

Seven participants discussed what they perceived as differences between men and women. They discussed differences in communication and working styles between the genders.

Ishvani, Becky, Adelaide, Valerie, and Hazel all said that men and women communicate differently. Valerie said that she and her friends spent a lot of time discussing relationships

between men and women. “There was a lot of complicated stuff that goes into that because we communicate differently and all these things.” Ishvani said, “When you start communicating, you’re at really different wavelengths sometimes with a man. Although you are doing the same work, yet your means of communicating are a little different.” Hazel, as noted earlier, said she found it easier to talk to men than to women. Becky said that the difference was the amount of information women provide when communicating or writing documentation. “I think [women are] more, maybe, detail-oriented.” Adelaide said that women were “sometimes a little more chatty.”

Four of the participants said that men and women have different work styles. Olivia said that women are able to do more things at a time. “I don’t think that the men I know can multitask. I think that they can do a good job, but they do things one at a time and really focus.” Hazel thought that men’s unwillingness to ask for help was a disadvantage to them because it made them waste time. “Instead of asking someone who they know knows, they spend hours and hours figuring it out for themselves.” Valerie expressed the same idea but thought it was an advantage for men that “at least in regards to their work, they’re independent. They can figure stuff out or whatever.” But she also saw a difference in the career motivations of men and women. “One of the big, inherent things of women feeling valued is that they have the ability to help other people and see the results of it, too.”

#### *What Makes Women Happy*

When asked what they picture when they think of a happy or satisfied woman, most of the participants gave some variation on Ginger’s answer: “I think of a person who’s able to fulfill their dreams.” Adelaide said, “It’s just, it’s being comfortable with who you are. Knowing what

you want, and just doing that, and not being afraid to do it.” Becky responded with, “I think, I think one who is doing what she wants to do.” Hazel replied

Things I think are important to people are like, what they’re doing with their life, if they have some sort of purpose or thing that they’re doing or something they’re working towards, whether they have people who care about them (which, I guess, maybe I think that more about women than men), I guess that’s mostly everything. Whether they have a good quality of life of course.

Olivia said, “I think that you can’t have it all. You have to decide what it is you want the most. I’d say me, I’m pretty happy.” Susan said, simply, “Independence. Able to make your own choices, things like that.”

Ishvani and Camille both said that freedom from the confines of gender roles was an important part of happiness. Ishvani said, “I would feel that she should be, not known just as a person of a certain sex, with all the connotations that brings up, i.e. a female. She should be regarded as another intelligent person in society.” Camille said that the key to happiness was to keep challenging other people’s expectations:

I picture a happy or satisfied woman as a woman who can be a woman without anything holding her back. Without any obstacles....They try to put limitations on you and try to put boundaries around you and I just keep poking at those boundaries and making them go out.

Most of the participants described happiness more as a function of personal qualities that allowed a person to be happy (independence, confidence, self-knowledge, sense of purpose). Though some of them, like Adelaide and Becky, included things like a challenging career as key



elements of happiness, I found it interesting and exciting that most participants expressed the idea that happiness is more about who you are than what you have.

A few participants talked about what was *not* required for happiness. Adelaide said, “I just see a woman who’s comfortable with herself, what she really wants to do. And whether or not a family’s involved, that’s her choice. I guess I don’t necessarily see that as required.” Ginger said, “I think with my last job, I realized that happiness and money are not equated.”

Valerie suggested that to be happy, women need to feel that their work contributes to improving the lives of others. “Women feel fulfilled when they have the ability to help others, whether that’s through your job or your volunteer work, or your family or whatever. There are a lot of different outlets for that, but that’s really important. I’m not saying that there’s anything wrong with it, but one of the big, inherent things of women feeling valued is that they have the ability to help other people and see the results of it, too.” This observation seems consistent with the goals expressed by some of the participants in this study. Valerie and most of the other participants who were interested in teaching saw it as a means to help others, act as a mentor, and be a role model. Ginger, who wanted to work in industry, also said she was attracted by the chance to do some good for the Caribbean nation where she was raised and for the healthcare industry.

### *Motherhood*

Motherhood seemed to be an important part of many participants’ constructions of gender. Only four participants, Hazel, Ginger, Susan, and Linn, did not mention children at all in the initial interview. For the rest, the issue of children came up when they talked about themselves and their goals for the future.

Often the question of children came up for these women when they thought about their careers. Olivia said that she was only able to work and go to graduate school at the same time because she did not have children. She said that she considered that issue and discussed it with her husband at each step of her education. “Every time before I went back to school, I talked to my husband about, ‘What do you think about having kids?’” Probably, few men would have thought about this issue in the same way, especially when there were no actual children in the picture. Camille said that she had more freedom to focus on her own dreams because of where she was in her life:

Being a little bit more mature, I have a whole different outlook on life than if [I was] 30. I’m not trying to have kids, did that. Was married, got divorced, did that.

So a lot of things that might bother other women or the concern about the clock or things like that, I’m not concerned about.

Ishvani, a widow who is no longer of childbearing age, said regretfully, “No. No, I don’t have children. So far, I don’t, and there’s no way it’s going to happen now. So I don’t.”

Three of the youngest participants, Valerie, Adelaide, and Becky, all single women in their twenties, also mentioned children in the initial interview. Valerie said her goal of being a college professor partly grew out of seeing that her professors were able to balance work and family:

I know some of them have families, are raising families, and some of them are older, and their children are off doing careers and stuff too. Some of them even said to me that being a professor is a good career to have. It’s secure and you can support yourself, and it’s flexible. Much more flexible than some other jobs that you could possibly get.

Adelaide said simply, “I don’t want children.” Becky said that she thought a life that was just about home and family would be dull to her. “I don’t want that responsibility, even.” Later she elaborated:

I don’t see that getting married and having a family is necessarily going to make me happy in itself. I need more challenges, not that having a family isn’t a challenge, but more of the mental challenges that biology or computer science involve.

She said that for women like herself, intellectual stimulation was important. “That’s what makes us happy, and then, maybe later on we decide to do the family thing.”

#### What Are Their Constructions of Computer Science?

Participants seemed to have fairly similar constructions of computer science as a discipline. Most said that computer science was, at its essence, problem-solving. Because of this, computer science required both an organized, analytical approach and a creative mind. This combination satisfied the participants’ need for intellectual challenges. They also said that computer science was fun because it was constantly changing. Finally, computer science was hard work and required many hours of uninterrupted work time.

#### *Computing as Problem-Solving*

Computer science was not primarily about programming, participants told me; it was problem-solving. Adelaide said, “I was never a huge programming person, and I kind of, I don’t know, saw through that. It’s a tool to be used and it’s not the be-all, end-all. It’s not just programming, it’s solving problems using programming.” Olivia told me that her career choices were influenced by her interest in problem-solving:

I love puzzles and problem-solving. Whether it’s a crossword puzzle, or a bigger puzzle, I’m a big puzzle person, problem-solving kind of person. It’s probably why I also went into management, because management really is the opportunity to solve problems in really creative ways. I think there are just so many problems in the world that require some sort of solution, whatever that solution may be, but in my mind, I think when I really started taking my computer science classes, there were just multiple problems in my mind that I thought could be solved with technology. That really attracted me to wanting to learn more.

Becky said, “I seem to be very analytical, so just being able to solve a problem by writing a program and especially just even the, I guess, satisfaction of actually getting it to work is really cool to me.” Susan also went in to computer science because, “I thought it was more math-oriented, and problem-solving, things like that.”

### *Programming as a Language Skill*

In computer science, participants are literally learning other languages. Each programming language has its own specific syntax and punctuation. Three of the participants made this connection explicitly. Two others had done undergraduate work in language-related fields.

Three participants, Valerie, Ginger, and Olivia, two of whom were from the Caribbean, said that they saw programming as learning another language. Ginger said:

Well, I love languages, and programming was the opportunity, really, to learn new languages. And I have, I’ve learned C++, and Visual Basic, and Java. So that was one very nice piece to it, the language part was wonderful.

Olivia also said that she saw programming as learning a language. “To me, programming has always been about translating languages. Since I already had to translate language to speak English, it was like, okay, this makes sense. This I can do.” Valerie, a native English speaker, also made the connection between computing and languages. “Teaching programming is like teaching another language, except that most people come to college and have never seen this language before, so it’s very tough to learn.”

Adelaide was a computer science major and had minored in English. Hazel’s undergraduate major was linguistics, and that led her to computer science. “I was interested in computational linguistics, and so I took a lot of computer science classes, and I liked them way better.” She applied to both linguistics programs and computer science programs for graduate school, though she was more interested in computer science.

### *Two Sides of Computing*

In the interview, I asked participants to describe the attributes of a good computer scientist, and then asked them to compare that description to themselves. Most either said that they were that person, or that they wanted to be. There seemed to be two sides to a successful computer scientist.

On the one hand, you need to be methodical, careful, and analytical. As Olivia said, “Being analytical, being patient, being able to focus. I think that’s what it takes to be a good computer scientist. I think those are the qualities that it’s always taken.” Participants said it required patience to work long hours to figure out a problem and make sure every semicolon was in the right place. Computer scientists needed to be good at math and understand computer theory. These are probably the same things that outsiders would cite as important skills for a computer scientist.

There was also a flip side. Being a good computer scientist required creativity, the ability to approach a problem in a new way. It required the ability to be “playful,” according to Adelaide. Valerie said that computer science researchers had to “try new ideas and try crazy things and not have the kind of personality where you’d be disappointed if something you tried didn’t work out.” This is probably why so many of the participants said that working with computers was “fun.” Computers gave them an opportunity to apply their intelligence in a creative and challenging way to solve problems and get immediate feedback. As Becky said:

When you finally get it, you think, ‘Yes! It works!’ I just kind of like that feeling that I’ve accomplished something, and getting something that just seems so, I don’t know, it just doesn’t quite work out at first, that you actually have to know what you’re doing, and you’ve now accomplished something that does some certain task. I don’t know, it’s kind of fun.

Adelaide also said that the challenge was what attracted her to computer science. “Computer science wasn’t comfortable, it wasn’t easy, it made me really, kind of, I felt like a fish out of water a lot at first. So I kind of liked that challenge, I guess.” Hazel said, “My very first computer science class was, like, almost a discrete math class, and it was way more fun than any math classes I had taken, and it was like, ‘Oh, this is fun.’”

### *Constantly Changing*

The fact that computer science constantly changes was both an attraction and a challenge. Camille had been working in the field since the 1970s, and saw a lot of changes along the way:

When I started, we were on cards. Punch cards and the black terminals with the green screens, and all of that. So to actually see it evolve into the Internet, and into all the different technologies, wireless, it was just amazing.

Ginger said she enjoyed the chance to be involved a field where things were constantly evolving.

“That’s extremely exciting for me. It’s not a stodgy, old, and dying field at all.” Valerie said:

You have to be willing to be a lifelong learner, because things are constantly changing so much faster than they are anywhere else. So that’s definitely one thing you would need to be successful, is the desire and the ability to really keep up with what’s going on it in the field.

Ishvani said she was “fascinated” with electronics and technology. “With computers, you do have to do a lot of reading and a lot of thinking on things to keep ahead of them.” Adelaide also enjoyed this aspect of computer science. “Who knows in ten years where we’re going to be? Who knows what devices we’re going to have? Who knows? And that’s kind of the fun of it.”

### *Hard Work*

Being a computer scientist also involved a lot of hard work. Adelaide joked that to be successful in the field, a person needed “a lot of caffeine and really good butt cheeks” for those long hours at the computer. Hazel also joked that a big key to success in computer science was “the desire to work very many hours in a row! Although that’s probably [true] in any field.” Becky said she was up to the challenge. “I’ve always been a hard worker...I definitely have the dedication.”

### What Are Their Career Aspirations?

Participants’ career aspirations could be grouped into three general categories. Seven participants were either primarily or secondarily interested in teaching. Two participants were primarily interested in research careers. One participant had decidedly unconventional career goals. The final participant’s career goals could best be described as “undecided.”

*Teaching*

Not surprisingly for a group of doctoral students, many were aspiring professors. For four participants, this was their main motivation for getting a doctoral degree. Three others considered college or university teaching as a fallback career option.

Adelaide, Camille, Linn, and Valerie decided to work toward a Ph.D. so they could pursue teaching careers. “I would like to teach at a college or a university that has at least a graduate... I would like a master’s, if not a Ph.D. program. I really like to teach. That’s why I wanted to do this,” said Adelaide. Camille saw university teaching as a vehicle to promote women in computing:

I’m going to be a university professor. I ran a technology camp for girls, back at Rosary. I’ll probably do more of that, to really recruit and bring in more women, because that’s kind of my banner that I’m interested in. That’s what my research is actually on, for my dissertation.

Linn was interested in emulating the lifestyle of her undergraduate advisor, “He teaches during the academic year, and then during the summer, he travels around...I want to be a professor at a liberal arts school, so that I’ll have some free time. I like teaching as well.” Valerie wanted to emulate her undergraduate professors, especially her advisor:

I really want to graduate and get a position at a small teaching school. I don’t want a big research university like this. I would love to go back to the school I attended, if that’s possible. I’ve even talked to my old professors about that and they said they’d love to have me.

Hazel, Becky, and Olivia were considering academic careers among other options. Becky originally was not interested in teaching, but became interested through her experiences as a



tutor. “Maybe I would enjoy that. I haven’t done that much teaching here. It’s still one of those things that kind of scare me.” She said she would be primarily interested in a school that would allow her to do interdisciplinary work. “I’d probably be teaching in computer science since that’s where my degree is, but I would definitely want to be at a school or an institution where they would let me work jointly with the biology department.”

Olivia considered university teaching a possible “back-up career.” She had primarily been interested in continuing to work in industry after she finished her degree, but was impressed by the opportunity college teaching affords to help mentor others:

I was impressed with the caliber of professors we have here...a lot of people come into the profession because they want to teach, they want to educate, they want to open somebody else’s eyes, they want to share knowledge. Now I’m thinking, ‘Oh, I could do that.’ I could help somebody else.

Role modeling can work both ways, though. Hazel said that she was not so sure she wanted to be an academic because, “I have seen how much my advisor works and I’m not sure I want to work 13-hour days after I get out of grad school.”

### *Research*

Computer science is a field where the line between an academic career and a career as a researcher for industry seems blurry. And though most academics do both research and teaching, most of the participants expressed a definite preference for one or the other.

Two of the participants who were interested in teaching careers expressed less interest in research, and seemed to see a professor’s role primarily as a teaching one. These participants had attended small, teaching-oriented colleges and said that their undergraduate professors were their primary role models. Adelaide said she would expect to do some research as a college professor:

I mean you’re kind of forced into it, if you want to go into teaching. It does interest me a little more. I don’t want to be a heavy researcher. With research, it’s very easy to spend all your time... and neglect your students. So, it’s a hard balance, I think, to find. So I just, 80% emphasis on teaching and 20% on research is ideal for me.

Valerie, who wanted to be a college professor, was apprehensive about her ability to succeed as a researcher, “you have to try a lot of times before you succeed, I don’t know if I have that so much, which is why I really don’t want to get into research.” She wanted to work at a liberal arts college where teaching is emphasized.

The other two participants who wanted to teach expressed more interest in research. Linn was still figuring out a focus. “I kind of like systems architecture. But I’m still looking around right now. So I’m still looking into networking architecture, and software engineering. I’ll have to decide next quarter, by the end of next quarter, I guess.” Camille saw her research as an extension of her interest in teaching, and was doing research on “the seminal barriers that cause women not to major in computer science or get an IT career.” This research is another way for her to help other women succeed in computing.

Three participants were primarily interested in research, at a university or in industry. Hazel had originally been interested in an academic career, but after seeing her advisor work long hours, she said, “I sort of feel like, maybe industry is a better option. You get to do the fun research but you also get to go home after eight or nine hours.” Olivia said, “I can be a college professor. I like the research part.” Ishvani said, “my first instinct would be to work in industry, especially in a research area.” Becky was passionate about bioinformatics and said, “I had always assumed that I would go into research,” but she was starting to be interested in teaching.

She said she would be interested in “teaching at a university or doing bioinformatics research at a company where I have a senior research position.”

### *Unconventional*

Ginger found it impossible to channel her enthusiasm into just one career. Rather than choosing between her interests, she saw her future career as a new kind of hybrid:

I’d like to have multiple careers all at the same time. I’d like to do a little teaching but not your traditional teaching. I’d like to do a little bit of research, but I’d also like to stay, in part, in industry too. It might be the healthcare industry; it might not be the healthcare industry... I’ll create it myself. I mean, I’ll have to. There’s probably nothing that really exists right now that would be sort of a step into this type of position, and it will be all of the things that I want it to be...I also have an interest, sort of long-term, after the Ph.D., to go back to the community where I was born and really help them to advance from an educational standpoint, as well as just learning about housing and employment and other social services opportunities through the use of technology.

### *Undecided*

Susan had been a doctoral student for longer than the other participants. Possibly because she was so focused on finishing her degree, her career goals seemed vague. “Well, I’d like to move, get into industry and teach,” she said. When asked what kind of industry, she said, “Something like Motorola, any kind of industry.” I asked what she saw when she thought about the future and she said, “I really don’t know. It’s all up in the air. That’s what’s scary about it.”

### How Do They Feel About Their Chances to Succeed in Their Chosen Career and Field?

I asked each participant how confident she was about finding the kind of position she was looking for after graduation. I also asked how their graduate programs had influenced their expectations of success. Though many of them started off by saying they had not thought about it much, most either seemed pessimistic or cautiously optimistic. Two participants did not give an indication toward one side or the other, so they were listed here as not sure.

#### *Not Sure*

Two of the participants said they had not thought much about what kind of success they would have in the job search process. Susan said that she was not sure about her plans for after graduation. “I really don’t know at this point. I hope I graduate with my Ph.D. That’s my number-one worry.” Hazel said that it is too hard to predict what will happen after she got her degree. “I mean, right now it looks good, but it seems like things in computer science change really, really fast. So in four years? I guess, who knows how easy or hard it’s going to be?”

#### *Pessimism*

Two of the participants seemed more pessimistic. Though Ishvani said “I haven’t thought that through at all,” when asked about her career prospects, it was clear that she was concerned about her chances for finding a job when I asked what she would like to do after graduation. “I’ve heard that it’s hard to get teaching positions in CS, that many universities are not hiring. So my first instinct would be to work in industry, especially in a research area. I haven’t made any kind of headway there,” she said. Adelaide was also apprehensive about the job search:

With such a downturn right now, there’s actually a flood of people applying to schools that are “below them.” Down on the academic tier. So you get people from a higher one going one or two down even, looking for jobs. So, it’s not that

easy. I’ve seen people apply for over 100 positions and get no offers. So it’s a full-time job that takes almost a year for a lot of people.

The technology bust in 2000 seemed to have demoralized many people in computer science and discouraged people from studying technology fields, Adelaide said, but she expected things to change, because “people aren’t enrolling, and now the need is actually going up, and there’s going to be a big four-year bubble.”

### *Cautious Optimism*

It was encouraging that the other six participants believed they had a good chance to succeed in their careers. Linn said she had not focused on her career prospects much but said, “if I can get the Ph.D., I think I could find a school, like a small liberal arts school that would take me as a professor.” Valerie also thought that getting through her doctoral program would be the most difficult part:

Well, as long as I graduate I don’t think it’s going to be a huge problem...Obviously, if I restricted myself to only apply to one place, that wouldn’t work, but there are lots of smaller schools...computer science instructors are in higher demand than other types of instructors, because they have more options with their degrees...So I don’t really consider that it would be a big problem, trying to find that kind of a position.

Both of these participants were in their first year of graduate school, and were finding things to be more difficult than expected. They thought things would be easier after graduation.

Four of the participants were optimistic both about their graduate programs and about their chances to succeed after they finished their degrees. Becky said, “I kind of think, especially since I’m a hard worker, that my chances are probably fairly good as far as getting the position

that I want.” She believed that her background in biology and computer science would help make her marketable in her chosen field. “Just what I’ve done, as far as my background, shows that I am capable of working in bioinformatics. We’ll see what other people think.” Camille also said she felt “very, very confident,” about her chances:

The market is slow, and I know there’s a lot of competition, and also it’s a little harder for women to get into faculty positions, but I have an excellent faculty advisor, the Provost is going to do recommendation letters for me, so I’ve got a lot of good backing and support.

Ginger felt encouraged by the messages around her. “It really appears to me that there are opportunities out there, and more so than ever before, for everyone, not just women.” She thought, though, that she may have to become an entrepreneur to do some of the things she wanted. If she did not find the kind of opportunity she sought, “I’ll create it myself. I mean, I’ll have to. There’s probably nothing that really exists right now that would be sort of a step into this type of position, and it will be all of the things that you want it to be.” Olivia also seemed optimistic:

There are jobs available; these are corporate jobs, time-punching jobs, not as much creativity. You can’t start up your own company, and a lot of people – what Gen are we, Gen X, Gen Y – they’re not into the whole corporate structure. The job is there, but “I could do this from home, or I could do this from the beach.” No. Get in the office with the rest of us, and this is what you have to do. I think the jobs are available.

Olivia and Ginger were working full-time while pursuing their degrees, so their past success in the work world may have made them feel more comfortable about their future career prospects.

*The Influence of Affirmative Action*

Five participants brought up Affirmative Action and its effects, or potential effects, on their careers. Adelaide seemed uncomfortable with the idea and said, “Equal opportunity employment can force unqualified people into certain positions.” She worried that she would be confronted with a situation where an employer would mention her gender as a factor. “I just sort of wonder what things will come up as I do a job hunt. If they’ll be like, ‘Well, we’re looking for a woman for this position.’ I’d sort of cringe to hear that.”

Valerie seemed more comfortable with the idea of Affirmative Action. She mentioned a conversation with her younger brother, who is also a computer science major, who suggested that she was accepted into her graduate program just because she was a woman. I asked if she thought it would be a bad thing if her gender helped her and she said, “I’m not bothered by that, because I think it’s great that they’re trying to get more women into computer science. I don’t look at it as discrimination.” Becky said one of her parents’ friends told her, “Female, American in computer science, you can write your ticket anywhere.” She did not think that was the case, however. “I don’t look at, necessarily, that I’m a female in computer science as being better than being a male, but just the fact that I’ve put forth the work, and the effort.”

Two participants said that they had already been assisted by Affirmative Action to some extent. Camille said that certain people were surprised to find that she was actually competent because they thought she was not hired for her skills:

I was a ‘two-dinger,’ I was a Black woman. I got a lot of that, and like I said, what you have to do is that you just can’t take it personally. You have to know who you are. And be proud of who you are. I’m proud of being Black, I’m proud of being a woman. I don’t have any problems with it.

Olivia said that in her early career, “Affirmative Action...put my foot in the door, but, happily, I’m a hard worker and I know what I’m doing.”

Finally, Hazel expressed skepticism that things were really that rosy for women in the real world, despite the perception that organizations wanted to hire women computer scientists. For example, despite all the advertisements that encourage women and minorities to apply for positions in higher education, she said, “I’m not sure it really works that way, because there are far fewer female faculty than there are female grad students, ratio-wise.”

#### In What Ways, if Any, Do Women Graduate Students in Computer Science Believe Their Gender Has Affected Their Experience in Graduate Programs?

The effects of gender on participants’ experiences seemed to be subtle. Many participants said that gender did not seem to be important, but some of those same participants also talked about confronting the expectation that women did not belong in science. Many expressed feelings of isolation and alienation. Some also said that women made the men around them feel that they had to be more careful about what they said or how they acted. Two participants felt that some faculty and peers were nicer to them because they were women. Finally, five participants discussed the influence of people or programs that encouraged women to study computer science.



*Is Gender Really Important?*

Most participants said that they did not think that gender had much of an effect on their experiences. Few cited examples of blatant, overt sexism in their graduate programs. Linn was not sure why I would study the experiences of women in computing:

People always talk about being a women and then men, and being successful in the CS field or whatever field. For me, at least, I think it doesn't matter which gender, whether you are a man or a woman, it just depends on the person.

Adelaide said that she thought of computer science as a meritocracy. “I would hope at least, in my ideal head, my ideal world in my head, that it comes down to ability.” Becky said, “I don't know if there's anything, in that I don't think I've been treated any differently from being a female, there's nothing negative, or not necessarily even positive that I can say.” Hazel said, when asked about her experiences as a woman graduate student, “I think it's mostly like being anyone in the graduate program. I mean, I don't really know how it's different than for anyone else.” Ishvani said that when working with other students, “There was no question we were all pretty much equal.” Olivia said that she had not noticed that her gender had been a factor in her experiences as a doctoral student. “In the Ph.D. program here, I can't say that it has. Once again, like I said, maybe it has, but I haven't noticed, I can't say, really.” Susan said, “I think I'm treated like an equal.”

*Dealing With the Perception That Women Do Not Belong in Science*

Three participants said they had, at times, felt pressure to prove that they belonged in computer science. Camille said that she felt doubly challenged to prove that she belonged in a doctoral program:

As soon as they see me, they question whether I “have it” in order to be a Ph.D. student or not. But like I said, I don’t know if that’s the woman part or the minority part. After talking to me, they.... A lot of people afterwards have talked to me, as Ph.D. students, and understood my industry experience, and said, “Oh yeah. It’s no problem, she’s competent and she should be here.” But I always have to prove that I should be here. Just automatically. So I’m just used to it. It doesn’t bother me, I don’t get offended. I’m like: “Okay, here we go, one more time. I’m smart enough to be here, I’m competent enough to be here, you know.” You have to have the right attitude about it. You can’t be mad about it. You can’t be upset about it. At least, I can’t.

Olivia said that at her undergraduate institution, she encountered some professors who made her feel like an outsider. “There were a lot of professors there, there were a lot of male professors there, who didn’t think that girls should be in engineering, and they didn’t think that minorities belonged in the school at all.” Hazel also said things were harder as an undergraduate:

Maybe not now as much, but as an undergrad, it was definitely alienating, and I sort of still expect that. I expect that people are going to look at me like, “What are you doing here?” I don’t think they, maybe some of them do, but not nearly as many do now.

Even those participants who said that gender was not important said that women in the sciences challenged some people’s expectations. Adelaide said, “There’s this perception that women can’t be good at technical things. I guess I get confused with how people can just assign sexual roles and expectations based on your abilities because you’re a woman or because you’re a man.” Ginger said, “You sort of have this feeling, or you kind of hear that the sciences,

especially the technical sciences, are sort of male work.” Ishvani thought that she might have to work harder to prove herself in the work world:

Because it’s not a traditional area for women, parents and even peers, as you grow up, do not direct you to this area of study. In that sense, it still is pretty much off the track. Women do have to prove themselves a lot to be accepted, within the community of professionals, especially at the higher levels.

### *Kid Gloves*

Adelaide said that when she was doing one of her internships, she noticed that the men treated her just a little bit more delicately than the other students working there. “They were always, like, more careful around me not to make certain jokes, not to say certain things, and they treated me a little bit, like with kid gloves.” Linn said that her officemates joked that they had to be more careful now than when there were “just guys” in the office. “My officemates, they always say that they have to be more careful in the office, because I’m the only female in that office.” She said, that they were probably just kidding, “because they always say things anyway.”

### *People Are Easier on Me*

Linn said she liked working with her officemates because they “always helped me with stuff.” Hazel said that she thought one faculty member was easier on her because she was a woman:

One of my professors, I’m almost positive, has graded easier for me than for other... I’m, as I mentioned before, very bad at [systems] architecture. I just don’t get it. I get it as much as I need to and that’s it. It takes me a lot of studying, a lot more than it takes for anything else. The architecture professor, he curves in a

funny way. He basically just puts the line wherever he feels like it. The line was right after my grade. It was for me. Not because that was a magical number, but it was for me.

She also said that she thought other students were nicer to her too. “If I have a problem with my computer and I can’t figure it out, they’re willing to help me. If it was someone else, they’d probably say, ‘Well, Google it.’ Or, ‘Go ask tech support.’”

### *Isolation*

Participants did report feeling isolated at times from the other students in their programs. Becky said that she had good professional relationships with the other students in her program but that she did not socialize with them:

I think, just because a lot of them are male, and especially foreign, that there is kind of a gap. I relate fine with them, but I’m not very close, you know, buddy-buddy, we don’t do anything outside of classes with anyone just because there is that difference. So I think it definitely is a big part to my interaction. I have other friends who are outside the department. That definitely helps a lot. But I think, yeah, the environment would definitely be different if there were more females or even more Americans in the department, but there’s just a small handful of us.

She said that there was a strange combination of isolation and lack of anonymity as one of the few women in her program. “Everybody seems to know who you are.” Ishvani said:

The only experiences I’ve had are in my classrooms, where sometimes I feel I’m the only woman in a classroom of men in certain courses that I have done. I’d just be the one person and that makes it hard, because when you start communicating, you’re at really different wavelengths sometimes with a man. Although you are

doing the same work, yet your means of communicating are a little different. That may be a bit of a challenge that I’ve had, but that’s been my closest personal experience.

Adelaide said that sometimes “there’s sort of that aspect where you can get treated a little bit, like on the outside.” Camille said her program should do more to encourage peer support. “That’s one of the real concerns I have about the program. They don’t encourage people to really get together and kind of help each other a lot.”

*People or Programs That Promote Women in Computer Science*

Hazel said that as an undergraduate, a woman faculty member really encouraged her, and she was experiencing the same thing as a graduate student. “It helps a lot with my advisor, who’s also trying to get women into computer science. She’s not only happy about the work I do, but also happy that I happen to be female.” Ishvani got her real start in computer science through a “Technical Jobs for Women” program in Australia. Olivia said that Affirmative Action had helped her get “a foot in the door” in her early career. She said that one attraction for her of an academic career would be the chance to be a role model and a mentor to other women. Linn said that sometimes programs to encourage women can make women students more conscious of their differences:

I don’t feel anything particular, myself, but then sometimes, there are programs just for women, things that encourage more women to get into the programs, and all that stuff. The outside factors kind of make me feel that, “Oh, we’re the rare kind.”

Valerie said she appreciated The Association for Computing Machinery’s community for women, ACM-W, because it gave her a chance to socialize with other women computer

scientists. “Really, it’s just a social organization more than anything... You get together and meet people and find resources.” Camille had presented at the Grace Hopper Celebration of Women in Computing the previous year, and said that the experience inspired her:

It was just, it was wonderful to see that, 1300 women. It was just awesome. It’s really nice. I get charged on stuff like that. So that just gave me energy to come back and finish and bring in more women. Some people, it can crush you, so it’s how you look at things too. You could say, “Well, yeah, that’s 1300, but that’s only 20%....” You know, you can be disappointed, but that just energizes me to make it better.

Camille was doing dissertation research on women in computer science. She said that she had been helped along by other women in her career, so for her, research and teaching was a way to give back.

### Summary

All of the participants had a construction of their gender that did not restrict their horizons or their career possibilities. There was a split among participants, however, as to whether they thought other women were equally unfettered by gender constraints. Some of the participants seemed to find it easier to minimize the importance of gender and identify with men than to create a construction of womanhood that allowed for technical competence and interest. Even in these cases, however, most seemed to imply that other women imposed restrictions on themselves by conforming to traditional gender expectations. They did not seem to be expressing a belief in some sort of natural superiority of men over women.

Most of these women had constructions of computer science as a challenging, “fun,” creative field, even though it required careful, analytical thinking. They saw programming

primarily as a problem-solving tool, and saw a connection between programming and language skills. The fact that computer science was a constantly-changing field was both an exciting aspect and one of its greatest challenges. Finally, participants said that computing involved a lot of hard work.

Most participants aspired to academic careers. A few of those who hoped for faculty positions said that they were not interested in research and expected their work to be teaching-focused. Other participants, especially those who had previous professional experience in computer science, were passionately interested in research. One wanted a career that combined teaching, research, and entrepreneurship in a unique way. One had career goals that seemed vague.

Six participants seemed cautiously optimistic. They had not experienced anything in their graduate careers to suggest that they would have trouble finding the kind of position they wanted after graduation. Two were more pessimistic because of a general sense that the economy was bad, especially in the technical sector. Two participants said that it really was too soon to tell what they would experience in the work world, because the field of computer science changed too quickly or they just had not given the question much thought. Several participants discussed the effect that Affirmative Action had or might have on their careers. One participant was opposed to Affirmative Action because, she believed, it gives unfair advantages to “unqualified people.” Those who thought they had benefited from Affirmative Action felt that it had helped open doors for them but that they had to follow up on that opportunity with competence and hard work. One participant did not think Affirmative Action was having that much of an effect on the academic job market, as evidenced by the continuing underrepresentation of women among the faculty in computer science, especially compared to the percentage of women graduate students.

Participants tended to downplay the influence of gender on their experiences as graduate students in computer science. Very few could point to specific examples of outright sexism that they had experienced or witnessed. However, most had noticed more subtle messages about women in the field. Some said they had to deal with a persistent, mostly unspoken perception among their peers that women and racial and ethnic minority students were less competent or did not belong in the sciences. Some felt that men around them were more careful about what they said or treated them with “kid gloves.” A few said they felt that peers and faculty were easier on them than on the men in their classes. Most mentioned feelings of isolation. Several mentioned people and programs that support women in computer science, like ACM-W or activist women faculty, as an important positive influence on their experiences.

The shared elements in the stories of these women suggest that the influence of gender has operated in subtle but important ways. In the next chapter, I organize these common themes into a data model that attempts to highlight the essence of the participants’ experience.



## CHAPTER VI: DATA MODEL

In Chapter Five, I presented the responses to each of my five research questions. In this chapter I present a data model that organizes the major themes that emerged from the participants’ responses. Previous research on the scarcity of women in computer science has seemed to focus either on questions of difference – what differences between women and men make women less likely to thrive in computer science – or on deficit – what problematic elements of computer science make it an unattractive field for women? This study is an attempt to shift the focus to the ways that our imaginings of ourselves shape our sense of what is possible for us by looking at the women who had chosen to study computer science and who had navigated the “leaky pipeline” successfully. I wanted to see what kinds of constructions of gender and computer science these participants held that made it possible for them to pursue graduate degrees in a male-dominated field, and what experiences had helped them form these constructions.

Within the framework of the theory of gender constructions, the participants’ constructions of what it meant to be a computer scientist and their constructions of what it meant to be a woman had to fit together. If a participant held constructions of her gender and computer science that were mutually exclusive, then she would not have been likely to choose this field. The constructions had to be compatible.

The participants I interviewed seemed to have gender constructions for women, or at least for themselves, that were less restrictive than traditional gender roles and norms. They did not accept limits on what they can accomplish or what roles are appropriate for them because of their identity as women. They had also defined computer science in ways that were consistent with their views of themselves. When asked to define a successful computer scientist and then to

describe themselves, most said they were close to their definition and were working to bring themselves closer. These constructions of themselves and the field seemed to grow from similar experiences and environments. The data model below highlights these common elements.

#### A Conceptual Model of the Experiences of Women Graduate Students in Computer Science

The following model, depicted in Figure 1, is intended to give an overview of the essential elements of the participants' experiences. Though each of the participants was, obviously, an individual, there were common experiences that give a sense of what inspired the first “click” of interest and what sustained these women as they studied in a field where women are still in the minority.



*Figure 1.* Model of the experiences of women graduate students in computer science, showing family influences as the root, creating and sustaining factors, obstacles and challenges, and hopes and dreams.

*Family Influences Are the Root*

Family influences seemed to be critical in shaping the expectations and aspirations of these women. One important thing a family could contribute was a sense of possibility and a freedom from confining gender roles. Most of these participants were encouraged by their families to pursue education and were taught that women could do anything they wanted to do. That is important – most participants were not limited to imagining typically “female” careers or expected to only fulfill a domestic role as wife and mother. The participants’ mothers may have been stay-at-home moms or may have worked outside the home. In all cases, they valued education. Most encouraged their daughters to think about careers from an early age. Family expectations and values helped shape participants’ career goals.

Family members also provided role models and support, both financial and emotional. Family circumstances like health crises, divorce, and financial pressures affected some participants’ choices. In my model, family influences gave women their start in becoming computer scientists.

*Family influences and gender constructions.* Seven of the participants said their parents and other family members gave them the message that gender did not limit their possible career choices. As Becky said, “Maybe it’s just my background or even how I was brought up by my parents, as far as being told that I could do whatever, and it didn’t matter whether I was male or female.” Valerie explicitly stated the importance of this kind of message. “I’ve just grown up with that mentality...there’s not necessarily anything different I should consider, career-wise or school-wise or whatever, just because I’m a woman.” These participants had the freedom to consider all possibilities and explore all their interests.

Camille, Ginger, Olivia, Ishvani, and Linn all reported that at least some members of their family were “chauvinistic” or “gave priorities to the guys instead of the girls.” In Camille’s case, for example, even though she said her father was a “chauvinist,” she also said he raised his daughters to be independent and strong. “I kind of grew up thinking that I could do and be anything that I wanted to, in one sense, and then thought that I had a role that I had to play in another sense.” Other than Camille, the participants who talked about male chauvinism were born outside the U.S., and some saw these messages simply as a function of their parents’ culture. The participants rejected sexist ideas when they were countered by other examples and experiences. Ginger said her father told her he would never vote for a woman prime minister. “As I grew up, I kind of realized that he’s just a representative of the culture that he’s from, and there is all that ignorance there.” Olivia said that even though her family talked about traditional gender roles, “my family is, just a lot of strong women. But I guess, when you’re raised with a bunch of male chauvinists, you have to be.”

These traditional families still valued education for their daughters. Linn said that her family left her mostly on her own, and school was her primary focus. Ishvani’s very traditional family still believed that she should get an education, even if it was just considered something to keep her busy until marriage. This education gave her a good start toward her future career.

*A focus on education.* A focus on education was another important family influence for these women. Adelaide, whose mother did not work outside the home, said that “homework always came first, no matter what.” Becky’s parents were both professors, and she said, “It had always kind of been assumed that I would go on for graduate school.” Education was also very important to Olivia’s divorced, working mother:

In order to live in my mother’s house, you had to go to school and/or have a part-time job. All three of us have graduated from college. As a matter of fact, my sister had moved away and my sister said my mother tricked her, got her back, and she was able to finish her college degree.

Susan’s father was so committed to his daughter getting a good education that “he was willing to pay for everything.” All of the participants mentioned that they grew up believing that education was important.

*Financial motivation.* Though most of the participants enjoyed computer science for its own sake, a few said that family influences led them to consider potential salary when making career decisions. This was one of the things that helped push them toward a technology career. When Camille’s father “didn’t want to pay any more money” for her schooling, she got her first job at a telecommunications company that trained her as a programmer and opened up a high-paying career. Susan’s father, who supported her through most of her schooling, was not willing to pay for a master’s degree in social work because “you get paid peanuts,” so Susan decided to study computer science because she “thought it was a hot field.” Olivia said that part of the reason she was interested in computing was to be able to contribute to her family’s income:

I wanted to get a degree in something that would be a good career, would have a lot of choices, but would also have a good pay scale, so that I could help out at home, because I was the oldest of three.

Valerie’s mother also suggested that she consider earning potential when planning her career.

“What are you going to be able to do that you’ll be able to have some secure job where you can support yourself?”

Even if participants were initially interested in computer science because it seemed to be a lucrative field, their motivations could change. Ishvani originally just wanted a job when she started working in computing in Australia. Though she already had some interest in computers, the chance to work in a technical field was also a good financial opportunity for her. When she started working on her doctorate she said, “I hadn’t planned a lot on how I was going to use my qualification.” She was studying to help her through grieving her husband’s death and chose to study computer science because she had experience in that field and it interested her.

### *Creating and Sustaining Factors*

Family influences were important in shaping participants’ expectations for their careers and shaping them into women who knew that they could succeed. For them to choose to enter the field of computer science, participants also had to have experiences that promoted an interest in technology. Once they made the choice to study computer science, there were also common experiences that helped sustain their interest and provided support as they continued their studies. Like the support that helps protect a young tree and keep it growing straight and true, these protective factors were most important when participants encountered challenges to their confidence or their enthusiasm about studying computer science. These creating and sustaining factors are explained below.

*The first “click” of interest.* Valerie described programming as something that “clicked” for her — it immediately made sense and seemed to fit the way she thought. What made this initial click of interest turn into a career for her and for other women in this study?

Participants had their interest sparked during a required general education course, work experience, or through the influence of someone they admire. Early experience with computers helped, the earlier the better. Another part of the click seems to be an analytical mind and an

interest in problem-solving. Programming is a problem-solving tool, and these participants saw that clearly. Though they enjoyed programming for its own sake, they also saw what computing could do.

Each participant remembered how her interest in computers was first sparked. Ishvani was interested in computing because her friend and her father were in technical fields and she looked up to them. As an adult, she got a chance to pursue computer science education through a Technical Jobs for Women program. Adelaide had a computer in the home that she used to type up her notes and access online bulletin boards. She got her first exposure to programming through a Boy Scouts Explorer internship. She got a broad overview of computing, including machine language and web design. This program also exposed her to role models who had doctoral degrees in science fields, including computer science. Later she held jobs where her technical skills were valued and appreciated. These experiences, and not just the fact that “the books were cheaper,” probably led her to take her first computer science course.

Olivia was in a technical track already but then switched to computer science as a major because she was struggling in electrical engineering, and because a woman faculty member at her on-campus job suggested she take a computer science course and see if she liked it. There was a required computer science course for her major anyway, and she found that it was “a perfect match.” Hazel had been “programming since she was ten,” and then took a computer course as part of her undergraduate education. She did not switch majors at that time, because “they made you take random engineering courses,” but the interest was there.

Camille was a math major who was hired and trained as a programmer by the telephone company in the 1970s. Susan switched to computing because she was good in math, she had a sense of computer science as a marketable degree, and because she was exposed to computers

through her job with a nonprofit agency. Becky used to program on her graphing calculator in high school and took a computer science class in college because she thought it would be fun. She ended up double-majoring in computer science and biology because she “really enjoyed” computing after that first course.

Ginger had also taken computer science courses as an undergraduate health administration major, and liked computers but did not see herself as “one of those people” spending all their time in the computer lab. But the interest was there and later, as she saw the need for better ways to manage data during her career in health administration, she was attracted to the Internet and all its potential. It only took one computer science class for Linn to realize she enjoyed programming because “it was logical” to her.

*Chance.* Once they became interested in computing, chance seemed to play a role in some participants’ career paths. Adelaide said that when she was starting out as an undergraduate, she decided to take a computer science class instead of a chemistry course because she was put off by the students who administered the chemistry placement exam, and because “the books were cheaper for computer science.” She already had an interest in both subjects, but chance tipped the balance and started her off on a career path in computer science. When applying for graduate programs, Becky was interested in both biology and computer science, but opted for computer science partially because she was a “nervous test-taker,” and “the exams to get in for computer science were usually less hectic than the biology ones.”

Ginger had initially ruled out Rosary because she thought the program there focused on older programming languages like COBOL, but happened to run into a woman on the train reading a Java textbook, and struck up a conversation. “She said she went to Rosary. I thought,



Rosary? She’s learning Java at Rosary? Well, maybe they’ve done some different things.... that’s when I decided to maybe give them another try.”

*Early academic success.* All of the women in this group were academically successful enough to be admitted to doctoral programs. But several of them specifically mentioned their prior academic achievements. They seemed to draw confidence from these earlier successes, especially Olivia, who said she was determined to do well as an undergraduate even when she found school to be tougher than she expected. “Everybody thought I was so smart. There was no way I was going to let them down.”

Valerie was in a similar situation, struggling with her early experiences in graduate school, but able to reflect on the undergraduate professors who suggested she apply to top graduate programs, “I suppose because they thought I had the potential to do something great at a big name university.” When Camille’s GRE scores proved to be an obstacle to getting into a Ph.D. program, she knew that if she did some work at the school, she could get in. She was confident that once the faculty saw her work, they would be impressed. She thought, “I’m going to meet faculty. I’m going to show them that I can do this, regardless of my test scores.” She aptly proved her abilities by performing well in her master’s program, graduating with distinction, and winning two scholarships for her doctoral program.

*Peer support.* Participants reported seeking out and benefiting from peer support. Some participants naturally gravitated toward seeking support from women, but some were comfortable seeking support from both women and men. Linn said that the upperclassmen who shared an office with her helped her out a lot, even though they teased her that having a woman around meant they had to be more careful with their jokes around the office. Becky said that as an undergraduate, it helped that her cousin – one of the sons of the uncle who worked at a

computer store – was also in the computer science program. “We had a lot of classes that we were together in, so if we were doing group projects or something, we would be grouped together just because we work well together.” Camille had found a group of several women that she worked closely with, and speculated that women might be more likely to seek out peer support than men:

We work even now together, even though our research is totally different, just to work and support each other, saying, “Are you having this kind of problem, let me help you think it through.” So women really have to do more of that, because there is a smaller amount of us, and at least, I need that support group. I don’t know if men do or don’t need – but I think they do.

Without her network, Camille said, “it could be lonely and it could be discouraging, because there are a lot of men out there and not a lot of women.”

Valerie said that working with another woman in her program helped in navigating an otherwise large and anonymous graduate school experience:

I don’t know if it’s more so for women, but sometimes the whole grad-school thing is not very friendly. At least that’s the way it feels. You have all these things to do and you’re kind of left on your own to figure things out. Things in general, and assignments and classes. Especially lately, in the last couple of weeks, we realized, if we’re going to make it through here, we need to stick together and help each other out.

These statements about the importance of peer support, and their experience of being disoriented or unsure about program requirements, echo Ali and Kohun’s (2006) research on risk factors for attrition in graduate programs that suggested these feelings were experienced by graduate

students as isolating. Valerie’s experience in particular suggests that this confusion may simply highlight existing feelings of isolation. When she had a question she could not answer, Valerie did not seem to feel comfortable asking faculty or more experienced students for help. In her case, the peers she sought out may not have had any more answers than she did, but working and socializing with them at least made her feel a little less alone.

*Feeling comfortable with who they are.* Several participants said that an important part of their success was being comfortable with who they are. It seems only logical that women would be better equipped for success in the computer science field if they were secure in themselves and were not trying to fit into someone else’s idea of who they should be. This includes comfort with non-traditional gender roles but also extends to a general sense of confidence and competency. Most described themselves as independent and comfortable being different from other people around them.

Students who were newer to graduate study were more likely to mention anxiety, self-doubt, and fear that they did not fit in with the other students in their program. They still said that they wanted to be more confident, and knew that they were being too hard on themselves. Camille, Adelaide, and Olivia were all further along in their graduate programs and said over the years they had become more confident. It could be that successfully navigating a difficult field gave them that confidence, or it could be that those without it would be more likely to leave graduate school.

*Fitting together relationships and computer science.* Several participants mentioned romantic relationships. None of the women in this study identified themselves to me as lesbian or bisexual. Of the eight participants who mentioned current or past romantic partnerships, all were involved with men. Three participants, Hazel, Ginger and Olivia, are currently married. They

said that their husbands were supportive of their career aspirations. Ginger said that her husband is “open to letting me do whatever I want to do,” especially since she takes care of the household expenses. Olivia said her husband was supportive and joked that she was getting her doctorate just so she would have the upper hand in arguments. Olivia did seem to feel some obligation to fulfill certain expectations, but suggested that the pressure came from her and her family and not from her husband. “I do think, I feel, I’m the wife. So I should do some things.” Hazel wrote, in a follow-up email exchange, that her husband was in the military and she did not get to see him much because he was stationed in another state. She said that because he is a computer programmer, she sometimes talks through her work with him, “but it’s a lot more common for him to talk problems through with me, since he has exactly six weeks of training, and I have a lot more.” Ishvani was widowed, but she said her husband had helped her and encouraged her when she was starting a technical career. “We always had pretty much of an equal relationship, so that was okay.”

Several participants mentioned motherhood, whether or not they were mothers, as a factor that they considered when making career plans. Some, like Becky, said that they saw a family as optional. Women like her, she said, wanted to have an intellectually challenging career and then, “maybe later on we decide to do the family thing.” Valerie said that she was more attracted to the idea of working at a small college because her professors were able to have families and successful careers. Hazel wrote in an email that she and her husband had discussed their family plans:

We have discussed “the future,” and when we have children (well, a child), and my husband plans to stay home to take care of our child; I always sort of assumed that that was an option for me, and fortunately found a husband who agreed. An

assumption that I would have to take primary responsibility for a child or housework would probably have caused me to seriously question whether I really wanted to be with whoever I was with.

In only a very few cases did I ask women whether they had children, and only if the participant mentioned being married. The fact that childless women, and even unmarried childless women, had considered the demands of parenting when making their career goals underscores an important difference in the upbringing of men and women. Women are encouraged to think of themselves as wives and mothers first, not only in a traditional culture like Ishvani's, but also here in the U.S., where women like Valerie are encouraged to consider careers that have flexibility and security, criteria that make them more suitable for women with families, who still bear the majority of the housekeeping and childrearing responsibilities at home (Eisenhart & Holland, 1992/2001; Steinham, 1983; Valian, 1999).

*Smaller undergraduate institutions.* Several of the participants in this study attended smaller colleges and universities and a couple suggested that their experiences there were part of what helped create or sustain their interest in computer science. Adelaide went to a small school where two of the three computer science faculty were women. She got an early teaching experience as an undergraduate because her school did not have a graduate program from which to draw teaching assistants. She also said that attending a school where most of the instructors were women meant “there was no question whether or not you could be successful as a woman.” Linn said that even though she was shy and did not speak a lot of English when she first got to her selective women's college, “all the professors knew me because of the small-sized classes.” Most of her classes had fewer than ten students in them. Valerie also suggested that the small

size of her undergraduate program was important, and her relationship with her advisor there, who was also the department chair, was critical in shaping her career aspirations.

*Teaching experience.* A few participants had already taught as adjuncts, and many of the rest had teaching assistantships. Susan was one of the participants who had some teaching experience. “I taught at a junior college, community college...part-time, as an adjunct faculty member.” The participants who had taught or co-taught courses seemed to find the experience empowering, and for many, teaching experiences helped shape their career aspirations.

Linn was in her first year of graduate school when we talked, and she said it was sometimes hard to balance her teaching responsibilities with her classes. She enjoyed the helping aspect of teaching, however. “I like explaining stuff to students, and if they don’t understand, they come and ask me and I explain it to them, and I have satisfaction, and I think that’s good.” Valerie echoed the idea of getting satisfaction from helping students. “I love teaching, because you can see the results. You can see how you help people.”

Camille was able to teach as an adjunct faculty member at Rosary while working on her dissertation, and ran a technology camp for girls. “I’ll probably do more of that, to really recruit and bring in more women, because that’s kind of my banner that I’m interested in.” Olivia said that she liked having an opportunity to help make a difference for women and minorities “just by doing something I enjoy, just by sharing the knowledge I have, just by being there.”

Teaching experiences seemed to help reinforce and strengthen participants’ commitment to computer science. Adelaide found that there were a lot of opportunities for teaching as a computer science student. “I did some lab assisting and teaching assisting all throughout my undergraduate [years], and then by the time I got to graduate school I got to run my own class. All because I got into computer science.” It was easy to tell that teaching was one of the primary

things that motivated her. Her face lit up every time she talked about being in the classroom. “I love it.” Valerie’s dream of being a professor helped maintain her determination at school when things got tough. “That’s really been the one thing I’m holding onto as things have gotten a little shaky. I want to be a professor. So I’m still here and I’m trying to stick things out.”

*Faculty (especially women faculty).* Like Valerie, most participants said faculty served as important role models and mentors when they were making their career decisions. Though the National Science Foundation (2004) found that women are only a small minority of computer science professors, almost all the participants named a woman computer science faculty member as someone who had helped or encouraged her. One woman faculty member in particular was the advisor to one participant, had encouraged a second to change her major to computer science from electrical engineering, and was mentioned as a role model by a third participant – every one of the participants who had come into contact with her had been influenced or touched by her in some way. So the few women who are there can exert a disproportionately powerful influence on women students.

Role models were important to most of these women. Seeing someone with whom they could identify, often a woman but not necessarily, pursuing computing as a career and seeming to enjoy it, made a big difference. It seemed especially important to Ginger that she saw women being treated as leaders in the field, possibly because she also aspired to be a leader:

What’s nice is that, there are at least three women that I know of there and can point to and say that they have Ph.D.s from wherever they got them, in computer science, and they are successful researchers. And they also mentor and advise graduate students. And they’re very visible. These aren’t just women that are sort of relegated to the back.

Ishvani said that having women as role models was important to her. “We don’t have too many women in the field, although it’s improving, but here, the ratio is still not there. So I do look up to them quite a lot.” Becky and Ishvani both mentioned that they felt more comfortable approaching their advisors, who were women faculty, than they would have been about approaching a man. Ishvani said, “I think it comes from my side. I guess I’m much more comfortable having female advisors. For that it’s probably my comfort level; I’m much more comfortable with them.” Valerie, who had not yet chosen an advisor, suggested she might give preference to women when making her selection. Students still have few women role models among the faculty of most computer science departments, however (COSEPUP, 2007; NSF, 2004)

*Love of the field.* It is hard to overstate the importance of a love for the field, which several participants cited as an important characteristic of a successful computer scientist. The women who were feeling less sure of their love for the field were also feeling most unsure about their chances for success. These feelings of doubt may have been a temporary response to the stresses of graduate school. A new idea or project may have been able to revive their enthusiasm for the field. If a student truly lost interest in computer science, she would find it more difficult to overcome obstacles and challenges that could put her at risk for leaving her graduate program and the field. Contrary to Woodfield’s (2000) findings, these women did derive a sense of play from computing, something that they saw as one of its most enjoyable elements. “If I didn’t love it, I wouldn’t be here,” says Becky. Love of the field, and the related attitude that computing was “fun” could help sustain women in the field even as they encountered challenges or feelings of isolation. Loving the field made it worth it to swim against the current and be the only woman in the class.



*Obstacles and Challenges*

Though most participants said they had not experienced overt sexism in their graduate programs, they seem to have encountered similar obstacles and challenges. Some were clear roadblocks, like difficulties in graduate admissions. Others were smaller incidents that helped to create a chilly climate for them and for other women in their programs (Hall & Sandler, 1982). Like bugs, these micro-inequities are small but can be insidious (Rowe, 1990). Cumulative, subtle incidents can form an invisible barrier to women’s full participation in the field and can limit their achievements (Pascarella et. al., 1997). These factors are what Luke (2001) meant when she presented a picture of higher education as a system of glass “walls and ceilings” (p.10).

Depending on the quality of support and other sustaining factors in their lives, the obstacles participants encountered could have been minor problems for them or could have been major setbacks that challenged their commitment to the field or their confidence that they could succeed. So far, these women had overcome the obstacles, but their experiences suggest factors that may cause some women to leave, or never enter, the field of computer science.

*Graduate admissions.* One of these challenges was the graduate admissions process. Though the conventional wisdom would seem to indicate that graduate programs are competing to lure the few interested women applicants, the experiences of this group of academically-successful women suggested otherwise. Just getting into graduate school was difficult for many of the participants. Some only applied to two or three schools. A few were rejected on their first try and did some coursework at the school they wanted to attend to introduce themselves to faculty and prove they could handle the work. A couple said the reason they chose their graduate school was because it was the only place where they were offered funding. One student wanted

to go to a master’s program to explore computing as a field, but the only school that accepted her with funding accepted her on the condition that she enter the Direct Ph.D. program.

It was striking that so many of the women had trouble with graduate admissions. This could suggest that they were not getting good advice about how many applications they should submit or what schools they should target. It could also be an example of admissions committee members consciously or subconsciously choosing people like themselves (Cuny & Aspray 2001). This may be a bigger factor in programs where graduate admission is a “matchmaking” process in which faculty members choose students with whom they would like to work. It was interesting that so many of the participants mentioned having women advisors, when women are such a minority of graduate computer science faculty. Women may be more likely to choose to work with women students than men are.

*Advisor issues.* In the programs these women attended, where the student’s dissertation project was often determined more by their advisor’s research agenda than their own, choosing an advisor was probably the most important decision that a graduate student had to make. Changing advisors because of personality conflicts or because of a change of direction in research interests meant slower progress through the program. Three out of ten participants in this study had changed advisors, and each said that doing so meant at least an extra year of work. Sometimes this process was painful and involved hurt feelings on both sides. One participant seriously considered changing schools in the aftermath of an advisor change, which would have undoubtedly meant even more of a delay.

Participants who had not yet chosen their advisors were understandably nervous about the process. Linn said she wanted to make the right choice, because, “I have to work with him or her

for another five or six years.” Valerie was feeling anxious about looking for an advisor when we spoke:

How do I go about putting out those feelers and saying, “Who might be looking for people on their research projects?” How do I get to know these people and find out what they’re like before I commit to doing a project with somebody?

She felt that being in the Direct Ph.D. program put her under pressure to commit to a project when she would rather be exploring the field of computer science as a master’s student.

*Losing confidence.* Graduate school could be challenging even for students who had always been academically successful. Adelaide said that teaching on her own for the first time terrified her, and she seriously thought about turning down her assistantship. “I’m broke, and my student loans will come due if I don’t come to school, but I can just get a job and go to graduate school and everything will be okay and I just won’t teach!” Other participants said that they worried that they would not make it through their coursework. Linn said, “I’m afraid that if I don’t pass the qualifying exam, I’ll get kicked out of school. You have two chances. But there are people who got kicked out, so I’m really nervous about it.” Valerie said that feeling lost and not knowing how to navigate the program made her wonder if she was motivated enough to make it through a doctoral program. The newer a participant was to graduate school, the more likely she seemed to be to worry that she was not smart enough or determined enough to make it through.

*“I don’t spend my free time programming.”* Some participants in this study reported doubts about themselves or the computer science field because, as Linn said, “even though I claim I like computers and I like programming, I don’t think I want to do it 24 hours. I don’t think I want to do it all the time.” Linn preferred to spend her free time playing video games,

shopping, or cooking. This made her anxious about her choice of field, she said. “The guys are all into it so much that sometimes I’m scared. If I don’t like it that much, will I be able to make it?” Valerie said she had the same doubts, but had worked through them:

I had a little revelation, you might call it, which is pretty obvious, but it hadn’t crossed my mind. If you go to some accounting major, do you think they do accounting in their free time? I realized this all of a sudden. You know what? There’s nothing wrong with that. There’s nothing saying that I’m any less of a computer science major because I don’t spend my free time programming! And that just made me feel so much better once I realized that.

This revelation helped her to see that she could still be devoted to her field even if she chose not to spend her free time programming or reading technology magazines. She said that preferred to relax by reading a novel or reconnecting with her first love, music.

This image of successful computer scientists as driven and completely focused on computers is what Margolis and Fisher (2003) called “geek mythology” (p. 61). Many of the women they interviewed said that this image was not appealing to them. Other researchers have also described the negative influence of this image of computer science students as “geeks and nerds” (Carlson, 2006). Ginger said she was initially turned off from computer science because it seemed that computer science majors at her undergraduate institution “lived in the computer lab” and were “so intensely into [computers] and seemingly interested in absolutely nothing else.” She said that one of the reasons she chose the doctoral program at Rosary was because it was friendly to part-time students, and as a married woman with a job and a love of travel, this appealed to her. “This program takes five years even as a full-time student. I just was not keen on putting everything on hold for five years until it was over.”

Olivia said that the nerdy image of computer science did not bother her because she had always been brainy:

When I first got started in it, people who were in computer science weren't very social. I know, that sounds like a bad thing. But, I was kind of, being a bookworm, you were kind of to yourself. Nerds have nerdy friends, right? So we weren't big on the social skills, but this was something that we could do, this was something that I enjoyed.

Olivia said that once she got into the work world, she realized that she was a better communicator than she thought.

### *Hopes and Dreams*

Participants' hopes and dreams often helped sustain them in the face of obstacles they encountered, but they seem to be more than just another sustaining factor. Hopes and dreams tell us what these participants wanted to become, both as computer scientists and as women. Like the small tree growing in the shadow of a larger tree, these students often referred to role models in the field who had lives that they said they wanted to emulate. When participants talked about future plans, they talked about more than what jobs they wanted to hold. They talked about the things that they wanted to accomplish with their careers *and* with their lives. These hopes and dreams seemed to be grounded in their constructions of computer science – they saw working in computer science as a means to achieve the things they wanted for themselves, not just for their careers. Participants wanted to engage in activities that were intellectually challenging. Most participants also said that they wanted to have a chance to help others. Finally, they also wanted a balanced life.

*Intellectual challenges.* Most of the participants said they found computer science, and especially programming, to be “fun.” Participants said they enjoyed mental challenges, from debugging a program to solving crossword puzzles. They wanted careers that would be intellectually stimulating and let them put their analytical skills to good use. Becky said, “I definitely like solving problems. I definitely like figuring out what’s wrong, in certain cases, just, there’s that challenge aspect.” Ishvani looked forward to a career in computing because she would always be learning. “Technology fascinates me, especially electronics. It’s been changing all the time, so it’s a challenge to keep ahead of it.” Participants said that the fact that computer science was such a challenge, and would continue to challenge them throughout their careers, was what made it so exciting.

*Making a difference in the world.* In the previous section, I quoted Valerie, who said that women felt validated when they had the ability to help people. During the member-checking process, Hazel rejected the idea that women had an inherent need to help others in order to feel fulfilled. She said that her family’s values, and not her gender, were the biggest influence on her goals and expectations. She said, “I’m getting the very subtle impression that we are attempting to justify or excuse or explain or motivate our career choices within the stereotypically feminine framework.” It is possible, and probably more accurate, to frame these women’s career goals as a desire to make a difference in the world through their lives and work, a concept that is less tied to stereotypical ideas about women.

Most participants did seem to want to make a difference in the world. Some wanted to serve as role models and mentors, like Camille and Olivia. Others looked forward to the rewards of teaching and sharing their knowledge, like Valerie and Adelaide. Ginger saw research and technology development as another way to make an impact:

I think what I want to do is focus on those areas that help people who are in the greatest need, where there's a lot at stake, to use technology as a partner to create tools that they can actually use, either to make important decisions or do better things with their lives.

Not only was computer science challenging, it was practical and you could see the results right away, Hazel said. “Whereas if I was in physics, maybe I would get something that worked, but mostly I'd probably be studying for the rest of my life before I made any real impact on the world.” Like the women in Tillberg and Cohoon's (2005) study, these participants had constructions of computer science that were broader than the stereotypical idea of computing as a solitary and dull pursuit.

*A balanced life.* Whether or not participants wanted to have children and a family, most said that they wanted a balanced, well-rounded life. Their desires echoed those reported by the men and women in Wulff, Nyquist, and Sprague's (2004) study of graduate students. Camille's move from a high-powered career as a manager to pursue an academic career was a conscious choice to put her quality of life over salary concerns. Participants wanted a challenging career, but they also wanted to have time for family and leisure. Linn wanted to emulate her undergraduate advisor, who taught during the school year and spent his summers traveling. Most participants saw a faculty position, or at least one at a small four-year college, as a career where there was more opportunity to have a balanced life. Valerie saw that her professors were able to have the flexibility to spend time with their families and pursue other interests, and that made the career more attractive to her. Even Ginger, with all of her ambitious plans, said, “I do, very much, want to have a balanced life.”

### Summary

The experiences of the women in this study showed some basic similarities, which are outlined in the data model explained in this chapter. Their families were of crucial importance in shaping their gender constructions and encouraging them to pursue their education. They experienced similar creating and sustaining factors that helped engage their interest in computer science and keep that interest alive. They also experienced common obstacles and challenges, both large and small. And they shared many of the same hopes and dreams.

In the next chapter, I discuss these findings in depth in the context of the literature on women in computer science. I also make recommendations for how graduate students might more effectively recruit and support women in computer science. Finally, I suggest directions for future research.



## CHAPTER VII: DISCUSSION AND CONCLUSION

The participants in this research were an impressive group of women – bright, ambitious, and enthusiastic about their field. After reading so many discouraging stories of discrimination and frustration in the literature, it was comforting to see that there were women who were succeeding and thriving in graduate programs in computer science. Though they had faced some challenges, most, especially those who have been in graduate school the longest, had found their experiences generally positive and rewarding.

## Discussion

The findings presented in the previous chapters give an information-rich picture of the experiences of women graduate students in computer science. A few points in particular echoed or questioned concepts I encountered in the literature.

*Small Things*

Examples of outright sexism in graduate programs were rare. Only a few of the participants had encountered individual faculty members who seemed hostile to the women and/or students of color in their classes. More common were the kind of micro-inequities that can create a chilly climate for women. (Hall & Sandler, 1982; Rowe, 1990). Valerie gave an example: A woman faculty member always asked the men in the class for help when she was having trouble with her computer, even though she knew that there were women in the classroom who were also computer scientists. This is reminiscent of the observation by Pascarella et al. (1997) that even well-meaning faculty call on men more often than women and generally “[take] men’s contributions more seriously than women” (p. 110). Hazel said that, especially as an undergraduate, there was a perception among her fellow students that women “needed the easy assignment in a group project.” These small messages can accumulate if they are not negated by

more positive messages. In some ways, these kinds of micro-inequities can be especially discouraging. It seemed easier for participants to find strategies for handling visible obstacles, like sexist faculty or difficulties with graduate admissions, than to find a way to challenge the small, almost imperceptible slights the participants reported. These women students had the sense that their experiences of being left out or ignored were just personal failures to fit in, rather than instances of gender-related discrimination.

### *Isolation*

For women in computer science, these micro-inequities can be compounded by a sense of isolation and a lack of peer support. Because women are such a small minority of most doctoral programs in computer science, and may not be able to compare their experiences with those of other women, they may see these small incidents as a reflection of a lack of ability on their part. If women already feel that faculty or other students in their program question their competence, they may not want to compound this by asking questions about program requirements or about other issues with which they are struggling.

I saw this most clearly in Valerie’s loneliness and her reluctance to talk with faculty about her difficulties in focusing on a research topic. She and Linn both said that they were losing confidence, partly because they were finding their classes more difficult than they expected, and partly because they were worried that other students were more intensely interested in computers than they were. Ginger and Olivia both said that the program at Rosary was so unstructured that a student could get lost. Becky said she felt isolated in her program and did not socialize with other students outside of class.

Ali and Kohun (2006) reported that doctoral students often experienced confusion about program requirements or processes as isolating. “What may start as simple confusion about the

program or the requirements of the program quickly grows into a feeling of being left behind and overwhelmed” (p. 24). These feelings may be magnified by women and other minority groups in the field because they may have fewer close contacts with other students. When Valerie had the feeling of being overwhelmed, she seemed to instinctively reach out for more peer support. She found even simple things, like watching a movie with other women in a computing club, helped her feel more connected and secure.

*Downplaying or Disowning Femininity*

As discussed earlier, some of the participants seemed to see themselves as different from other women and spent more time with men. This could have been a survival strategy in a world where men generally do have some advantages. Aligning themselves with the women might mean that they would be overlooked. Women who think of themselves as “one of the guys” and adopt more masculine communication patterns may be more successful in an environment like computer science. Women, like it or not, may internalize some of the messages that women are less respected than men, so they would prefer to “align [themselves] with the men,” as Adelaide said. Women are not exempt from the unconscious tendency to undervalue the abilities and accomplishments of women (Kolodny, 2000; Valian, 1999). The men seem like the “go-getters” and women who want to be successful might get the message that the easiest way to do that is to be “one of the guys.”

Rather than trying to reject gender roles outright, many successful women may see themselves as the exceptions to the rule, more independent and brave than other women. This would seem to confirm Valian’s (1999) observation that “The more agentic and instrumental a woman is, the less she can see herself as feminine. Depending on her self-concept, that may or

may not concern her” (p. 182). If a woman does not want to minimize her successes and ability, she may feel the need to downplay femininity.

Women like Adelaide and Hazel may have chosen to identify more with men because they found it easier to avoid gender roles for women that they found too limiting. Or maybe women who do choose to work in computer science internalize a conflict between “trying to be a girl and be technical at the same time,” to quote one of Margolis and Fisher’s (2003) informants (p. 30). This conflict seems like the rule, rather than the exception, for successful women. A woman who wants to succeed as a computer scientist may “accept the masculine culture and adjust [her] expectations and aspirations accordingly” (Dryburgh, 2000, p. 194) or even, like Pattatucci’s (1998) informant, think of herself as an “honorary male” (p. 106) if it helps her to feel more equipped to fit into the culture. The fact that women feel the need to choose between femininity and success says a lot about how powerful gender constraints continue to be.

There is a lot to reject in femininity as it is stereotypically defined. Valian (1999) said that most people associate masculinity with independence, assertiveness, and leadership and associate femininity with nurturing and social behavior. Disowning femininity may be a good strategy for intelligent, ambitious women if owning it means being “always acting in the service of others, never acting for [themselves]” (p. 14).

It seems oddly symbolic that Adelaide had had a breast reduction. Although she did it for health reasons, rather than to change her looks, she said she noticed that men took her more seriously after the reduction. Adelaide said that she noticed a similar affect when she cut her hair, which had been very long, to make her look older and more professional.

Appearance was one area where participants expressed their lack of interest in conforming to gender roles. As children, participants may have chosen to act as “tomboys”

because this gave them more freedom and more room to explore who they were. As adults, they were neatly dressed and attractive, but most said that they usually did not spend a lot of time fussing over their looks. In a field populated mostly by men, dressing simply and professionally can send a signal that they want to be taken seriously as men’s intellectual equals. Again, as Valian (1999) suggested, looking too overtly feminine may put women at a disadvantage. According to common-sense perceptions of gender, “The qualities required of leaders and those required for femininity are at odds with each other” (p. 136). Besides, comfortable clothes send the message that you are equipped to handle long hours sitting at a computer. Participants may also have simply made the practical decision that time and money spent on beauty maintenance were better spent in other ways.

After they had achieved some success in their academic careers, some of the women felt more freedom to experiment with fashion and other stereotypically feminine means of self-expression. Adelaide talked about enjoying “looking girly” sometimes, whereas she said she de-emphasized her appearance and wore a lot of black earlier in her career, because of the sense that “looking nice and being smart didn’t go together.” Hazel said that though she “cared about that stuff sometimes,” she felt that practical concerns should sometimes outweigh fashion. The example she cited, the friend who was working on an academic conference and worrying about her shoes, was a good example of how too much concern about appearance can distract women from more important issues. Becky said that sometimes she cared about things like appearance and sometimes she “could [not] care less.” It seemed like these women found a way to play with their appearance, rather than be defined by it. As Butler (1997/2003) suggested, they may see gender as more of a performance than something unchangeable, as reflected in Adelaide’s statement that she likes “to be a girl sometimes.”

*The Importance of Constructions of Motherhood*

To many of these women, an important part of their construction of women was motherhood, whether or not they had or wanted to have children themselves. When women brought up the issue of children, it was usually in rejection of a narrow role for herself as primarily a wife and mother. Not all participants expressed themselves this strongly. Olivia, for example, seemed like she was interested in having children when her husband felt ready. She said she would consider quitting work if she had children. Becky, however, said, “I would be very bored being a housewife” and that she needs the “mental challenges that biology or computer science involve.” She did not rule out the idea of having a family, but she said that her career came first.

Wanting children did not mean that a woman accepted traditional gender roles without question. Valerie considered it a positive thing that her professors at a liberal arts college “have families, are raising families,” and the flexibility she saw in their schedules appealed to her as a way to potentially balance her interests in having a family with having a career. And Ishvani, who sounded regretful about not having children, still thought that a woman should “be able to feel that she’s an intelligent part of the community” and “not known just as a person of a certain sex, with all the connotations that brings up.” Women like Adelaide, who were not interested in children, may have constructions of motherhood that were more confining and therefore incompatible with the way they wanted to see themselves.

*Reactions to “Geek Mythology”*

Margolis and Fisher (2003) used the term “geek mythology” as shorthand for the perception that all computer scientists were nerdy men with an intense, obsessive interest in computers (p. 61). This perception, they said, was one of the things that chased women students

out of the computer science major at Carnegie Mellon. Several participants had doubts at some point in their program resulting from geek mythology. Some, like Ginger, were turned off by their construction of what it meant to be one of “those people.” Others were afraid that their interest in computers was not as intense enough for them to be successful. Still others worried that they were not smart enough or quick enough to keep up with their classmates. Some participants had overcome these fears, but others were still struggling with them.

Other women were not as bothered by geek mythology, and some seemed to actively embrace it. Though in Woodfield’s (2000) study, the men saw working with the computer as play and the women did not, many of the participants in my study talked about playing with technology and said that they thought computers were fun. The fact that other people are intimidated by computers and find working with them so difficult gave some participants a thrill of accomplishment when they mastered a difficult computer problem. These participants readily admitted that working in computers meant many hours in front of a screen, but said that the work was rewarding because you could make the computer do what you wanted. One participant said she saw the computer as a “gadget to play with,” a “toy.” Woodfield’s informants would have been from a different generation than the participants in this study. Maybe more girls and women now have the experience of playing with technology earlier in life.

#### Limitations and Lessons Learned

This study focused on the experiences of ten women doctoral students in computer science. I do not claim that these findings are generalizable to the experiences of all women in computer science, or even to all women graduate students. However, there were enough similar themes in these women’s stories to suggest that some of these insights may be transferable.

*Perceptions Are Snapshots, Not Fingerprints*

An important limitation is that these interviews provided a snapshot of the women’s feelings and perceptions at one particular point in time. I checked the transcripts with the participants shortly after our interview, and shared the profiles with them after they were written to make sure that I had accurately recorded and interpreted the students’ experiences. Still, constructions and perceptions will, by nature, evolve over time. For example, I recently received an email from Valerie that said, “Things are indeed looking up around here... I got a research assistantship for this summer and the upcoming year, and I’m getting involved in a couple of different research groups.” She no longer seemed as intimidated by the idea of research. This was good news, and not unexpected. It seemed likely that her feelings of being overwhelmed would diminish as she adapted to graduate school.

As snapshots, these findings give a useful sense of what the students were feeling when we spoke, but just like any other snapshots, they are only able to present what was going on at that particular moment in time. They are not fingerprints, unchangeable and indelible. It would be interesting to see how these participants’ perceptions change over the next five or ten years.

*Recruiting Graduate Students for Research*

When I began this study, I had no idea how difficult it would be to recruit participants. I first attempted to contact participants through faculty members in their programs. Though I found one or two participants this way, it did not prove to be an especially effective method of recruitment. First of all, some faculty did not know the women students in their programs. Also, my efforts to recruit at one school were rebuffed with the explanation that their women computer science students were bombarded with requests to participate in interviews and other research, and faculty understandably wanted to protect them from excessive encroachments into their work



and personal time. Finally, requests from an unfamiliar person are easy to reject or ignore especially when delivered by email or telephone.

I found that personal contact was a more effective recruitment method. I had a friend at one of the schools who was able to connect me with my first two participants. Once I found one student at a school, she would sometimes help me make contact with her friends in the program. Also, at one participant’s suggestion, I attended two small regional conferences for women in computer science. I made contact through those conferences with faculty at two of the schools and also met two other participants this way. Those conferences also gave me a better insight into what current computer science research is like and gave me a chance to present some preliminary findings to women in the field.

The recruitment strategies I used, especially the fact that sometimes one participant put me into contact with others at her school, may have resulted in recruitment of participants with more similar experiences than I expected because I sometimes ended up interviewing friends. As outlined in Chapter Four, however, there was enough variation in age, race, ethnicity, and other characteristics that I feel that multiple “angle[s] of perception” have been represented (Moustakas, 1994, p. 91).

### Implications for Practice

The similarities among these women’s experiences suggest ways that computer science programs could “act more thoughtfully and tactfully” to recruit and support women students (van Manen, 1990, p. 23). These suggestions are detailed below. Overcoming the remaining barriers to women’s full participation in computer science would give departments a richer, more varied talent pool from which to draw.

Hopefully, these findings could also help the participants and other current graduate students. I shared my preliminary findings with one of the participants before presenting it at a conference and she said, “So I’m not the only one?” One of the important goals of research of this type is to help people see that they are not alone in their struggles, so I took this comment as confirmation that I was going in the right direction. That comment helped confirm for me that I had teased out the shared meanings in a way that “*is validated by lived experience and it validates lived experience* [italics original]” (van Manen, 1994, p. 27). When I presented at the conference, I also got nods and confirmatory comments from the audience of women students and faculty. When I shared these findings with the participants of the study, they replied with comments like this one: “I found that the ideas and the similarities between the participants and me were very interesting. I’m surprised that most of us feel the same way about many aspects of computer science.”

Though the women in this study faced some specific challenges related to their gender, most were happy with their choice to pursue doctoral degrees in computer science. The fact that their experiences were so generally positive may be heartening to other would-be graduate students. The participants in this study were able to find ways to overcome the obstacles they faced. Their struggles and successes suggest ways that departments could help other students, especially other women students, explore and nurture their interests in computer science.

#### *Give Undergraduates the Big Picture*

Giving undergraduates more exposure to and experience with research may help students see themselves as potential researchers. Discussing current computer science research with undergraduate students also could show these students “the big picture” and give them a sense of what computer scientists really do.

Fox and Stephan (2001) speculated that women chose careers at teaching colleges because men had a better chance getting hired at more prestigious research schools and in industry and women expected to get the “employment ‘left-overs’” (p. 119). In contrast, the participants I interviewed who wanted these kinds of positions seemed to indicate that they had a strong interest in teaching and less interest in doing research. Some saw their professors at small colleges and universities as role models with a good quality of life. These participants were also less familiar with research or feared that they did not have what it took to be good researchers. Wulff, Austin, Nyquist, and Sprague (2004) also found in their study of graduate students that both men and women who had attended liberal arts colleges saw teaching-focused environment as their ideal, “despite four years of exposure to academic life in a research university, and in some cases, because of it” (p. 58). They found that some of these graduate students felt the need to downplay this aspiration because most of the faculty at research institutions saw a research-focused career path as the only valid one. Participants who had already worked in industry or who had other research experience were more interested in pursuing opportunities in research. But even in a teaching-focused environment, aspiring faculty members may be expected to do some research.

These participants’ feelings about teaching show that experience can help students feel less intimidated by challenging activities. Participants were initially nervous about teaching, but were able to overcome those fears after getting classroom experience. Similarly, earlier exposure to research could demystify the research process for students and help build their confidence. Faculty members who involve undergraduates in research and encourage them to attend local conferences could also help students see the “big picture” of computing. I attended one of these conferences, and it was exciting to see the variety of research that computer scientists are doing.

“Women in Computing” conferences may be even better at providing role models and inspiration for women students. Students might not think to attend a conference unless computer science departments actively encourage them to go and help them to find funding, or at least facilitate carpooling and room-sharing. If undergraduate computer science majors, and even non-majors who are interested in computer science, attended conferences and assisted faculty in research projects, they may be more likely to stay in the field and aspire to be researchers.

*Recruit the Right Women*

At one school I visited, I met with a woman who worked in multicultural affairs and also did programming to increase the participation of women in technology fields. She said that, among other recruitment efforts, she was conducting programs that emphasized the more feminine aspects of technology. Two examples she mentioned were the technology of fashion and the technology of cosmetics. This kind of program may reach out to a different audience than the current group of computer scientists. However, the strategy could also backfire and make the program less attractive to women who “could [not] care less about that stuff,” like many of the women in this study. It also seems to trivialize women as interested in only superficial things like appearance.

To reach out to a broader audience without turning off the women who are already interested in computers, it may be better to emphasize some of the aspects of computing that interested these participants. Women students may be more attracted to computing if promotional efforts emphasized the creative and problem-solving aspects of programming, for example. Some participants were also attracted to computing’s connection to language and logic. Efforts to promote computing in this way might attract women with strong analytical skills who might otherwise major in English or music, like some of the women in this study. Math majors

or women who enjoy math, like Camille and Susan, are also logical targets for recruitment efforts. And as in Becky’s case, it may be wise to recruit women who are interested in other sciences like biology, in which computers are used for cutting-edge research.

If graduate programs in computer science are going to reach out to these groups, faculty on admissions committees would also need to be receptive to qualified students who “have backgrounds that look quite different” than students they have traditionally accepted (Cuny & Aspray, 2001, p. 6). Departments should consider their admissions policies carefully. If highly-qualified and successful students like Camille would be excluded because of standardized test scores that do not provide a fair assessment of their abilities, admissions committees should consider whether a strong emphasis on these exams actually serves the best interests of graduate programs.

### *Take Advantage of Chance*

Several participants mentioned chance occurrences, like Adelaide’s discovery that “the books were cheaper,” as a factor in their entry into computer science majors. Schools cannot plan for chance events to occur, but they can take advantage of them.

Many participants said that their interest in computer science increased as they learned more about it. If introductory and general education computing courses are challenging and engaging, students may consider computer science as a major. Computer science department chairs might also consider publicizing their faculty members’ research and announcing interesting speakers and events in their programs. This may attract the attention of students who are undecided or, like Ginger, may have gotten a negative impression of computer science. Departments should not ignore the importance of word-of-mouth recruitment. Students who are excited about their studies, like the woman Ginger met on the train, may be one of the most

effective recruiting tools available to graduate programs. This should be added incentive to provide support and encouragement to their graduate students.

*Actively Recruit Women Faculty*

It is clear from this research that the participants saw women faculty as especially good role models for their own careers. Women faculty were also more likely to reach out to women students and take a special interest in mentoring them.

As I selected sites for this study, I found that many computer science departments had no women faculty, and it was rare to find a department with more than one or two women as professors. Departments with few or no women faculty should realize that they are going to have a hard time recruiting and supporting women students. This is not to suggest that men could not, and should not, be mentors and role models for women. Many of the participants, however, expressed a preference for women as advisors and found it easier to approach a woman for help.

Departments that are serious about increasing the number of women students in their programs should actively recruit women faculty to their programs. Hiring committees could also consciously examine their criteria and their decisions about who is qualified enough to bring in for an interview. If they have a hard time finding suitable women faculty, and their decisions about fit primarily are based on “intangibles,” they may want to ask themselves if their hiring rubric does not contain, even subconsciously, “the additional tacit criterion of actually being male” (Woodfield, 2000, p. 161).

*Facilitate Faculty-to-Student and Peer-to-Peer Support*

Most students could name at least one or two faculty members who took a personal interest in them during their college or graduate school years. These faculty served as important mentors and role models – they not only supported women in computer science, they showed

what a successful computer scientist looked like. Creating departmental social events and other casual opportunities for faculty and students to interact may help students meet role models and mentors they might not otherwise encounter.

Peer support was also critical to help students feel connected and confident. Feelings of isolation put students at high risk for leaving graduate school (Ali & Kohun, 2006). Yet many participants said that they found it difficult to connect with other students and their schools did not do enough to encourage collaboration among students. Especially when they are new to graduate school, students may appreciate it if departments facilitated opportunities for students to socialize and work together.

Margolis and Fisher (2003) found that women and racial and ethnic minorities were at a much higher risk for leaving computer science programs. Leaving it completely up to students to find peer support makes it more likely that women and other minority groups are left out. Computer science departments might consider partnering with other departments, the graduate college, and student affairs offices on their campus to develop appropriate programming and facilitate other support services for all their graduate students.

#### *Share Information Through Official Channels*

Relying on the grapevine to distribute information may leave computer science students, especially women and minorities, without the knowledge of processes and procedures necessary to successfully navigate graduate school. One of the participants in this study told me that her program required all students to take an orientation course. The course helped her feel more comfortable and less intimidated. “You learn about professor-student relationships. You learn about all sorts of things...It was like, ‘Oh, this is like everything else. This is like everything else that I’ve been through.’”

Requiring an entire course for socialization and orientation may seem extreme, but departments could easily provide detailed information about program requirements, announcements of upcoming events and deadlines, and models of successful research projects on departmental web pages. They could offer workshops and other informational sessions for their students to make sure they know where to find these resources. Student groups could also be encouraged to post the kinds of unofficial information that incoming students need – where to find quiet places to study, how students connect with advisors, how to study for comprehensive exams – on organization websites and discussion boards.

One university that created more official channels for information and socialization of doctoral students found that their students graduated “at a rate substantially higher than the national average” (Ali & Kohun, 2006, p. 32). Doctoral students who fail to complete their degrees represent a significant waste of resources to their departments. In light of this fact, why leave something so essential to student retention to chance? Providing official channels of communication would be a cost-effective way to protect departments’ investment in their students.

#### Recommendations for Future Research

The interview protocol that I developed for this study yielded interesting insights into the experiences and perceptions of participants, especially on gender constructions, which are often hard to access. The concept of gender constructions is unfamiliar to many people, and ideas about gender are generally not fully conscious. Though the questions may have seemed repetitive at times, asking the same thing in multiple ways seemed to help participants explore the question of gender from different angles. Often early in the interview, participants downplayed the importance of gender to their experiences, but upon further discussion and reflection, they would



often talk about examples where gender did make a difference. These are insights that could not be as easily gathered from surveys or other written methods. Several participants commented that the interview process helped them reflect on things they had not really thought about before. It seemed to be “an educative experience for all” (Guba & Lincoln, 1989, p. 258).

### *Longitudinal Research*

As I mentioned under limitations, this study provides a snapshot of women’s perceptions and experiences. I interviewed women at different stages of the graduate school experience, which provides something of a cross-section that may suggest how women’s experiences evolve as they move through computer science programs. Still, these women were individuals, studying at different schools, and Linn’s perceptions in her second year may be completely different from Hazel’s, and both may feel differently from Camille when they are writing their dissertations. Though there some questions that asked participants to reflect on their past experiences, they viewed those experiences through the lens of their feelings and situations at that moment.

Margolis and Fisher’s (2003) four-year study followed a group of students through their undergraduate years and was able to show trends in the way their feelings about computer science changed over time. It might be useful to do a similar longitudinal study of graduate students, since studies suggest that graduate school is weak point in the pipeline (Woodfield, 2000).

### *Women Faculty*

Because there are so few women computer science faculty, it would be both challenging and interesting to study their experiences and perceptions. Because they would have been through the hiring and promotion process and would more years of experience in the field, they would probably have more explicit ideas about gender’s influence on their careers in computer

science. One woman faculty member, for example, told me about a recent tenure denial that she was sure was gender-related and said this was just one example of how the culture at that school was unfriendly to women. Women faculty members would also be able to provide comparisons between the environment they encountered as students and the environment for current students in computer science.

### *Women Information Technology Professionals*

Information technology is a very different field from academic computer science. However, need for qualified information technology personnel is expected to grow, and many computer science graduates will enter this field. Computing companies have been making efforts to recruit women and are eager to expand their talent pools, but as Woodfield (2000) found in her case study, subtle factors can make it harder for women to feel fully accepted in this environment than men.

Woodfield’s study focused on one software company and looked at co-workers’ and management’s perceptions of women as workers in that company. A study that focused more specifically on the experiences and perceptions of women working in information technology might add to our understanding of what constructions and experiences prepare women for success in that field.

### Conclusion

There are many reasons for the continued underrepresentation of women in computer science, especially at higher levels of the academic hierarchy. By emphasizing gender constructions, I do not mean to discount the other factors in this complex phenomenon. I just want to focus in on one important influence.

What we imagine for ourselves helps to determine our reality. If I cannot imagine myself as a successful computer scientist, I will not enroll in a computer science program, or if I do, I am unlikely to succeed. It would be too easy for me to get discouraged or overwhelmed in such a challenging environment if success does not seem within my grasp. To become interested in computing, I have to see myself and computer science as fitting together. We have to “click.” Beyond that first click of interest, I need to have a sense of myself as competent and capable. I need to see computing as exciting and inherently engaging. I need to see it as similar to other things I like, whether learning languages, solving puzzles, or playing with a toy. As a woman, I need to see computing as something that is compatible with my ideas about what it means to be a woman, or I need to downplay the importance of gender as a factor in my experience.

Our constructions of ourselves are not something we assemble consciously like a model airplane. They are more organic, and grow out of our experiences like a tree. They start to sprout as we grow up in families and are given messages, explicit and tacit, about what is possible for us. They are influenced by our environment. Some ideas are encouraged, others are pruned or stunted. Negative ideas can crowd out our confidence like weeds, or we can be given supports from encouraging role models, mentors, and peers.

The women in this study are striving to be successful computer scientists. Whether they flourish or wither will depend partially on their personal characteristics and partially on the soil in which they grow. Hopefully, their environment will be fertile and rich. The experiences of these participants prove that women can have a strong love for computer science and find it a richly rewarding field. Computer science departments that wish to encourage healthy development of all their students can learn from the experiences of the women in this study to act more thoughtfully. They can do more to provide the right conditions and support for that growth.

This research is a modest attempt to contribute insights on how to do that, starting from the radical idea that if you are interested in the answer to the eternal question “What do women want,” the best thing to do is ask them.

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APPENDIX A: TEXT OF RECRUITMENT EMAIL TO FACULTY MEMBERS

Dear Faculty Member:

My name is Jennifer Sader, and I am a doctoral candidate in the Higher Education Administration program at Bowling Green State University. I am doing my dissertation research on the experiences and constructions of women graduate students in computer science. I am currently looking for individuals who would be interested in participating in my study. I am writing in the hope that as a faculty member, you may be able to refer women students in your graduate program who may be interested in participating in this study.

As a woman who has worked in information technology at Bowling Green State University for the past seven years, I am interested in the underrepresentation of women in computing fields. I am studying the influence of gender on women's expectations and experiences in graduate computer science programs. I am looking for women graduate students in computer science who would be willing and able to talk about their experiences to contribute to the understanding of this group.

I am interested in learning what common themes arise from the experiences of my participants. The study is qualitative in approach and methods. The primary data would come from a sixty-to-ninety minute interview with each of the participants about their perceptions and experiences. These interviews would be conducted at the students' residences or at another location convenient to them. Some follow-up contact would be necessary to confirm that students' experiences are being accurately represented. I know that these students are enrolled in a

rigorous course of study and will not make excessive demands on their time. The result of this study will be a synthesis of the participants’ experiences and shared constructions, and participants will be asked to review and comment on these syntheses.

Participants must agree to the interviews being tape-recorded to assist with gathering the most complete and accurate data possible. Every attempt will be made to protect students’ confidentiality. Each participant will be asked to choose a pseudonym to be used in place of her name in all data reporting. Any identifying details that would interfere with confidentiality will be removed or obscured. Upon completion of the initial interview, each student will receive a copy of her transcript for review, and will have the opportunity to clarify, delete, or add any information as necessary to accurately portray her experiences and constructions.

### **Why Should Students Participate?**

There has been a lot of research into the reasons for the scarcity of women in computer science, but less is known about how women graduate students construct their own experiences. This study is intended to contribute to our understanding of women who have chosen to study computer science and to provide information about how successful students in graduate school think about themselves, about gender, and about what it means to be a computer scientist. This may help suggest ways that computer science programs and faculty could more effectively recruit and support women students.

If you know students who would be willing and able to participate in this study, or if you would like to know more about my project, please contact me via e-mail at [jsader@bgsu.edu](mailto:jsader@bgsu.edu) or by

telephone at 419-373-6709. I will be happy to answer any questions you might have, as well as to discuss the project further with you. Please keep in mind that email is not 100% secure, so if you would like to discuss sensitive information, you may prefer to use another contact method. Students are free to remove themselves from the study at any point without penalty to them.

If you have questions regarding this study, you may contact either Jennifer Sader or my advisor, Dr. Ellen Broido through the telephone numbers or e-mail addresses provided below. If you have questions about students’ rights as research participants, you may contact the Chair of Bowling Green State University’s Human Subjects Review Board at 419-372-7716 or via e-mail at [hsrb@bgsu.edu](mailto:hsrb@bgsu.edu).

I appreciate your time and attention to this matter, and look forward to hearing from you.

Sincerely,

Jennifer L. Sader  
Doctoral Candidate

419-373-6709  
[jsader@bgsu.edu](mailto:jsader@bgsu.edu)

Dr. Ellen Broido  
Higher Education  
Administration  
419-372-7382  
[ebroido@bgsu.edu](mailto:ebroido@bgsu.edu)

## APPENDIX B: TEXT OF RECRUITMENT EMAIL TO STUDENTS

Dear Potential Participant:

My name is Jennifer Sader, and I am a doctoral candidate in the Higher Education Administration program at Bowling Green State University. I am doing my dissertation research on the experiences of women graduate students in computer science. I am currently looking for individuals who would be interested in participating in my study. You were referred to me by Faculty Member as a student who might be interested in participating in this study.

As a woman who has worked in information technology at Bowling Green State University for the past seven years, I am interested in the underrepresentation of women in computing fields. I am studying the influence of gender on women's expectations and experiences in graduate computer science programs. I am looking for women graduate students in computer science who would be willing and able to talk about their experiences to contribute to the understanding of this group.

I am interested in learning what common themes arise from the experiences of my participants. Eight to ten participants will be included in the study. This study is qualitative in approach and methods. The primary data would be gathered during a sixty-to-ninety minute interview about your perceptions and experiences. These interviews would be conducted at your residence or at another location of your choice that is convenient to you. Some follow-up contact would be necessary to confirm that your experiences are being accurately represented. I know that you are enrolled in a rigorous course of study and will not make excessive demands on your time. The



result of this study will be a synthesis of all participants’ experiences and shared constructions, and you will be asked to review and comment on these syntheses.

To be eligible to participate, you must agree to the interviews being tape-recorded to assist with gathering the most complete and accurate data possible. Steps will be taken to assure your confidentiality. You will be asked to choose a pseudonym to be used on all materials associated with the study. Any identifying details that would interfere with confidentiality will be removed or obscured. Upon completion of the initial interview, you will receive a copy of your transcript for review, and will have the opportunity to clarify, delete, or add any information you feel is necessary to accurately portray your experiences and constructions.

### **Why Participate?**

There has been a lot of research into the reasons for the scarcity of women in computer science, but less is known about how women graduate students construct their own experiences. This study is intended to contribute to our understanding of women who have chosen to study computer science and to provide information about how successful students in graduate school think about themselves and computing. This may help suggest the kinds of interventions that could help schools increase their enrollment of women in these programs and help faculty to more effectively recruit and support women students.

If you are willing and able to participate in this study, or if you would like to know more about my project, please contact me via e-mail at [jsader@bgsu.edu](mailto:jsader@bgsu.edu) or by telephone at 419-373-6709. I will be happy to answer any questions you might have, as well as to discuss the project further

with you. Please keep in mind that email is not 100% secure, so if you would like to discuss sensitive information, you may prefer to use another contact method. If you agree to participate in the study, please be informed that you have the right to drop out at any time, without penalty to you. Your decision to participate or not to participate in this study will have no impact on your relationship with the institution of higher education in which you are enrolled in any way.

If you have questions regarding this study, you may contact either me or my dissertation director, Dr. Ellen Broido through the telephone numbers or e-mail addresses provided below. If you have questions about your rights as a research participant, you may contact the Chair of Bowling Green State University’s Human Subjects Review Board at 419-372-7716 or via e-mail at [hsrb@bgsu.edu](mailto:hsrb@bgsu.edu).

I appreciate your time and attention to this matter, and look forward to hearing from you.

Sincerely,

Jennifer L. Sader  
Doctoral Candidate

419-373-6709  
[jsader@bgsu.edu](mailto:jsader@bgsu.edu)

Dr. Ellen Broido  
Higher Education  
Administration  
419-372-7382  
[ebroido@bgsu.edu](mailto:ebroido@bgsu.edu)

APPENDIX C: INFORMED CONSENT DOCUMENT

PARTICIPANT CONSENT FORM

Investigator: Jennifer L. Sader  
247 S. Enterprise St.  
Bowling Green, OH 43402  
419-373-6709 (home)  
419-372-7382 (office)  
E-mail: jsader@bgsu.edu

I, \_\_\_\_\_,  
consent to participate in Jennifer Sader’s dissertation, entitled “Women in Computer Science: Opening a New Window on the Debate.” I have been informed that my anticipated time commitment as a participant is for one 1 ½ hour long personal interview, to be followed up with telephone and/or online contacts as necessary to clarify add, and delete data. I further have been informed that I will be asked to review the detailed transcript and the study findings. I have also been informed of the following:

- a. interviews engaged in will be audio-taped, transcribed, and analyzed for this study;
- b. information about me will be collected via audio-tape and the researcher’s notes; upon completion and approval of the dissertation, all audio tapes will be destroyed or returned to me;
- c. all information, analysis, and supporting notes will be kept secured in the investigator’s home or office and the researcher’s computer records will be protected;
- d. pseudonyms will be substituted for my name and for my institutions at all phases of the study, records of data collection, and in the preliminary and final drafts of the dissertation. Only the investigator will have access to the list matching pseudonyms to study participants’ names;
- e. I will have the opportunity to review transcripts of my interviews and the overall findings before the final draft in order to ensure accuracy by either confirming or denying the investigator’s descriptions and the use of direct quoted or summarized statements. Should it become necessary, I may negotiate changes of the above with the investigator;
- f. the information obtained during this study will be used in a dissertation which will be read by the four members of the dissertation committee, and will be accessible to the public in its final form at Bowling Green State University and through Dissertation Abstracts International. Also, the transcriptions and final draft, in whole or in parts, may be used by the researcher in other publications or in public presentations.

- g. my participation is voluntary and I am free to withdraw from participation at any time.
- h. my risks as a participant in this study are expected to be no greater than those associated with everyday life. If I am experiencing emotional distress as a result of my participation in this study, I should contact either Jennifer Sader or Dr. Ellen Broido at the phone numbers or email addresses provide below for referral to counseling.
- i. that I will receive a copy of this form for my records, including, if I request it, a copy of the signed version of this form.

If I have questions regarding this study, I may contact either Jennifer Sader or Dr. Ellen Broido, dissertation director, through the telephone numbers or e-mail addresses provided below. If I have questions about my rights as a research participant, I may contact the Chair of Bowling Green State University’s Human Subjects Review Board at 419-372-7716 or via e-mail at [hsrb@bgsu.edu](mailto:hsrb@bgsu.edu).

I agree to participate in this study having read, been informed of, and agreed to the above.

---

Participant’s Signature and Date

I would like this pseudonym to be used in place of my name all materials associated with the study:  
*(If I do not choose a pseudonym here, I will provide one later or allow one to be chosen for me.)*

Jennifer L. Sader  
Doctoral Candidate

419-373-6709  
[jsader@bgsu.edu](mailto:jsader@bgsu.edu)

Dr. Ellen Broido  
Higher Education  
Administration  
419-372-7382  
[ebroido@bgsu.edu](mailto:ebroido@bgsu.edu)

APPENDIX D: INTERVIEW PROTOCOL

What are women graduate students’ career aspirations?

Tell me a little bit about your educational background.

When did you decide you would like to be a computer scientist?

What are some of the factors that helped influence your decision to study computer science?

What people have you looked to as role models or mentors when making your career decisions?

What are your plans after you graduate?

Have your plans changed since you entered the program?

How do they feel about their chances to succeed in their chosen career and field?

How do you feel about your chances to find the kind of position you’re looking for after graduation?

How would you say that your experiences in the program have affected your expectations of future success?

In what ways, if any, do you think that women’s experiences working in computer science might be different than men’s?

How do women graduate students in computer science construct the idea of womanhood?

What events, people, or messages in your life influenced your ideas about what it means to be a woman?

What do you picture when you think about a happy or satisfied woman?

How would you compare yourself with this description?

In what ways do you see yourself as similar to or different from other women you know?

What are their constructions of what it means to be a computer scientist?

What about computer science attracted you to the field?

What do you think it takes to be a successful computer scientist?

How would you compare yourself with this description?

What is it like to be a woman studying computer science?

In what ways, if any, do they believe their gender has affected their experience in their graduate programs?

What attracted you to [name of school]?

What factors did you weigh when deciding between programs?

What is it like being a woman in the doctoral program at [name of school]?

In what ways do you think gender has played a role in your relationships with other students and faculty in your program?

What kinds of messages have you gotten about men’s and women’s relative chances for success in your chosen field?

In what other ways, if any, do you think your gender has had an effect on your experiences as a Ph.D. student at [name of school]?