Forging Paths Through Hostile Territory:

Intersections of Women's Identities Pursuing Post-Secondary Computing Education

by

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ABSTRACT

This study explores experiences of women as they pursue post-secondary computing education in various contexts. Using in-depth interviews, the current study employs qualitative methods and draws from an intersectional approach to focus on how the various barriers emerge for women in different types of computing cultures. In-depth interviews with ten participants were conducted over the course of eight months. Analytical frameworks drawn from the digital divide and explorations of the role of hidden curricula in higher education contexts were used to analyze computing experiences in earlier k-12, informal, workplace, and post-secondary educational contexts to understand how barriers to computing emerge for women.

Findings suggest several key themes. First, early experiences in formal education contexts are alienating women who develop an interest in computing. Opportunities for self-guided exploration, play, and tinkering help sustain interest in computing for women of color to engage in computing at the post-secondary level. Second, post-secondary computing climates remain hostile places for women, and in particular, for women of color. Thirdly, women employ a combination of different strategies to navigate these post-secondary computing cultures. Some women internalized existing dominant cultures of computing programs. Others chose exclusively online programs in computing to avoid negative interactions based on assumptions about their identity categories. Some

women chose to forge their own pathways through computing to help diversify the culture via teaching, creating their own businesses, and through social programs.

DEDICATION

For my incredible family: Your love and support mean the world to me.

For Anu, Tina, Stella, Riley, Flo, Joey, Nikky, Xena, Alice, and Biafra. My deepest thanks for sharing your stories with me. Your dedication, courage, and perseverance are inspiring.

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INTRODUCTION

Background

Computers are ubiquitous in our society. I was awoken this morning by the alarm on my iPhone, which I then used to check the weather and my email before I even made it to the shower. On my way to an appointment, the GPS relayed directions aloud in an increasingly familiar synthetic voice. Sitting down to work, I am glued to a computer all day, whether I lug my laptop to campus or park in front of my desktop in the technological command center that my home office has become. When I'm done for the day, I relax by browsing the newest stories and articles turned up by my RSS feed of blogs, tweets, and news sites on my iPad, watching TV shows streamed from the Internet, or turning on one of my household's many video game consoles.

The infiltration of computing technology into every corner of our lives serves to naturalize them, obscuring the ways each device or computer program is a result of a historical process of development shaped by social and cultural forces. As such, the development and use of computing technologies are embedded within larger social inequalities, especially around gender and race. These inequalities serve to pose constraints on the possibilities of the uses of these technologies.

As computing has become an everyday experience for more people worldwide, there has been an increase in the attention given to the producers of these technologies. With the information sector quickly coming to dominate the post-industrial, globalized economy, more people are turning to computing as a career or source of work. As a result, institutions teaching computing skills have been faced with an increasingly diverse group of students. However, as more women and students of color look into these fields, they have largely found computing programs (and the careers they lead to) to be unwelcoming and often hostile environments for them. Still holding onto a disciplinary and institutional culture which privileges White masculinity, and those model minorities who can mimic them well, this field has been resistant to change.

A gender gap in (CS) science and computing fields more generally persists despite several decades of concerted efforts to understand and alleviate it. According to the National Science Foundation's Science and Engineering Indicators (2010), research efforts have worked to improve recruitment, retention, and graduation rates of women in post-secondary science, technology, engineering, and medicine (STEM) programs in the United States. However, enrollment in computer science remains low and, furthermore, gains that were made in the enrollment of women in computer science undergraduate programs between 1993 to 2007 have declined from 2008 to 2010. Men continue to earn close to 80% of all computer science undergraduate degrees (National Science Foundation, 2010).

For this reason, computer science and other computer-related programs offer a particularly compelling site for the investigation of social justice issues and social inequalities affecting the educational trajectories of women of color. The field offers the potential to impart the knowledge basis needed to create new and innovative technologies in a rapidly evolving economic context that increasingly relies on the integration of new technologies. As the producers of the technologies we fit into our daily interactions, computing professionals can have a profound, and often almost unnoticed, impact on how we go about our everyday lives. To explore how and why women of color are excluded from this field then is to help understand how social inequalities continue to shape our everyday technological environment.

Research Focus

Much of the research examining the gender and racial disparities in computing programs has concentrated on examining traditional, four-year, face-to-face undergraduate programs in the formal discipline of computer science (Cohoon & Aspray, 2006). Academic studies examining more applied computer-related programs such as information technology (IT), network administration, and web design present a different picture. These studies suggest applied computing programs have had some of the highest graduation rates for women and students of color (Jesse, 2006; National Science Foundation, 2010). In addition to more prestigious institutions such as Massachusetts Institute of Technology and Carnegie

Mellon University, one of the highest producers of bachelor's degrees in information technology (IT) and computer science in 2001 was Strayer University, a for-profit institution with numerous campuses in the Washington D.C. metro area (Jesse, 2006, p. 241). Enrollments in undergraduate computer science and computer-related programs continue to increase at other for-profit institutions such as DeVry Institute of Technology and University of Phoenix (National Science Foundation, 2010, pp. 2-10). Particularly attracted to this type of program are non-traditional students, those who enter post-secondary education after some years away from higher education past the high school level. This research also suggests women and students of color are more likely to fall into this category of non-traditional students (Jesse, 2006). Additionally, non-traditional students are increasingly choosing to enroll in primarily online programs (Jesse, 2006; National Science Foundation, 2010).

This study attempts to address some of the gaps in the literature outlined above by providing an in-depth exploration of women's educational trajectories at various points in their lives. By focusing inquiry on a small group of diverse women from varied backgrounds, the goal of the study is to better understand similarities and differences across women's experiences in different computing education contexts. Several questions guide the current study: What early experiences with computing did women feel influenced the ways they decided to engage with computers in their lives? Having decided to pursue computing education, how did women's on-the ground experiences in various contexts shape later experiences they had with computing? What were the strategies women employed to help them navigate their educational pathways through computing? This study aims to add a more in-depth understanding of the barriers women still face when attempting to engage with computing education and the strategies they use to navigate various contexts.

To do so, I conducted interviews with a diverse group of ten women who had pursued computing in a post-secondary context. These women ranged in age from 19 to 56 years old, allowing me to explore similarities and differences across three generations. The women identified as Black, Asian, Latina, Middle Eastern, White, and mixed race. Their countries of origin included United States, India, Iran, Trinidad and Tobago, and Vietnam. This diversity of origins was important in that it allowed a comparative, cultural dimension to enter into the analysis. Though their levels of academic achievement varied, these women had earned associate's, bachelor's, and master's degrees, and, in one case, a Ph.D., representing the full spectrum of women who pursued computing in a post-secondary context. Finally, a number of the women worked in technology fields, or even taught computing, allowing them to comment on how experiences in computing programs would compare and contrast with those in the workforce.

The data collection technique I chose was in-depth interviews. These allowed me to use a more conversational, informal, semi-structured approach to interviewing that allowed for the building of rapport through mutual self-disclosure. Interviews lasted from one to three and half hours and covered topics ranging from early experiences with technology, family support and encouragement (or lack thereof), experiences with computing in school, and, when relevant, issues the women had faced working in computing careers.

Significance and Limitations of the Current Study

A majority of the literature exploring the gender and race gaps in computing have taken a quantitative approach (Singh, Allen, Scheckler, & Darlington, 2007). Furthermore, reviews of the existing literature have also called for more in-depth analyses of the intersections of identity categories and how they shape experiences women have in computing (Cohoon & Aspray, 2006; Singh et al., 2007). In particular, Singh et al. (2007) emphasize how studies that attend primarily to discrete identity characteristics analyzed separately from one another may not capture the full experiences of how intersections of women's identities in various contexts impact their experiences in computing fields. Furthermore, recent studies that have approached the problem from a more qualitative perspective have provided some important insights about how women and students of color experience computer science programs. As such, in this study, I adopt a qualitative approach emphasizing intersectionality in order to move beyond the narrow conceptualization of previous research.

With ten participants occupying a diverse range of identity categories, it was not my aim to test hypotheses or create causal models. Rather than trying to explain why gender and race gaps exist in computing, I have turned to a more procedural approach to try to understand how those gaps are created and perpetuated. As such, this study is located in a particular set of times and places and is not meant to be a generalized explanation of the experience of all women of color in computing. Nevertheless, because of the rich depth of detail in the narratives shared by the women who participated, this study can contribute to our broader understanding of social inequalities in computing education and our society more broadly.

Overview

Chapter Two presents a review of the existing scholarship on underrepresentation of women and students of color in computer science. Pertinent literature used to inform the theoretical and analytical frameworks employed in the study are also outlined. Next, Chapter Three begins with the research questions developed from the existing literature, then moves on to explore the methodological strategy used in the current study. The chapter concludes with an introduction to the study participants including demographics and educational experiences. Each of the following three chapters attempts to unpack the role intersections of identity had in various contexts in which women in the study experienced computing education. Chapter Four explores participant's early experiences with computing and unpacks significant experiences that influenced women's choice to pursue an education in computing. Chapter Five explores women's experiences in various types of computing educational experiences and programs, emphasizing the role of hidden curriculum in structuring computing program cultures. Strategies women employed to navigate various computing programs is the subject of Chapter Six. Finally, Chapter Seven explores implications of the study findings, examines the utility of the theoretical and analytical frameworks employed, and provides some conclusions.

Chapter 2

LITERATURE REVIEW

This chapter reviews the scholarship dedicated to exploring the persistent problem of underrepresentation of women and students of color in post-secondary computing programs, by which I mean not just computer science and computer engineering but also computer-related programs such as network administration, IT management, systems analysis, and web design. The questions that guide this literature review are: What do previous studies on the underrepresentation of women of color identify as factors contributing to the problem? What aspects of computing push women and students of color away from post-secondary programs? What have studies of online post-secondary computing programs discovered in these educational contexts?

To answer these questions, I examine research on the specific recruitment and retention barriers for women and students of color (also referred to as minorities or underrepresented minorities in most of the literature) in post-secondary computing programs. In this review, several major themes emerge: the importance of role models and mentoring; the influence of curricular and pedagogical approaches used, and; the impact of gendered and racialized cultures in post-secondary computing programs. The focus of much of the scholarship has been on traditional four-year, face-to-face programs rather than online programs. This literature offers an important set of findings that identify the types of programs making significant impacts in recruiting and retaining women of color in computing fields. This research is especially important to consider given findings about the non-traditional pathways many women and students of color take pursuing post-secondary computing education (Jesse, 2006). Finally, I examine the remaining gaps in the literature, and locate this study's contribution to existing scholarship.

The Problem of Persistent Social Inequalities in Computing Education

For decades, major initiatives at the national, state, and local levels have been implemented to recruit more women and people of color into STEM fields. The results of these recruitment efforts have generally paid off as the number women and people of color entering science, engineering, and the medical field is increasing at an unprecedented rate (Cohoon & Aspray, 2006). However, within technology fields, and in computer science in particular, the representation of women and people of color has remained low despite recruitment and retention efforts. Even though some gains were seen in the enrollment of women in the mid-1980s, those gains stalled and reversed during the early 2000s (Cohoon, 2002; Cohoon & Aspray, 2006; Varma, 2007).

Researchers have identified several factors contributing to the lack of women and people of color in higher level computing occupations and professions. First, researchers have found that students perceive computer science to be an environment that is not welcoming and even overtly hostile to women and students of color (Shashaani, 1994; Stake & Nickens, 2005; Tsagala & Kordaki, 2005). This is particularly the case for women who leave and re-enter the workforce due to childbearing or family responsibilities (Etzkowtiz, Kemelgor, Nueschatz, & Uzzi, 1994). Second, researchers recognize that early socialization to computer technology influences students' choice to major in computer-related fields (Shashaani, 1994; Stake & Nickens, 2005; Stone & Kitlan, 2010; Tindall & Hamil, 2004). A third factor contributing to inequalities is the impact of this socialization, which results in girls and women lacking experience, familiarity, and pre-requisite knowledge of computing and programming. Students who are not socialized to work with technology at an early age are at a disadvantage in traditional computer-related undergraduate majors and tend to have higher attrition rates than students who are (Singh, Allen, Scheckler, & Darlington, 2007; Varma, 2007). The next section explores these barriers in more detail.

Barriers for Women and Students of Color pursuing Computing Programs

Much of the initial research on women's underrepresentation in computing programs attempted to pinpoint specific sites where interventions might be used to encourage more women to pursue computing degrees. Beginning with enrollment, research explored the barriers to admissions and found several important issues such as selection criteria and applications processes for incoming students. By privileging strong math and science foundations and previous computing knowledge and experience, women and students of color were often seen as less qualified candidates. Another significant barrier was conflicts in transfer credits experienced by students transitioning from two-year to four-year college programs or who enter programs after their freshman year. Decreased access to programs due to high demands for limited spaces, and a lack of transition and support programs from students who wish to enter computer-related fields in graduate study but who do not have undergraduate computing majors were also found to pose significant barriers for underrepresented groups of students (Cohoon & Aspray, 2006). Studies show that this latter factor, in particular, has significant implications for women who often develop interests in computing at older ages than traditionally college-aged students (Jesse, 2006).

While underrepresentation of women in computing has been a primary focus in the literature on social inequalities in STEM fields, underrepresentation of students of color is also an important concern which has received some attention. Representation in computing is not consistent across all ethnic or racial identity categories. For example, studies have established that African Americans, Latina/os, and American Indians are considered to be the most underrepresented groups in computer science, while Asians have a higher degree of representation in these departments (Varma, 2006). Much of the existing literature on students of color in computer science identifies the demographic characteristics of students in an effort to establish the degree of underrepresentation of various racial and ethnic groups (Cohoon & Aspray, 2006; Singh, Allen, Scheckler, & Darlington, 2007).

This is to say, while there is some research on the impacts of gender and race on retention in computing programs, much of this literature examines the problem from one of the two lenses, separating identity categories. As such, a gap in the research on women in computer science is the lack of attention paid to racial and/or ethnic differences among women or examinations of other identity categories that may structure students' experiences in computing programs. Considering the breadth of literature on women in computing, there is still a need to consider the diversity of women's experiences that is not a monolithic approach which ignores intersectionality. Some researchers (Singh et al, 2007) reiterate the importance of unpacking the identity category of "women" to focus on more diverse categories that result in the social construction of everyday experiences of people within a given cultural and temporal context. To this end, they call for the need to take into account racial and ethnic backgrounds, socioeconomic status, sexual orientation, disability, nationality and other identity categories.

Across this literature, several key trends are identified as hindering the efforts to recruit, retain, and successfully graduate women and students of color in computing programs. Researchers found barriers in the enrollment and retention that are related to the lack of sufficient mentoring experiences in computing programs. Another contributing factor to barriers in recruitment and retention is the dominant curricular and pedagogical approach that provide advantages to boys and men who are socialized to computing much earlier than girls and women. Finally, the gendered and racialized cultures of STEM fields, particularly in computer science, have sabotaged well-intentioned intervention efforts.

Role models and mentoring in post-secondary computing programs.

While some progress is being made to alleviate entry barriers for women in computing programs, persistence and success in programs has come under further scrutiny. Specifically, researchers are looking at the high levels of attrition among women enrolled in traditional face-to-face computing programs and have begun to examine retention strategies such as the impact of role models, mentoring, and peer support. Initial studies found that a lack of female role models in CS and other STEM disciplines had an impact on women's representation in these departments (Townsend, 1996).

However the data on role models has been mixed and somewhat inconclusive. Joanne McGrath Cohoon and William Aspray (2006) caution that much of the research on role models and mentors has somewhat conflated the two. They explain that, "role models need not interact with students to be effective, whereas mentoring is an active process of sponsoring. Mentors are likely to be role models, but role models can be completely unaware of the part they play in demonstrating how to be a computer scientist" (Cohoon & Aspray, 2006, p. 156).

In terms of role model presence as a factor influencing initial choice of computer science as a major for women, Brandice Canes and Harvey Rosen (1995) found no support for this link. However, other studies on STEM fields more generally have found that role models may influence women's retention and persistence in a program. John Robst, Jack Keil, and Dean Russo (1998) found that female students who are taught science and mathematics courses by women faculty had higher rates of retention. Susan Haller and Timothy Fossum's (1998) study found that peer mentoring and role modeling among female computing students at the University of Wisconsin was successful in increasing retention. However, the research team of Henry Etzkowitz, Carol Kemelgor, Michael Neuschatz, and Brian Uzzi (1994) found the simple presence of female role models was not enough to retain and encourage women, particularly if the role models adopted and embraced an assimilationist "male model" of the dominant science and engineering culture at the institution. The significance of women as role models only occurred when these women demonstrated being able to successfully balance work and career demands with family obligations.

Research on active mentoring relationships provides more compelling evidence that mentoring is an important and effective strategy to recruit, retain, and graduate women in computing programs. For example, in a nationwide survey of 117 computer science departments, Joanne McGrath Cohoon, Margaret Gonsoulin, and James Layman (2004) found that increased mentoring resulted in more undergraduate seniors entering graduate programs. In other disciplines, research on mentoring more generally finds that students have higher cumulative GPAs and lower drop out rates than students who do not have mentors (Campbell & Campbell, 1997). Peer mentoring and support has also been studied, finding very positive outcomes for female student retention and persistence rates (Craig, 1998; Matyas & Dix, 1990).

Researchers have found that a lack of mentoring impacts students of color in ways similar to its effects on women (Singh et al., 2007; Varma, 2002; Varma, 2006). Major finding show that increased faculty and peer mentoring supports retention and persistence of students of color. Roli Varma's (2006) study identified the significance of mentoring as students feeling more comfortable addressing problems, concerns, and issues they are experiencing with faculty and students from similar identity categories (p. 132).

Research on mentoring and the impact of role models in other disciplines point to the need for computing programs to consider gender and other identity categories such as race and ethnicity more explicitly (Margolis and Romero, 1998). Findings suggest a need for more nuanced inquiry in computing that not only examines academic socialization to the discipline, but also aspects of professionalization that can re-inscribe dominant notions of social inequalities, gender stereotypes, and expectations that can limit faculty perceptions of students' abilities and potential.

Approaches to curriculum and pedagogy.

In addition to research on the impact of peer support and mentoring, studies on the impact of curriculum and pedagogy in computing programs have revealed similar barriers to the participation of women and students of color. Research focusing on the impact of curricula and types of pedagogies in reference to women's underrepresentation in computing draw from the larger body of literature exploring the phenomenon in post-secondary education more generally. However, Cohoon and Aspray (2006) caution that studies on the relationship between gender and learning style are contested and argue that more conclusive research needs to be done to explore the relationship in the specific contexts of computing. For example, there are studies on high-school-aged males and females exploring differences in learning styles, motivation, and independence that point to significant differences between the genders (Deweck, 1986), but there is also research that does not support these findings (Meece & Jones, 1996).

Jane Margolis and Allan Fisher's (2002) landmark study of Carnegie Mellon University's computer science program provides some of the most compelling evidence for the impact of removing curricular and pedagogical practices that favored students with computing experience.

They found that incoming classes were primarily male because men tend to have more socialization and previous experiences with programming and advanced computer knowledge than women. Based on the recommendations of the researchers, the program adopted an entry-level intervention strategy and re-focused selection criteria to select for applicants who "demonstrated more independence, energy, creativity, and community involvement" (Margolis & Fisher, 2002, p. 136). In this way, Carnegie Mellon University was able to actively recruit a more diverse incoming class. Importantly, the dramatic increase in women's representation was seen with very little loss of academic quality in the program. Another strategy explored in the study was aimed at combating the high dropout rates of first-year computer science majors (Margolis & Fisher 2002). High dropout rates were found among students with little previous experience in computing resulting from late entrance into the program or because of little experience with programming before college. Margolis and Fisher found that the single introductory course taught in the program favored students with more computer experience. As a result, the researchers recommended that the department offer graduated levels of the introductory course, tailored to students' varying levels of computing experience. Students of both genders reported a higher degree of satisfaction with the new programs (Margolis & Fisher, 2002 p. 130).

Providing some foundation for these findings, Elaine Seymour and Nancy Hewitt's (1997) found student exodus from undergraduate STEM fields to be the result of poor pedagogical methods and weak teaching strategies. Heidi Fencl's (1997) work on female-friendly pedagogy provided some insightful data on the need for new pedagogical strategies to retain women in computing programs. Pedagogical innovation and intervention efforts are attempting to address shortcomings that affect students more generally and women's success more specifically. For example, paired programming pedagogy is a practice encouraging collaborative learning by pairing students who switch off between writing and monitoring programming code. This method was hypothesized to help retain more women based on findings that collaborative learning methods were preferable to women (Chase & Okie, 2000). Subsequent studies have found that paired students were retained at higher rates with no performance differences between paired and non-paired students (McDowell, Werner, Bullock, & Fernald, 2003). However, women in the study reported a higher confidence level during paired programming exercises, but on average, their confidence levels were still lower than men's. While the findings for retention improvement for students overall was positive when utilizing paired programming pedagogy, it is clear that this strategy alone will not change women's underrepresentation in computing programs.

Several key recommendations for retaining and encouraging students of color in computing programs are similar to those made for women. Varma (2006) finds that making courses more relevant and inclusive can help retain more women and students of color. This can be done by improving student-teacher relationships, creating more gender- and racially-inclusive curricula, providing opportunities for peer mentoring from more senior students to incoming students, and enhancing attempts to facilitate community-building among students rather than competition. However, despite this emerging array of strategies, the fundamental issue of racialized and gendered cultures in computing program remains a complicated context that significantly impacts the effect of role models, mentoring, curricula, and pedagogy.

Gendered and racialized cultures of computing programs.

A majority of the literature on computing and STEM fields examines women's early socialization towards technology, their previous experiences working with various types of computer technology and programming languages, and the climate in post-secondary programs. This set of foci speaks directly to the ways the larger dominant cultures of computing may contribute to the persistent social inequalities around race and gender, which include both individual level measures as well as evaluations of larger macro-level structures. In terms of gender socialization patterns that influence an individual's choices of major and future career plans, Jerry Jacobs (1995) found consistently gendered patterns in terms of which degree majors men and women chose. For example, women continue to be overrepresented in nursing and teaching while men tend to be overrepresented in engineering and computing fields. However, Jacobs (1995) found that there was a decline in gender segregation practices in the fields during the latter part of the 20th century, which were attributed to early socialization process that are part of an ongoing process of cultural and social change. This finding is also supported by studies utilizing Allan Wigfield and Jacquelynne Eccles's (2000) expectancy-value model. This theory explains individual choices as influenced by numerous factors ranging from stereotypes and cultural values that shape the expectations of success, perseverance, and includes the likelihood that an individual will pursue a given activity or behavior, such as majoring in a computer-related field. These more individual-level measures concerning socialization patterns and experiences with technology also discuss findings about men and women's previous uses and experiences with computing technology prior to entering computing programs.

Research on the digital divide initially focused on lack of access to computers and computing technology. However, research on men and women's computer use and experience characteristics appear inconclusive. For example, some research found very few gender differences in computer use or computing ability (Hargittai & Shafer, 2006). While there were no discernible differences in amount or degree of computer use, the purpose and function of computer use revealed more specific differences attributable to gender. Men were significantly more interested in computer programming and how computers work (Rowell, Hankins, Parker, Pettey, & Iriarte-Gross 2003). McCoy and Heafner (2005) reported similar findings when they examined possible gender differences in computer use for communication purposes. These findings were further supported by DeBell and Chapman's (2006) study on gender differences among college freshman in computer and technology experiences. They found that computing experiences have equalized with men and women having similar amounts of Internet, email, word processing, and spreadsheet experience. However, a study by Creamer, Burger, and Meszaros (2004) did find that men were more likely to use computers for entertainment purposes such as gaming or fun activities while gender differences were negligible in terms of computer use for social networking and educational purposes.

These gendered differences in access and usage had further consequences. In the McCoy and Heafner (2005) study, men rated themselves higher on self-reports of computer expertise than did women. Similarly, Besana and Detori's (2004) study found that male students tended to display both a higher level of confidence in their technology knowledge, as well as a more relaxed and playful attitude towards technology. Clegg, Trayhurn, and Johnson (2000) and Varma (2002) found that women's choices in majors were constrained by gendered understandings of technology. Specifically, Varma (2002) found that female students played fewer video games and did not see themselves choosing careers as computer scientists or computer engineers.

Part of this self-selection process has been treated as a function of an overwhelmingly masculine culture that dominates computer fields in both the workforce and in academic programs. Sociological and feminist research contributes to this line of inquiry. Sociological studies have focused on understanding gender segregation patterns as macro-level processes (Cohoon, 2006). Particularly at more prestigious institutions, structural pressures encouraged women to adopt patterns of work, study, campus face-time with faculty and staff, and dedication to research established by traditional (read single, White male) STEM students (Charles & Bradley, 2002; Cohoon J. M., 2002; Cohoon & Aspray, 2006; Margolis & Fisher, 2002).

The phenomenon of women assimilating to a male model is supported by the literature and is known as the College of Engineering Effect (Camp, 1997). This effect refers to the lower retention and graduation rates of women in computer science programs that are contained within a larger college of engineering. An explanation offered by researchers for the lack of academic success focuses on women's socialization patterns within computing programs. Women (and men) are socialized to assimilate to the status quo model irrespective of other duties such as family and childcare. Consequently, they are forced to navigate the tension between their career and family responsibilities. A study of women in science and engineering programs at a Carnegie Institution explored factors hindering the progression of women into careers in CS and computer-related programs after enrollment (Etzkowitz et al, 1994). By providing key in-depth analyses of everyday socialization patterns and structures that exclude women and men with families and children, the study identified the ways that single males were supported and encouraged. This study provided an important framework for understanding the culture of science and engineering departments, which contribute to the tension women feel about adopting the dominant model of a competitive masculine culture versus finding and emulating role models that balance family and childcare responsibilities. The demands of the culture of science are often overtly hostile to childrearing and childbearing.

Feminist theorists have also weighed in on the impact of culture and gender on women's experiences with computing technology education. Cohoon (2006) examined how these approaches break down on a specific spectrum. On one end of the spectrum are studies employing a more essentialist perspective arguing that men and women having different skills and interests due to inherent sex and gender characteristics (Turkle & Papert, 1990). On the other end of the spectrum, Judy Wajcman (2010) and Wilson (2003) argue that technology is constructed as a masculinized space and as an expression of a larger male-dominated culture, which actively rejects women and explains women's absence and men's overrepresentation in computer-related fields. Wilson's (2003) study suggests that the social constructions of computing and technology examined in the subjective realities faced by women lead them to understand the field as a hostile and unwelcoming space for women.

Looking comparatively at predominately White institutions and minority-serving institutions, Lopez Jr., Zhang, and Lopez (2008) found that women in computer science departments at both types of institutions anticipate gender stereotyping in their departments as well as in future work contexts (p. F4B-20). African American computer science students attending primarily White institutions reported higher experiences of racial stereotyping in their departments than peers attending historically Black colleges and universities (Varma, 2002; Varma, 2007). However African American students in both types of institutions anticipated future incidents of racial stereotyping in the workplace. The experience and expectation of stereotypes is an important aspect of the overall experiences of students of color in computing programs because of the serious and direct impact on the retention and persistence of these students.

Varma (2007) utilized a theoretical framework of social control theory by John Braithwaite (1989) to research the impact that second-hand knowledge of negative experiences of women and students of color has on the drop in women's enrollments in computer science programs. Her study examined 150 students from minority-serving institutions of which 30 were White, Black, Hispanic, Asian, and American Indian. The study showed that, through stereotypes, female students became hyperaware of male peers' perceptions of women in computing and the heightened sense of hostility led to increased attrition rates for women.

One recent key study has unpacked some of the important aspects of the complexity of the intersections between gender and race. This study was a mid-sized study of several minority-serving institutions (historically Black colleges, tribal universities, or Hispanic-serving institutions) that utilized data from 150 in-depth qualitative interviews with students from five specific racial categories (White, Black, Hispanic, Asian, and American Indian - as per categories utilized by the National Science Foundation categorizations) (Varma, Prasad, & Kapur, 2006, pp. 303-304). Using Pierre Bourdieu's theoretical framework of habitus, the researchers analyzed findings on daily interactions and existing conditions in computer science programs to uncover how different institutions were perceived differently by students. These different perceptions were varied as a result of their distinct experiences and dispositions constituting the habitus of the individual students, which is influenced by gender and race. Their positionality, "makes them give different meanings to the same actions, or give a gendered connotation to a common and everyday social behavior" (Varma, Prasad, & Kapur, 2006, p. 303). Interestingly, more than half of the students (58%) responded that they could not think of any specific incidents relating to being a woman in the computer science program. Even more interesting was the finding that more females replied this way (67%) than males (53.4%) (Varma, Prasad & Kapur, 2006, p.

306). However, even when negating the existence of these experiences, both men and women students still expressed knowledge of existing gender differences.

Students from various racial backgrounds perceive women’s presence and underrepresentation differently. White, Hispanic, and Asian males noticed the absence of women in computing programs more than Black and American Indian males. Yet White, Hispanic, and Asian males were also the most likely to report there were no gender differences in their programs and were more unsympathetic in their responses about existing gender disparities. Black and Hispanic men, on the other hand, were more likely to have more sympathetic responses to gender equality issues in their departments despite being unable to point out specific gender-related incidents. In these responses, Black men and women, American Indian men and women, and Hispanic women were the only students to express that racial disparities are a factor reducing the numbers of women in the class. The authors suggest that this inconsistency in perception may result from a greater degree of consciousness around racial discrimination, which makes these particular students more aware of gender discrimination (Varma, Prasad & Kapur, 2006, p. 309). In response, researchers such as Varma (2007) and Singh et al., (2007) have emphasized the need to provide more formal and informal support systems and retention strategies for all incoming students.

Calls to do so are often framed within the context of a traditional pipeline metaphor which implies a smooth transition from secondary school preparation, to higher education and training, to careers in computing. The pipeline metaphor was used to describe the various points in time at which women and students of color are tracked away from computing programs. That is, it tried to neatly map the sorting mechanisms and student choices that led to retention. It locates problems as blockages in the pipeline occurring in what should be a relatively smooth process (Bowen and Bok 2000; Jesse, 2006). In other words, this research suggests that if traditionally marginalized students have barriers removed, it should result in an increase in student retention and persistence for women and students of color.

However, research focusing on non-traditional pathways into computing for women and students of color in universities finds a major problem with the pipeline metaphor. In their book, *The Shape of the River*, William Bowen and Derek Bok (2000) explain why the pipeline metaphor falls short, particularly when explaining how talent is developed and encouraged. They explain that the metaphor of the river offers a more realistic portrayal of the process of education and career choice, arguing that the pathway is not a smooth pipeline bur rather more like moving down a winding river, strewn with slow channels, rocky rapids, muddiness, and clarity at different stages. The authors suggest that when race is involved, nothing is simple, smooth, or predictable about the educational process. Jolene Kay Jesse's (2006) study of non-traditional students draws on Bowen and Bok's (2000) work to explore how more and more students are entering computing fields through very different paths. She finds that women and students of color are often present in higher numbers and have lower attrition rates in more technical-skills programs offered by private, for-profit universities catering to open enrollments and geared towards non-traditional students. As Jesse (2006) has pointed out:

> The dominance of Strayer University and other for-profit institutions in the production of IT/CS bachelor's degrees awarded to women and minorities seems to have filled a market niche for these populations that the traditional universities have not taken advantage of. (p. 250)

Online Post-Secondary Programs in Computer Science and Computer-Related Education

Given that many of the for-profit institutions cater to non-traditional students by offering online programs, it is imperative that studies explore the impact these online programs have on the retention of students of color and women. The higher degree of women and students of color gravitating toward these educational contexts begs the question of what these programs offer that traditional programs do not. Online computing programs are particularly important to explore in order to unpack the elements of online curriculum and pedagogy that can help or hinder students in their pursuit of education.

Scholars argue that online education has the potential to break boundaries and barriers that have kept traditionally marginalized populations from being able to obtain the economic, social, and cultural benefits of a higher education (Inoue, 2007). However, other scholars take a more cautionary stance, arguing that the presence of online education alone is not sufficient to guarantee access to quality education. Contrary to the more celebratory voices lauding the potential of online education, scholars from fields as varied as education, sociology, history, and new media studies argue that the presence of technology may actually reproduce and, in many cases, exacerbate existing inequalities and disparities because students possess different levels of technological literacy and technical skills. Success in online education is more likely when students have access to expensive equipment, subscription services, and socialization to online learning (Cuban, 1986; Ferneding, 2003; Inoue, 2007; van Dijk, 2005).

Online learning in computing: opportunities and challenges.

In general, studies of online education in computing programs at the post-secondary level are more broadly based inquiries focused primarily on the feasibility of teaching computer science concepts through various online mediums (Kleinman & Entin, 2002). The literature finds some substantial barriers to teaching more abstract concepts online and responds to concerns articulated by professionals in the field about the ability to teach programming concepts to students in an online medium, particularly as many of the exercises require team-based approaches (Matzen & Alrifai, 2006).

Research on the use of online education technologies in computing programs concur with some of the positive research findings on online programs as well as some of the more ambivalent or cautionary narratives in the literature. Teaching computer science online is challenging due to a number of characteristics about the field of computer science itself. As a highly technical subject, computer science involves learning scripting and programming languages and being able to manipulate highly abstract variables to produce specified outcomes, actions, or behaviors from a given program or piece of hardware (Hagan & Lowder, 1996). Yuwanuch Gulatee and Barbara Combes (2007) also point out that as a highly technical subject, students and faculty are struggling to navigate these new online spaces while dealing with the communication barriers placed by existing online learning systems. At the same, time, these new spaces must also adapt to the rapidly changing nature of the computer science discipline. The researchers find that the high frequency of communication that occurs between students and the teacher in traditional face-to-face computing courses—attributable to the use of complex concepts, operations, and symbolic language—creates a difficult situation when translated online as the physical separation between student and teacher makes it even more difficult to provide support, feedback, and guidance for students on more difficult tasks and materials. Indeed, recent research on student perceptions of learning computer science online find that students report it is more difficult to learn computing topics on the web than it is to learn topics in other disciplines utilizing web-based materials. This response from students was most prominent in introductory programming courses (Matzen & Alrifai, 2006). Therefore, much of the existing literature on the use of online learning technologies in computing fields at the post-secondary level has focused almost exclusively on researching various approaches to overcoming some of the barriers to learning computing online.

However, studies are emerging that provide a different, much more ambivalent picture of online educational technology's expanding (Cuban, 1986; Ferneding, 2004; Ferneding, 2003). Some of the larger, multi-institutional studies of the effectiveness of online learning counter the dominant narrative of the promise and progress offered by enthusiastic advocates of e-learning approaches. In Thwarted Innovation: What Happened to E-learning and Why, Robert Zemsky and William Massy (2004) studied sixteen universities across the U.S. involved in the Weatherstation Project (Hannon, 2009; Hanson, 2007). They found that online learning initiatives often fell short of expectations and had mixed results. For example, while much of the initial understanding around online programs' penetration predicted that online learning would open barriers to education faced by non-traditional students, particularly those in rural areas, the study highlighted the fact that most of the students enrolled in online programs were already on-campus students. Furthermore, students in the online courses reported that they did not find online learning experiences more or less useful than in-person courses. The study also found that faculty did not change their teaching methods or habits. Instead, online learning platforms were more likely to be utilized simply as a repository for traditional lecture materials (Zemsky & Massey, 2004).

Barriers to faculty participation in online learning development were examined in other studies such as Hannon's (2009) study on resistance to online teaching. By reexamining the problem through Michel Callon and Bruno Latour's (2005) actor-network perspective, Hannon found that social factors shaping technological innovations in the classroom are often separated from the technical factors also shaping the innovations. This separation creates an increase in the likelihood of failure of the innovation attempt, resistance on the part of teachers and educational professionals who may resist adopting technologies without clear understandings of how they improve upon existing methods, or the costs in time, resources, and training needed to engage or use new technologies (Jacobs, 1995).

Serious issues remain in using online programs to teach computing concepts. Much of the literature focuses on the nuts-and-bolts of how to successfully and efficiently implement online programs. Little attention is paid to the possible reproduction of barriers faced by women and students of color in these online spaces. By remaining at the descriptive level and not focusing on more explicit theories of learning, curriculum, pedagogical design and development, research on the gendering and racialization taking place in online learning spaces is almost nonexistent. Given the breadth of literature on the underrepresentation of women and students of color in face-to-face computing programs, the failure to examine these new spaces reveals assumptions about technology which see it as a neutral space. This assumption harbors a very real danger that reproduction of existing barriers for students continues will occur, leaving many potential students out of computing at a time when online learning is a space where many of these traditionally marginalized populations are seeking educational experiences.

Analysis of Gaps and Limitations of Existing Research: Implications for the Current Study

After reviewing the literature on women and students of color in post-secondary computing programs and exploring research on students in online programs more generally, it becomes clear that there are still some important aspects of social inequalities that have yet to be examined in a systematic manner. While much research now recognizes the various barriers these groups of students face, we still need a much deeper and more complex understanding of the issues structuring student experiences in computing programs. The review of studies on women and students of color in both face-to-face and online computing programs reveals an important issue that needs to be addressed in future research: increased emphasis on race and gender (Cohoon, 2006; Margolis & Fisher, 2002; Singh et al., 2007). Researchers acknowledge the limitations of existing research and recommend studying intersections of identity categories as they impact student's experiences of technology and education. However, few studies explicitly explored how these identities intersect and inform one another.

Several approaches are needed in order to unpack the racialization and gendering of online spaces in post-secondary computing programs. First, future studies must be more explicit in considering the racial and gendered social construction of technology. Such an approach would help build an understanding of how technologies are constructed as being exclusively associated with White male identities and, in turn, how these assumptions serve as deterrents to women of color in choosing computer-related careers and educational paths. Second, future studies must incorporate intersectionality to provide insight into the ways different groups are affected by multiple overlapping identities and how the perception of these identities are mutually informed by numerous factors such as students, faculty, curriculum, pedagogical approaches, as well as having shifting meanings in different contexts. Intersectionality is a useful approach to studying social inequalities as it allows for a framework conducive to exploring overt, delivered, and hidden curricula. Critical examinations of curricula and pedagogical approaches are vital for exploring the ways these factors continue to shape experiences of students in both face-to-face and online classrooms. Finally, research needs to move away from solely studying institutions. The literature recognizes the importance of student peer interactions and mentoring in computing fields at the undergraduate level (Cohoon & Aspray, 2006). However, many of these studies focus on formal institutionalized practices of peer mentoring while failing to examine informal peer interactions and mentoring, or identify the ways students supplement and scaffold their own educational experiences to deal with the various barriers they encounter. Attending to these informal means of support is an important area of inquiry because traditionally marginalized populations' contributions to technology, the development of the Internet, and the creation of validating, safe spaces can lend some insight into ways students are leveraging various resources to enhance their educations (Banks, 2006; Leung, 2005; Wright, 2003).

Developing Theoretical Frameworks

The literature above discusses important findings that draw on a variety of theoretical frameworks and sensitizing concepts focusing research on the persistent gender and race gaps in computing programs. However, given the questions I had concerning the role of larger social forces shaping social inequalities, I wish to draw from frameworks and organizing concepts that are flexible enough to explore social inequalities among varied contexts, yet address some of the shortcomings identified in the existing scholarship.

In this section, I explore the state of digital divide scholarship, a body of literature that was among the first to examine various dimensions of social inequalities shaping students' experiences of education in the rapidly changing context of computer-mediated communication. This section also addresses the major limitations of digital divide scholarship and proposes an alternative approach that is better suited to exploring how social inequalities are manifested in and through the technologies now employed in higher education. First, I review of digital divide scholarship with a specific focus on several key shortcomings identified within this approach. These shortcomings include a lack of robust theoretical frameworks for examining social inequalities and the need for more qualitative research on the digital divide, particularly in the context of higher education. Following the lead of Terry Anderson (2002), I propose supplementing digital divide scholarship with theoretical frameworks drawn from the literature on hidden curricula. Finally, I will conclude with a discussion of why the combination of these particular theoretical frameworks is useful for understanding the contemporary context of social inequalities and technology in higher education.

The Digital Divide

The literature on the digital divide in the United States serves as a point of convergence for issues of justice, education, and technology.

Though it is a much-debated subject, the digital divide has typically been defined as "disparities in information technology based on demographic factors such as race, ethnicity, income, education, and gender" (Mossberger, Tolbert, & Stansbury, 2003, p. xi). The digital divide began to gain recognition as a major policy issue in the mid-1990s. Some of the most influential publications addressing the digital divide were a series of reports called A Nation Online written by the National Telecommunications and Information Administration (NTIA) under the United States Department of Commerce. These reports were widely discussed by policymakers, educators, politicians, and scholars across various disciplines. Based on the United States Census Bureau's Current Population Survey, these reports provided one of the first large-scale national samples of household information and communications technologies (ICT) use in the United States (United States Department of Commerce, 1995). The reports showed that while Americans were increasing their access to ICTs, major gaps were observed emerging based on demographic (race, gender, ethnicity, income, age, etc.) and geographical (urban, rural, etc.) factors. Specifically, disparities based on race, ethnicity, and income actually increased from the initial 1995 report to subsequent reports in 1998 and 1999 respectively (U.S Department of Commerce 1995;1998;1999). As a result of these reports, social inequalities represented by the digital divide became framed as a singular problem that had a concrete, tangible solution: increase public access to computers, particularly in schools (Ferneding, 2003). This was the sort of problem that policymakers and politicians could easily address because it was framed in terms of numbers and defined (rather simplistically) as a measure of who did and did not have access to ICTs. Accepting the assumptions and following the lead of these NTIA reports, many of the initial academic studies focused on physical access to ICTs. Consequently, researchers found patterns similar to those reported by the NTIA studies (Broos, 2006; Goldfarb, 2008; Hohlfeld, 2008; Tien, 2008).

As a result, in the early 2000s there was a growing sense among the majority of researchers that the digital divide was narrowing and even closing. Costs for computer hardware and software decreased and more cost-effective Internet access became more widely available. Indeed, beginning in 2002, the Bush administration declared the problem of the digital divide "solved" as studies such as the final NTIA report showed approximately 80% penetration of Internet usage into American society (U.S. Department of Commerce, 2002). As a result, the Bush administration recommended shutting down programs researching the digital divide as initial analysis of the government research seemed to indicate the problem would soon be remedied once market-based solutions, such as Apple's 1:1 laptop program and similar programs from Dell, Gateway, and other major PC manufacturers had time to play out (Lott, 2002). In this mode, Michael Powell, then chairman of the Federal Communications Commission, famously referred to the digital divide of the early 2000s as a "Mercedes divide," implying that, like a fancy car, though everyone would like to have it, more than basic access is a luxury not a necessity (quoted in Mosseberger, Tolbert and Stansbury 2003, p. 5). Since the reports suggested the majority of the population had some sort of access to ICTs, it was no longer a question of whether people had access.

At this point, digital divide research split into two distinct trajectories primarily along politically partisan lines. On one hand, mainstream discourse became dominated by a market-based, neoliberal logic. In this thinking, having moved beyond a problem of basic access, the issue of the quality of that access was something to be solved by the market. On the other hand, some scholars and activists took a more radical turn, insisting that market-based approaches actually exacerbate the digital divide. These researchers argued the digital divide was far from being closed. As government funding was drying up, these scholars were noting how the digital divide was in many cases multiplying and becoming deeper and more complex. This side to the digital divide debate was taken up by a number of critical educational scholars (Mossberger, Tolbert, & Stansbury, 2003). They argue the digital divide is more nuanced and complicated than a simple question of "haves" versus "have-nots." In their critique of research findings on the digital divide, Karen Mossberger, Caroline Tolbert and Mary Stansbury note how the researchers responsible for these reports did not perform the sort of sophisticated statistical analyses necessary to identify interactions between variables and demographic factors. As a result, they argue, these studies do not provide a clear picture of independent effects on ICT use by students. They assert that though the problem might have been diagnosed and "cured," it was never really understood in the first place (2003, p. 23).

Other researchers have also tried to redefine the debate to more accurately reflect the multiple dimensions of the digital divide (Barzilai-Nahon, 2006; DiMaggio, Hargittai, & Shafer, 2004; Hargittai, 2002; Mossberger, Tolbert, & Stansbury, 2003; van Dijk, 2006). In particular, Jan A.G.M. van Dijk (2006) makes a compelling argument that focusing strictly on physical access to technology ignores the various social, psychological, and cultural factors that influence access to ICTs. To remedy the situation, van Dijk proposes reconceptualizing the digital divide as being made up of several types of access: motivational, material, skills, and usage (2006, p. 224). For van Dijk, potential technology users must first be motivated to use these technologies by clearly seeing how they will be beneficial in everyday life. Only then comes the question originally posed, whether users are able to access the materials, the hardware and software. Next, van Dijk points out that it becomes important to question whether users have the requisite skills to achieve the specified goals outlined by curriculum with ICT. Finally, how people actually use these technologies becomes important. Are users leveraging the technology as a means of improving one's life chances or is the technology simply used to provide entertainment?

Since 2002, other scholars have made similar calls to expand the notion of the digital divide to encompass more dimensions. In their national survey study of poor populations in the U.S., Mossberger, Tolbert, and Stansbury (2003) likewise redefined the problem as not one but a series of digital divides: access, skills, economic opportunity, and democratic (2003, p. 9). This call for more complex understandings, the awareness of multiple divides and the impacts of technology on economic, educational, and democratic opportunities has not gone unanswered and has produced much needed literature on the daily behaviors and skill levels of ICT users. However, research on the skills divide focuses overwhelmingly on self-reports from study participants (UCLA 2003), which van Dijk faults as being inferior to experimental designs where skills of participants can be tested in controlled settings with clear criteria (2006, p. 228). Indeed, Ezter Hargittai's (2002) experimental design testing ICT skills found major variances on times to complete certain tasks online across different populations suggesting there are likely major disparities between self-reports and actual performance.

Shortcomings such as these in the digital divide literature are important to address. However, in the context of a larger inquiry into technology and social inequality, the major research questions of the digital divide project as a whole leave something to be desired. As critics raise difficult questions and complicate the scenario by adding new measures and criteria of validity, it becomes reasonable to wonder whether the digital divide was a misconceived project to begin with. Specifically, rather than a distinct phenomenon existing independently of other markers of social inequality, it is important to begin discussing the digital divide within the social contexts in which ICT users find themselves. In particular, van Dijk writes:

> The biggest shortcoming of digital divide research is a lack of theory. In the past 5-10 years, it has remained at a descriptive level, emphasizing the demographics of income, education, age, sex, and ethnicity. The deeper social, cultural and psychological causes behind the inequality of access have not been addressed so far. The most conspicuous fact is that the digital divide has not been discussed against the background of a general theory of social inequality, other types of inequality, or even a concept of human inequality in general…The next lacuna is a lack of qualitative research. Most digital divide research is based on quantitative data collection and tries to describe the large picture of the problem. Although this produces vast amounts of correlations, it does not bring forward the precise mechanisms explaining the appropriation and division of the technology concerned in everyday life. Qualitative research… is able to show how attitudes to computer and Internet use are created and how inequalities of motivational, physical, skills and usage access are maintained in particular small individual and group settings where interpersonal relations and particular cultures dominate. (van Dijk, 2006, p. 232)

The need for research underlies the importance of looking at the impacts of technologies within an embedded social context. Technology use is inevitably shaped by the same sorts of structural and institutional factors that influence much of our everyday lives: race, class, gender, sexuality, ability, nationality, as well as income, geographical location, and language.

The digital divide is not simply about how certain groups of people access, use, have the skills, or are motivated to use ICTs. It is also about how and why these activities become meaningful to them and whether they are perceived (by them and others) to be empowering. Focus on access, while important, ultimately fails to address the meanings people attach to their activities and thus how ICT use is socially constructed. In this regard, the scholarship of the digital divide provides a starting place to begin to look at the ways new technologies are reinforcing inequalities in post-secondary educational settings. To do so, this literature is best supplemented by other approaches.

Hidden Curricula in Higher Education

The literature exploring hidden curricula provides a more sophisticated way of thinking about how inequalities are produced and reproduced in education. Studies of hidden curricula can provide a framework for thinking about the unstated, implicit agenda of technology, potentially uncovering, illuminating, and scrutinizing the taken-for-granted aspects of technology implementation in higher education. The process of uncovering and interrogating curricula provides a more robust theoretical framework than offered in the primarily descriptive literature of the digital divide. Hidden curriculum approach emphasizes the importance of embedded, qualitative, and mixed-method studies that can provide insights into the everyday lived experiences of students, teachers, professors, IT professionals, and administrators in an increasingly technologized milieu. By doing so, it sheds light on how programs are socially constructed, including in gendered and racialized ways. In this regard, its strength comes from illustrating how inequalities are obscured or hidden by institutions, as Eric Margolis, Michael Soldatenko, Sandra Acker and Marina Gair (2001) point out. The tools of hidden curricula are thus particularly helpful in unpacking the construction of technology as an apolitical tool or neutral artifact.

As with many social theories, hidden curriculum scholarship has long explored the tensions of the structure/agency debate. Work in this field has spanned the continuum, alternately focusing on highly structural explanations for schooling phenomena and those that favor agency and challenges to existing hierarchies (Margolis, Soldatenko, Acker and Gair 2001). However, the hidden curriculum got its start in functionalist origins. The term "hidden curriculum" was coined by Phillip Jackson (1990) in his book, Life in Classrooms, originally published in 1968. Jackson's work in public primary schools in the 1960s offered him an opportunity to explore the social relations of the classroom. He did so by attending to how students were socialized to develop specific characteristics, behaviors, values, norms, and attitudes. By noticing how students who adhered to these preferred standards excelled in school, Jackson identified what he would call a hidden curriculum. Though not part of the educational goals or overt curriculum content (which typically conformed to the traditional three Rs of reading, writing and arithmetic), students' possession of these skills and fulfillment of behavioral expectations were requisites for success in the classroom. As a result, Jackson identifies his own three Rs of hidden curriculum: rules, regulations, and routines (1990).

Much of the initial work on the hidden curriculum stemming from Jackson drew upon the structural functionalist tradition in sociology. In particular, such works built on the scholarship of Emile Durkheim in order to emphasize the specific socialization of youth achieved in schools which could not be provided by familial socialization alone (Durkheim, 1956; Tucker 2002). Much of the writing from this early functionalist perspective viewed the socialization function of schooling as integral to the continuation of social life and, as a result, for the most part treated existing social relations as unproblematic. This assumption came under heavy attack in the 1960s as Marxist critiques of the capitalist system and the structural functionalist paradigm began to influence sociological theories of education.

Rather than simply accepting the premise that socialization through the hidden curriculum was unproblematic, sociologists of education began to take issue with the notion that schooling simply reproduced norms and values of the dominant status quo. In particular, in their landmark work, Schooling in Capitalist America, Samuel Bowles and Herbert Gintis (1976) extended the initial functionalist hidden curriculum argument by explaining how students were being socialized in schools to conform to existing social relations and stratification procedures in order to maintain the current capitalistic framework.

Several major approaches to the study of hidden curricula in schools became more developed during the 1970s in Britain. These approaches expanded the Marxist social reproduction theories emerging from Bowles and Gintis (1976) and the cultural reproduction theories of Bourdieu (1977). In response to increased calls for examinations of the everyday practices that shape the experiences of education, researchers placed more emphasis on ethnographic and qualitative studies. One of the most famous and influential examples was Paul Willis' (1981) *Learning to Labor: How Working Class Kids Get Working Class Jobs*. In his study, Willis provides an in-depth examination not only of how cultural factors shaped educational outcomes of working class boys but also how those students exhibited a resistance to efforts by the school to make them conform to middle-class educational expectations. As such, Learning to Labor brought a much-needed corrective to strictly structural examinations of hidden curricula. Willis' study challenged the assumption that socialization is something imposed from outside, top-down, one-way, and often in a hierarchical manner that students passively accepted.

While similar scholarship emphasizing everyday interactions became a major component of the investigation of hidden curricula at different levels, criticism also emerged. The exclusive focus in existing studies on the experiences of males and on the variable of class at the expense of other significant identity categories such as gender, race, disability, and sexual orientation came under question (Acker, 1994).

Wanting to emphasize the interconnections between culture, family, and the socialization occurring in schools, feminist thinkers such Dorothy Smith (1990) and Kathleen Weiler (1988) provided much-needed elaborations upon this theoretical framework, adding an analysis of gender.

The emphasis on agency in Willis's study represents an important point in the history of research into hidden curricula. This study marked a shift in the literature as scholars in this tradition began to place more attention on agency, resistance, and the forms of contestation exhibited by students in schools (hooks, 1994; McLaren, 1995). Both empirically and theoretically, scholars like Madeline Arnot (1987) and Angela McRobbie (1978) began to examine the ways intersectionality of identities like race, class, gender, and sexuality clashed with the accepted norms and roles reproduced in curricula (Acker, 1994).

Critical theorists expanded inquiry even further to also include an examination of the political role of schools (Margolis, 2001). In particular, empirical studies like those of Jean Anyon (1980) and Barrie Thorne (1993) began to take on a new focus. Not only did they look at issues intentionally or unintentionally left out of curricula due to their political or social controversy but, picking up on the work of Antonio Gramsci, they also focused on the ways in which systems of domination, oppression, and exploitation reproduce themselves through creating consensus.

Together, these critical theorists wanted to expand inquiry beyond a focus on the labor force and related theories of economic correspondence (Acker, 1994; Apple, 2004; Arnot, 1987; McRobbie, 1978). Though their approaches differed, they reoriented their attention towards the idea of resistance. This approach, also known as resistance theory, is grounded in critical educational orientations first outlined by Paulo Friere (2000) and further developed by thinkers like bell hooks (1994) and Peter McLaren (1997). Henry Giroux identifies this as the dialectical approach to hidden curriculum (2001). These thinkers assert that hidden curricula exist on multiple levels and that contestations between competing hidden curricula create the possibility of alternate spaces where agency and resistance can emerge both in teachers and students (hooks, 1994; McLaren 1997). This is a radically democratic, bottom-up, student-directed approach to education that focuses on community and local needs. This emphasis on the transformative power of education and its reproductive functions were part of much of the scholarship in this area.

However, this perspective has not been unanimously embraced. The power of agency and contestation among marginalized groups in schools has been called into question. Critical work, particularly scholarship by Michael Apple (2004), examines the power structures of ideology and hegemony in order to explore how resistance and agency can be subsumed, co-opted, and redirected towards outcomes that protect and support the status quo.

Moving the scholarship in new directions, Sakari Ahola (2000) has proposed a framework that may be ideally suited to the rapid pace of technological change and innovation of ICTs in higher education. His work identifies several key dimensions of hidden curriculum by synthesizing the conceptual frameworks provided by Mary Romero and Eric Margolis (1998) with those of G. Bergenhenegouwen (1987). Ahola develops four specific dimensions of hidden curriculum: learning to learn, learning the profession, learning to be expert, and learning the game. Learning to learn focuses on how students negotiate the methods and practices that will best help them learn new material. Learning the profession focuses on how various aspects of a student's discipline and profession are picked up. Ahola's concept of learning to be expert focuses on how students are able to develop competency and recognition as an expert in academia or their specific disciplinary field. Finally, learning the game refers to students being able to understand the unspoken socialization, rules, etiquette, and practices of a given discipline (Ahola, 2000, p. 4). These four dimensions of hidden curriculum are developed along two specific trajectories: socialization/professionalization and social and cultural reproduction (Ahola, 2000, p. 4). They provide another set of lenses through which to view how hidden curricula influence the recruitment, retention, and graduation of women and students of color.

However, in recent decades, interest in hidden curricula has largely dropped off in sociology of education and critical education research circles. Explorations and interrogations of schooling appear to have shifted more towards understandings of intersectionality, identity, hegemony, and postmodern theories with particular emphasis on the impact of globalization and the values of educational institutions as they confront a new economic order (Carlson, 1998; Monahan, 2005). However, as theorists of higher education have moved away from hidden curricula, interest has emerged in other professional fields such as scholarship on teaching medicine and law (Browning, Meyer, Truog, & Solomon, 2007; Costello, 2001; D'eon, Turner & Jones, 2007). However, there, it appears as a more practical framework to help professional schools understand how to interact with, teach, and retain an increasingly diverse population of students within professional schools. That is, to a certain extent, it has come full circle, taking on a more normative and prescriptive tone than a critical and descriptive one. At the same time, however, it is ostensibly being used in these programs to work to correct social inequalities.

Hidden curriculum and e-learning technology use in higher education

Studies on the hidden curriculum in to technology in higher education contexts and more specifically, e-learning education technologies (Anderson 2002, Winner 1997) are very limited. One of few that exist is the work of Terry Anderson (2002), chair of Distance Education at Athabasca University. He provides a key examination of the hidden curriculum of online education (2002). Anderson draws on Ahola's

(2000) four thematic conceptualizations of hidden curriculum and applies them to an e-learning context. As a result, Anderson comes up with several characteristics for each dimension. First, since this form of learning is, by definition, mediated, online students must achieve a level of mastery with a growing set of educational and communication technologies (Anderson 2002: 6). Though in some ways rehashing the emphasis on access to ICTs so prominent in the digital divide scholarship, Anderson is quick to point out that simple access is not sufficient for success in online programs. Competency with the e-learning technologies is necessary for success as well. Turning to the second dimension, learning the profession, Anderson argues that online education can have an advantage for many students who study part time and are already established within professional communities (2002, p. 9). In examining the third dimension, learning to be expert, Anderson emphasizes the difficulties of students attempting to demonstrate specialized skills and knowledge in an environment highly mediated by e-learning technologies. He notes that students are required to navigate technologies to defend and demonstrate their expertise in a given field (2002, p. 11). For the final dimension, learning the game, Anderson argues, "generally, the formal rules of the game are the same in both e-learning and campus-based formal education. Papers must be completed, tests written, presentations delivered" (2002, p. 12). Yet he also points out that the informal interaction with peers, a process that has been identified in hidden curriculum scholarship as integral for learning the game (Romero & Margolis, 2001, p. 92), is more restricted in e-learning contexts.

Anderson identifies several key tensions surrounding the use of ICT-based distance learning technologies and speaks directly to the potential pitfalls and possibilities of the hidden curriculum in an e-learning context. He argues:

> E-learning alternatives force institutions to confront the great untested (and hidden) assumption that campus-based education is always superior to that delivered in less physically restrictive contexts. E-learning has also been criticized as a conspiratorial tool of those who promulgate a world-view based upon globalization of culture and economy. It has also been argued that e-learning is a prime tool in the modernizing process of [the] 'disembedding'… of social relations from local contexts of interaction and their restructuring across indefinite spans of time and space… E-learning serves to re-contextualize knowledge and forces students into unfamiliar circumstances. Like campus-based education, it has the potential to be used either wittingly or unwittingly to promote a singular cultural or ideological bias. In addition there is no guarantee that telecommunications supported interchange will not further propagate stereotypes and ungrounded sense of cultural superiority. (Anderson, 2002, p. 16)

Anderson's work reminds us that e-learning formats have the same potential as more traditional campus-based formats for imparting a hidden curriculum.

Why Hidden Curriculum?

In attempting to understand the problem of persistence of women and students of color in computing programs, the concept of the hidden curriculum provides highly useful ways of examining everyday classroom activities and interactions for deeper ideological meanings. In particular, hidden curriculum provides an excellent framework for further examination of the symbolic environment of schooling, reading the signifiers of education, as well as the ways people and procedures are signified in education. The most important tool provided by the hidden curriculum is its emphasis on the means and processes by which education takes place. Studies of hidden curricula in higher education focus on understanding not only the desired qualities and characteristics of the imagined "end-product"—in this case, graduates—but also the ways by which various values, norms, practices, omissions, tracking, and socialization processes work together to produce very different outcomes for different types of graduates. As such, it is particularly useful for exploring gendered and racialized dimensions of the differences in the experiences of students in computing.

For my work, this can provide an important corrective to the goal-oriented focus of most digital divide research. That body of scholarship focuses primarily on ends, the kind of person (and more explicitly, the kind of worker) policymakers, politicians, and industry leaders want to produce. The emphasis on digital skills, innovation, and preparing a workforce for the knowledge economy by promoting familiarity with various e-learning technologies puts greater importance on the outcome, digital knowledge workers, than the process of how it is to be produced. As such, it tends to fail to address social inequalities since they are as much a product of procedures, how we accomplish something, as outcomes.

Furthermore, while, in theory, digital divide research focuses on addressing inequalities, in practice, in many cases these inequalities are overly simplified, reduced to terms of access. It becomes not a question of how, why, or to what ends are people using e-learning technologies but rather simply do they have access to these technologies. When framed this way, inequalities become quantitative, technological problems. This sort of framing suggests a naïve hope that simply providing access to technology will be enough to nullify the impact of inequalities. That is to say, the problems identified with much of the scholarship on the digital divide in the previous section can be categorized in another way: more attention was paid to the ends while little attention was paid to the complexities emerging around the means.

Theoretical frameworks provided by the hidden curriculum provide robust tools for unpacking the dominant discourse in which technology is framed as the saving grace. That is to say, they can help point out the extent to which e-learning technologies are a collection of solutions in search of a problem (Weizenbaum 1985), and then begin to consider how this came to be the case.

Adopting this diverse but interrelated theoretical approach can also help prevent a narrowing of discourse by further interrogating and unpacking the day-to-day practices of implementing technologies in computing education. For this study, methods of studying hidden curriculum provided insightful tools to examine the nuances and complexities of how instructors and students experience e-learning technologies in everyday higher education classrooms.

Attending to Intersectionality

An important part of the current research problem centers on building richer understandings of the experiences of women of color pursuing post-secondary computing education in both face-to-face and online contexts. One of the major critiques raised by researchers is a continued focus on separating identity categories such as race and gender in analyses of women's experiences (Singh et al., 2007). These researchers call for increased attention to intersectionality or how various identity categories such as race, gender, socio-economic status, age, and sexual orientation (to name only a few) come together in particular times and places. Researchers argue that multiple identity categories shape the social locations and everyday experiences of different types of people in ways that are highly context-dependent (Hulko, 2009). While the categories of race and gender have tended to be studied separately from one another in this literature, some studies taken multiple dimensions of identity into account, revealing the importance of intersectionality (Varma, 2002; Varma, 2006; Varma 2009).

The statement by the Combahee River Collective (1977) was one of the first articulations of the impact of intersecting identities. They revealed how multiple identity categories such as race, gender, and sexual orientation interconnected to shape the experiences of oppression felt by the women of the collective. They argued that their experiences as Black, lesbian women could not be fully understood by attending only to a single identity category at a time. This remains a foundational piece in intersectionality scholarship. Building on this work, Kimberle Crenshaw (1989) coined the term intersectionality and argued that experiences of Black women were not being fully accounted for by either antiracist or feminist scholarship at the time. Scholarship on intersectionality has been developed further by scholars like Patricia Hill Collins, who contributed the notion of interlocking oppressions in order to clearly articulate the compounding nature of social inequalities ascribed to multiple identities (2000).

Intersectionality has been hailed as one of the most valuable modern contributions of feminist scholarship (McCall, 2005, p. 1771). In particular, Leslie McCall has called for the need to develop a more robust conceptual framework along with complementary methodological approaches for studying intersectionality. However, on the alternate end of the spectrum, Kathy Davis (2008) argues that the strength of intersectionality is precisely this conceptual ambiguity, open-endedness, and flexibility.

This study is informed, in part, by this need for more attention to intersectionality. Given its history as a critical theory framework, the conceptual framework of intersectionality helps center focus on issues of justice and social inequalities. In doing so, I turn to the work of Wendy

Hulko (2009). She provides one of the clearest distinctions between two key concepts that figure heavily into the theoretical framework of the current proposal: intersectionality and social location. She explains that, "intersectionality can be seen to operate at more of a theoretical level and to refer to the way in which identity categories interact," while social location, "indicates the result of this interaction in terms of privileges and disadvantages and functions at more of a practical or everyday level" (Hulko, 2009, p. 45). Hulko elaborates on the distinction between the two terms by arguing that intersectionality can be thought of as an analytical tool employed by the researcher. Social location, on the other hand, is a more practical term that "refers to the relative amount of privilege and oppression that individuals possess on the basis of specific identity constructs, such as race, ethnicity, social class, gender, sexual orientation, age, disability, and faith" (Hulko, 2009, p. 48).

Hulko also adds several essential elements to account for the complexity of intersectionality in the process of research. First, she argues for the need to account for social context. To do this, she argues that both the experiences of the participant and researcher need to be foregrounded (Hulko, 2009). I attempt to do so by focusing on the narratives, stories, and experiences of women of color and allowing them the space to explain the salience of their multiple identities, the meanings they assign these identities, and how their social locations in various educational contexts (online and face-to-face) are affected by their multiple identities. To account for my own perspectives and provide a degree of transparency and grounding, I engaged with the experiences of the participants as a researcher reflecting on the patterns, similarities, and differences among my participants' experiences as well as my own experiences as a woman of color. It is my hope that a more robust understanding of the interplay between intersections of identities and the social locations of women of color will emerge through this practice.

Chapter 3

METHODS

Following the review of the literature that identified existing gaps and limitations of previous research on women of color in post-secondary computing education programs, I propose a methodology with the aim of collecting data to answer the following questions:

1. What early experiences with computing did women feel influenced the way they decided to engage with computers in their lives?
2. Having decided to pursue computing education, how did women's on-the-ground experiences in various contexts shape later experiences they had with computing?
3. What were the strategies women employed to help them navigate their educational pathways through computing?

I framed the methods used for this study within the mode of exploratory research. This mode of research emphasizes how people interact in a particular setting under study, what meanings people assign to their actions and how they do so, and what issues are of primary concern to them (Schutt, 2006, p. 14). Using this mode of research, I sought to gain a better understanding of how women of color go about making choices about the educational trajectories in computing programs. Specifically, I was interested in how early experiences with technology shaped their future educational choices. I was also interested in how various types of curricula in different contexts (face-to-face and online programs) were experienced by women of color in their respective computing programs. Finally, I felt it was important to understand the complexity of the experiences of women of color in these programs in a way that took into account the intersections of the identity categories they identified as being most important to them and how the degree of impact of these categories shifted and changed depending on their specific contexts.

I chose an exploratory mode of research for several reasons. The literature on women (and to a lesser degree, students of color) in STEM fields, and particularly in the subsection of computer science, is quite large. However, research that focuses on the specific experiences of women of color in computing programs remains small (Singh et al., 2007; Varma, Prasad, & Kapur, 2006). Other critics of the literature on the gender gap in STEM fields and CS in particular find that not enough attention has been paid to the importance of the intersectionality of race and gender identity categories (Singh et al., 2007; Cohoon & Aspray 2006).

It should be noted that I chose an exploratory mode despite the fact that several authors of literature reviews on the subject (Cohoon & Aspray, 2006; Singh et al., 2007) identify the need for more explanatory, quantitative methods in order to build rigorous (positivistic) theoretical models used to understand the persistent gender gap in STEM fields. Unlike exploratory research, explanatory research focuses on the causes and effects of social phenomenon. It does so by measuring the influence of change in one phenomenon upon another phenomenon (Schutt, 2006, p. 15). While such causal, explanatory research can be a valuable mode of inquiry, there are several dimensions to the literature on underrepresentation of women and students of color in computing programs that point to a need for more explanatory modes of research rather than attempts to neatly explain the problem through statistical modeling. Most striking is the literature which reveals that initial gains in recruitment and retention rates for women and students of color have begun to reverse in recent years (National Science Board, 2006; Varma, 2006). This progress towards gender parity was initially gained through intervention efforts based on empirical findings from explanatory studies. However, as with any complex social phenomenon, as the years have passed, it has become apparent that the initial causal explanations may have been insufficient. Explanatory studies have not been able to pinpoint why these gains have stalled and in some cases even reversed, suggesting that the phenomenon is not fully understood. That is, in order to create better causal models, more descriptive, process-oriented models illustrating what is really going on, on the ground, are required first. More research is needed about how computing programs attempt to retain women of color in order to understand why this group continues to be underrepresented (Cohoon & Aspray, 2006).

In order to explore these rich details of women's lived experiences, I could not focus on strict hypothesis testing. Such an approach relies on pre-established theories which the literature is now showing do not fully encompass the complexities of lived experiences of women of color. As such, I adopted an inductive approach (Emerson, Fretz, & Shaw, 2011). I began with grounded observations of the unique aspects of participant's stories about their educational trajectories. The moments shared in these stories range from participants' earliest childhood experiences with computing technologies to their experiences with computing technologies past their post-university lives. I then worked from these data to compile narratives which captured both the similarities and the differences that emerged in these women's stories.

To provide an account of this process, qualitative methods offer tools which can delve into the nuances of the lived experiences of women of color in computing in order to develop a more grounded, lived, day-to-day understanding of the phenomenon. Often embodying an exploratory and inductive approach, qualitative research encompasses a broad array of data-collection techniques united by their common interest in centering the experiences of the participants rather than starting with predetermined categories conceptualized a priori by the researcher. To do so, qualitative approaches emphasize observations of behavior, the study of everyday artifacts which shape social life, and an in-depth attention to participants' talk in order to understand how they are constructing meaning (Schutt, 2006, p. 315). Additionally, one of the strengths of qualitative research is that it can provide important viewpoints on areas that have been under-studied in the past. In the process, unanticipated findings are able to emerge more organically than in the rigorous prediction and testing of quantitative approaches (Denzin & Lincoln, 2003). Qualitative research also focuses on social context and the interconnections among social phenomena. This provides an important corrective to previous studies outlined in the preceding chapter. Another strength of qualitative research is its emphasis on the subjectivities of study participants and the meanings they attach to their actions, feelings, behaviors, and ideas about the social world (Emerson, Fretz, & Shaw, 2011). This is particularly important for the current study in order to better understand the diversity of ways study participants have navigated their educational experiences in computing. Finally, qualitative methods offer the important benefit of highlighting researchers' positions in the social world by building opportunities for reflexivity into the research process (Denzin & Lincoln, 2003).

Norman K. Denzin and Yvonna S. Lincoln (2003) further clarify the distinction between qualitative and quantitative methods:

> The word qualitative implied an emphasis on the qualities of entities and on processes and meanings that are not experimentally examined or measured (if measured at all) in terms of quantity, amount, intensity, or frequency. Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situation constraints that shape inquiry. Such researchers empathize the value-laden nature of inquiry. They seek answers to questions that

> stress how social experience in created and given meaning. In contrast, quantitative studies emphasize the measurement and analysis of causal relationships between variables, not processes. Proponents of such studies claim that their work is done from within a value-free framework. (Denzin & Lincoln, 2003 p. 13)

Denzin and Lincoln's distinction between qualitative and quantitative approaches illustrates how the rival calls within this field of study (on one hand, for more quantitative, explanatory studies and, on the other hand, for more qualitative, exploratory studies) can be understood as a product of competing paradigms within the social sciences. As Denzin and Lincoln point out, to adopt a qualitative approach is also to acknowledge the values laden within the research endeavor. Since it might well be the values hidden within the assumptions of previous researchers which have resulted in the existing theories failing to predict the decline in retention of women of color in computing, outlining my ethical commitments (and thus values) from the outset seemed to be an appropriate response. (See below for Ethical Implications.) In-depth interviewing provided a qualitative data collection technique which allowed me to do so.

In-Depth Interviewing

My intention in using in-depth interviewing to collect data was to engage participants in discussions about their learning histories, early experiences with technology, and how these factors shaped their pursuit of undergraduate education in computing. This informal, conversational, semi-structured form of interview involves exploration of personal matters such as the values, decisions, cultural knowledge, perspectives, and individual self-identity. A crucial part of the in-depth interviewing process is the development of intimacy between the informant and the researcher (Johnson, 2002).

Qualitative researchers see many benefits in using in-depth interviewing for understanding the deeper meanings research participants give to experiences and practices in their everyday life (Gubrium & Holstein, 2002). Specifically, in-depth interviewing is best in certain circumstances:

> ...if one is interested in questions of greater depth, where the knowledge sought is often taken for granted and not readily articulated by most members, where the research question involved highly conflicted emotions, where different individuals or groups involved in the same line of activity have complicated, multiple perspectives on some phenomenon. (Johnson, 2002, p.105)

The use of in-depth interviews provides the researcher with an opportunity to seek a deeper level of information and knowledge than can be obtained solely through other methods such as informal interviewing, focus groups, or survey instruments. At the same time, in-depth interviews can provide not just sources of data and knowledge but also a way for the researcher to unpack and analyze theories or to help verify and triangulate knowledge gained through other types of data sources such as observations and survey methods (Maxwell & Loomis, 2002). This process provides an opportunity for reflection on the multiple meanings and perspectives reported by participants by allowing the researcher to verify and validate different experiences.

Some limitations to consider with in-depth interviews are centered around the ideographic as opposed to nomothetic nature of interviews, particularly with smaller, qualitatively-based data sets. For ideographic approaches, the data collected can only be true for some times and some places as opposed to nomothetic approaches that focus on data that can be generalized as being true for all time and all places (Schutt, 2006, p. 196). The ideographic approach necessarily limits the ability to generalize findings. However, for the purposes of this study, in-depth interviewing is an important approach precisely because it sacrifices breadth for depth. That is, it compensates for a lack of generalizability by providing deeper insight into the specific practices and experiences participants identify as integral to shaping their educational choices.

For the most part, these interactions became lively conversations in which the women I interviewed shared stories, traded software tips, vented frustration, and commiserated about the very issues being studied. Interviews lasted from an hour to over three and a half hours. Seven of the interviews were conducted in person in a location convenient to the participant. In practice, this meant they took place in coffee shops, my office, participant's homes, or at their places of employment. Two of the interviews were conducted in audio chats on Skype. One interview was conducted by phone. With participants' permission, all of the interviews were audio recorded for later transcription and analysis. Participants were instructed that, should they wish, the audio recording could be stopped at any time. No participants requested the recorder be turned off.

Once the ten interviews were completed, the audio files were transcribed and the original recordings were destroyed. In the transcripts, all identifying information (names, addresses, institutions attended, etc.) was taken out and participants were assigned pseudonyms. During the interview, I asked participants to pick their own pseudonym and some chose interesting options. All of the names of people, places, and institutions contained in this study have been changed to protect the anonymity and confidentiality of the participants.

Sample Selection Procedure

In order to explore the question of how the educational trajectories of women of color are impacted by their experiences in computing programs, it was important to select as diverse a sample of women as possible. Doing so would allow me to highlight similarities, differences, and common themes emerging around their lived experiences. I recruited participants using a combination of purposive sampling approaches including criterion-based and snowball sampling. Criterion-based sampling is used to identify cases that meet some criterion, as a way of ensuring a form of quality assurance (Miles and Huberman, 1994 cited in Creswell 2007, p. 127). On the other hand, snowball sampling is used in identifying interesting cases utilizing the social networks and connections of participants who are asked to refer other potential participants (Miles and Huberman, 1994 cited in Creswell 2007, p. 127). I used these sampling methods because the population I was intending to study was relatively small and I needed the flexibility to select individuals that “purposefully inform an understanding of the research problem and central phenomenon of the study” (Creswell, 2007 p. 125).

As I began the recruitment process, I encountered some significant barriers (discussed in the next section) that led me to revise my initial criteria and sampling approaches. As such, the criteria for inclusion were as follows. Participants had to be (1) women (2) over the age of 18 (3) who had pursued education in a computing field at the post-secondary level.

The final sample consisted of a group of ten women very diverse in age, race and ethnicity, country of origin, and education. All but one of the women in the sample identified themselves as a woman of color. The study and sample therefore, focus primarily on intersectional experiences of women more generally, with a focus on experiences of women of color. Below, I have included a brief biographical sketch of each participant.

The youngest participant was Anu. At the time of the interview, she was 19 years old. Anu identified as being Bengali-American and had been raised in the American Southwest. She was pursuing a dual major in math and computer science.

Tina was a 27-year-old, international student from Mumbai, India. She had completed a bachelor’s degree in computer science from an Indian university. At the time of the interview, she was working towards a master's degree in nursing technology design and innovation in the United States.

Joey was 32 years old. She identified as "Hispanic." She had earned an associate's degree in network administration and, at the time of the interview, was completing an online bachelor's degree in business with a minor in communications. She was working as a coordinator for computing centers in public housing developments in a major urban center in the American Southwest.

Nikky was 37 years old and had immigrated to the United States from Vietnam in her early 20s. She received her initial training in computing on the job in a silicon chip manufacturing plant in the Pacific Northwest. She had returned to school to pursue her bachelor's degree in the social sciences.

Stella, 39-years-old, was originally from Iran and had immigrated to Canada in the last decade. She has a bachelor's degree in electrical engineering and a master's degree in electrical engineering with a specialization in control, automation, and communications systems. She earned both from Iranian universities. At the time of the interview, she was working as a professional engineer designing telecommunications technologies.

Xena was 43 years old. Originally from Iran, like Stella, she had emigrated to Canada in the past decade. She had earned a bachelor's and master's degree, and a Ph.D. in electrical engineering in Iran. She taught programming to undergraduates at a college in Ontario, Canada.

Alice was 44 years old at the time of the interview. Originally from the Caribbean, she identified as "half Black, half Indian." She had a bachelor's degree in computer science and an M.B.A. from an online program. She worked at an oil refinery in the Caribbean where she maintained databases.

Biafra, 46-years-old, identified as "Caucasian German." She was born and grew up in the United States. She had a bachelor's degree in journalism, an M.B.A., an M.I.M. (Masters of International Management), as well as a K-8 teaching certification in the southwestern state in which she lives. She was working as an instructional designer for online programs at several American universities.

Flo was 54 years old at the time of the interview. Since recently emigrating to the northeastern United States from Trinidad and Tobago, she identifies as Black, but she also sees herself as being a Caribbean woman of mixed race. She earned an associate's degree in meteorology and a H.N.D. (Higher National Diploma) in computer science. When I spoke with her, she was pursuing further education and was enrolled in an online Microsoft certified IT professional program. She was working as a change management consultant for the European Union.

At 56 years old, Riley was the eldest woman in the sample. She identified as mixed race and as a lesbian. She was born and grew up in the southwestern United States. She had a bachelor's degree in accounting and was a certified physical therapist. She was a web design professional, certified in several programming languages and web design standards.

Recruitment

It should be noted that the process of recruiting this sample was not a simple or straightforward one. I initially set out with a wide variety of recruitment strategies including the use of a qualitative survey as a way to collect some background data and as a recruitment tool. I advertised for survey participants on professional associations' and student organizations' listservs, in mailing lists for both local and national computer science departments, on social networking sites such as Facebook and Meetup.com, and even with targeted online ads through Google AdSense. When none of these advertisements generated much interest, I approached various student services offices at over 40 face-to-face and online campuses. This approach included reaching out to organizations such as offices for student affairs and outreach, commuter and adult students, and students with families. When this too failed to produce the desired sample, I began identifying local in-person organizations with ties to computing and showed up at public events such as film nights to attempt to recruit participants. Unfortunately, this strategy was not successful either.

Given these setbacks, I changed tactics and utilized more word-of-mouth approaches that drew on informal social networks instead of going through computing programs or institutionally-based resources. This approach proved to be far more effective a recruitment strategy than my initial one. Trying to understand why other approaches had been unsuccessful, I explored some of the responses I had received from institutional gatekeepers. One program coordinator told me, "Our students are so inundated with requests for study participation already, we aren't going to bombard them with more." Furthermore, I asked participants in the interview about why they had not completed the survey. Tina, one of the first participants explained:

> Women like us, we get asked to do surveys all the time! I'm so sick of them! But when my friend told me what you were doing and that you wanted to sit down and talk with us about our experiences, I was much more interested to do that than take another survey! ...I never get a chance to talk about this kind of stuff, it's not something that you normally get to bring up.

This was a sentiment I heard repeated not only from almost all of the women in the study but also from programs and individuals who declined to participate. That is, one explanation for my lack of success recruiting is study fatigue in these populations. It was only when these women realized that the interview would be an opportunity to have their voices heard, in their own words, that they became interested in participating. This suggests much about previous research in this area.

Coding and Analysis

Once data collection was completed, I began the coding process. To assist with this process, I used the qualitative data analysis software *DeDoose* (Lieber, 2011). Starting with an open coding approach (Strauss & Corbin, 1990), I developed initial themes. Generally, open coding is the first step of the analysis process and consists of the researcher taking data (such as interview transcripts) and structuring them into informational categories (Creswell, 2007). These were coded under categories such as: interest in computing; opportunities for computing; barriers to computing; social impact of computing; family dynamics; support systems; intersections of identity categories; types of technology used; cultures of computing programs; curricula, and; career- or work-related training. I then engaged in axial coding (Charmaz, 2006; Corbin & Strauss, 2008) and, by utilizing a constant comparative method (LaRossa, 2005), I developed key themes. These included: the importance of early experiences with technology; the role of family support in encouraging initial interest and persistence through a program; the cooling effect of high school computing experiences; the importance of online, informal communities in supporting women of color in computing, and; the persistence of dominant cultures of computing that continue to create barriers for the retention of women and non-traditional students. These themes were analyzed by bringing to bear the initial theoretical and conceptual frameworks drawn from literature on the digital divide (van Dijk, 2005), the hidden curricula in higher education (Margolis et al., 2001), and conceptualizations of intersectionality outlined by Wendy Hulko (2009).

Ethical Issues

Some ethical concerns I contended with as I embarked on this study concerned issues of privacy and possible emotional discomfort or distress that could occur due to the nature of the in-depth interviews. As a result, I took steps to minimize any potential negative effects brought about through participation in this study. I made sure to have information on hand during interviews for local counseling and mental health resources should difficult subjects be raised or if the participants requested access to such services during the course of the interview. Interviewees were also told during the informed consent process that these resources were available if they wished to receive them. However, none of the study participants requested these resources.

Before beginning the interview, all participants were provided with a letter of informed consent that detailed the purpose and duration of the study, as well as details concerning the steps that were taken to minimize or eliminate identifying information about research participants. Participants were informed that all data recorded would be stored in a secure environment behind an encrypted Internet firewall and on password-protected storage devices. Participants were also informed they could end their participation in the study at any time and that should they decide to terminate their participation, all responses, data, and information they had provided would be securely destroyed.

Chapter 4

FINDINGS: EARLY EXPERIENCES OF COMPUTING

While previous literature was useful for developing the research questions and methods shaping the initial design for the study, during data analysis, the focus was on understanding and communicating themes emerging from the stories of the women interviewed. Drawing from a grounded approach (Charmaz, 2006) to emphasize women's experiences, analysis of these stories revealed important themes that did not always fit with my initial conceptualizations. This chapter focuses on the following question: What early experiences with computing did women feel influenced how they decided to use computers in their lives? To answer this question, I explore how these women discovered an interest in technology in the first place as well as looking at how subsequent experiences in schools, at work, or in their personal lives further shaped the choices of technologies women engaged with and in what ways. Throughout the chapter, I explore women's stories and their varied meanings, paying particular attention to the ways in which intersections of identity categories operate in each of their different contexts. Where appropriate, the connections with digital divide frameworks are also explored. The themes discussed here provide an important foundation for understanding later experiences of negotiating hidden curricula, the subject of Chapter Five.

Developing Intrinsic Motivations for Technology Use: Formal Schooling Contexts and Tinkering

Women in the study, particularly those who expressed an early affinity for science and mathematics, were more likely to have discovered an intrinsic motivation to learn about various types of technologies at an early age. Differences of age, race/ethnicity, socio-economic class, location, nationality, and family dynamics all influenced opportunities women in the study had for accessing technology in pursuit of their intrinsic interests. Fifty-four year-old Flo, who identifies herself as a "mixed-race, Black Caribbean" woman, explained that her interests in science and mathematics were developed and encouraged very strongly during school. It was this foundation that helped lead her first to meteorology and then to computer science during her university education, enrolling in one of the first computer science programs offered in the Caribbean at that time:

> It was the British system and obviously mathematics and science played a major role in my early education.... I got a distinction in mathematics because those things were emphasized in our education system....
>
> I was offered a scholarship to study meteorology at the Caribbean Meteorological Institute in Barbados. I went off and I studied meteorology.... It was during that time while I was doing meteorology that I had to use all of the equipment that you could think of.... This is 1977 I'm talking about. We didn't have computers in those days, it was Teletype machines. We had to transfer all of our weather data using Teletype machines. Then in the nights, we had machines that would allow us to download satellite pictures and we had reader machines from which we would calculate balloon trajectories and radar readings, mapping the balloon and mapping wind systems, mapping pressure systems, looking at the topography maps, and all of that kind of stuff.

> I know that was my introduction to technology. It was not until 1982 or ‘83, somewhere between ‘82 and ’84, we got computers and it was then that I started to learn about computer literacy and started looking at computer science. By 1989, and this is the Caribbean I’m talking about, we had the introduction of the first computer literacy courses.
>
> That was when I got into the programming because I think I was in the first or second batch of NIRST. NIRST is the National Institute for Research, Science, and Technology, which is a national educational institution, whose focus and emphasis is on science and technology. They introduced the, it’s a British university program of the Higher National Diploma, the HND in computer science. I did that program.

As a woman who completed high school during the late 1960s, computing technologies were not present in Flo’s K-12 learning experiences at all. However, her foundations in mathematics provided an advantage when pursing computer science later. Financial support offered in the form of scholarships for high-achieving students with qualifying marks on mathematics O-level exams of the G.E.C. (General Education Certificate) provided Flo with further opportunities to pursue a mathematics-related field such as meteorology. In that program, Flo was able to become familiar with the professional associations and networks in her field and other related disciplines via the National Institute for Research, Science, and Technology. She explained that working with technologies available at that time such as Teletype machines gave her a foundation she would build on later. This experience helped influence her motivations for pursing computer science when it was first offered as a subject of study in the Caribbean. However, she attributed her strong math foundations and intrinsic interest in the subject with providing the motivation and ability to recognize computer science as an important field for study later in her educational pathway.

Like Flo, Tina had early experiences that influenced her later desire to pursue computing. Tina's story adds to this understanding of how motivations to use and engage with computing technologies are developed. Tina is a twenty-seven year-old woman from India who came to the United States to pursue a Master's degree in health innovation technologies at Greater Western University. Before coming to the U.S., she earned a bachelor's degree in computer science. She spoke about how she first began developing an interest in computing through her experiences in high school and at home:

> When I was in high school, I opted for computer science in my 11th and 12th grade. . . . I was looking at options in engineering, and I saw computer science and information technology. And we had an option to take courses from both streams. So that's what I did....
>
> Computer science is mostly hardware, I mean the courses in our college are mostly hardware related.... Like algorithms, or how the devices function, all those basics. But I was also interested in how information moves around, and how people, how they collect that information, how they distribute it, how everything goes on the network.... I was more interested in that. And that's why I took some courses in IT as well....
>
> When I was, first exposed to the Internet, I was really, really fascinated! I thought, "How does this work, and how is all this information coming to me? Where does it go? Who is using it? Who is seeing it?" And all that.... I didn't know how it works, so I couldn't imagine how all this information was going on the network, and then how I can communicate with other people....
>
> The whole graphical side of it, that was very fascinating.... Computer interfaces were really interesting too. I guess the whole interaction between humans and computers, that goes through interfaces, so I think it depends a lot on how the interface is designed. And at that point, I couldn't think of all that, but now when I look back, it's more like you communicated with the whole

> device and that feeling, that experience, like you have when you have your first car, or whatever.

Tina explained that her high school emphasized mathematics and engineering education and offered a wide variety of opportunities to explore aspects of computing. She was able to take not only introductory programming courses, and courses about how computer hardware worked, but also courses in IT network systems and courses on how information moved between various types of systems. This opportunity translated into her interests later in college where she pursued a bachelor's degree in computer science.

Furthermore, her early experiences provided some interesting perspectives on how early exposure helped develop Tina's interest in computing. Tina remembers her father being particularly motivated to teach his children about computers as they were beginning to emerge. Her initial experiences with computing at home were with one of the first widely available consumer-level computers, the Commodore 64. Purchased for family use, Tina found that experience to be a significant source of her initial interests in computing. With her father's encouragement, she and her siblings learned basic skills such as typing, manipulating a pointing device (joystick), and interacting with information on a screen (via games). This investment in learning about technology continued in Tina's family with the purchase of other computers. In high school, she received her own personal computer. From these early experiences, Tina's fascination with the movement of information over the Internet grew and provided the motivation to pursue computer science.

Linking directly to the issue of intrinsic motivation and aptitude in mathematics and computing are the experiences of Anu, a twenty year-old woman identifying herself as Bengali-American. She is a university student currently majoring in both computer science and mathematics. Anu's story provides an interesting counterpoint to Tina and Flo's experiences. Anu grew up during the 1990s when computing technologies were more widely available. Anu's experiences provide insight into how the presence of these technologies combined with her intrinsic interest in mathematics. From an early age, Anu reported being interested in math, enough so that she sought out information to supplement her mathematics education outside of school settings:

> Anu: We had video game systems and we had computers, but we weren't really into tech in my house… Obviously, I had a computer and I had PlayStation. [...] My parents both have degrees in medicine, so it wasn't like—they were never that interested in tech and stuff.
>
> Sher: Where did the interest in computing come from?
>
> Anu: I was always good at math. I liked it well enough, and then I got to calculus and kinda fell in love with the field. Then I started taking math at GWU. I moved past calculus, and it got even more interesting.
>
> Sher: Did you take any classes in computing or computer science when you were in high school?
>
> Anu: No. They didn't offer any at my high school.... I would read a lot about math, come to mention it. Wikipedia's great. You start with, "I'm interested in probability," and then you end up in topology! [...] It's very, very useful for a math major

and computer science actually. They have proofs and they write out algorithms and you just—it's just a go-to resource if you don't understand a concept.

Sher: What are some other resources that you would rely on?

Anu: Well a lot of professors from other universities, their course Web pages. [...] There's a really good resource for calculus, Paul's Online Notes. He's a professor. I don't remember which university, but he just posts calculus notes and those got me through Calc 3. [...] Well most course web pages are just open to anyone. As long as you can find them, you can use them.

Sher: When you found all this stuff, would you just use it as kind of a personal resource or would you end up collaborating with any of your teachers?

Anu: My high school went up to Calc 2 but I was—by that point, I was over calculus. It wasn't fun any more. I wanted to do theory. [...] I wanted to focus on discrete math, but they don't really do that in high school, which is really unfortunate because it's—I think it's way more useful than calculus. [...] I really like math.

Anu's experiences share some similarities with those of Tina, with some crucial differences. Anu's parents were also both doctors and had the economic means to provide her with access to a computer and a game system at a relatively early age. However, Anu's parents did not express the same interest in computing as Tina's father, who actively engaged with Tina to teach her about technology. Anu experienced technology primarily on her own, exploring the computer as she sought out online resources. Navigating the Internet and seeking out information on public sites, developing skills online, and applying them to her mathematics education, allowed her to learn at her own pace despite the limitations of the mathematics curriculum in her high school. This intrinsic motivation provided Anu with important foundational skills that would serve her well in her later mathematics and computer science programs.

While intrinsic motivation is an important part, the issue of motivation is directly tied to access. Jan A.G.M van Dijk's (2005) four stages of access—motivational, physical, skills, and usage—help us better understand how the digital divide operates. The interrelatedness of motivational access and physical access can be seen in the stories above. While Flo, Anu, and Tina all expressed interest in and an aptitude for mathematics and science at earlier ages, their families also supported their interests, encouraging them to pursue these subjects of study in school. School contexts were also important in some cases, such as with Flo and Tina. Both of these women reported coming from high schools that had strong mathematics and science preparation in the curriculum, with opportunities for students to pursue higher-level mathematics and engineering courses. Financial opportunities rewarding Flo's achievements in mathematics by funding a program of study in meteorology were provided via scholarship money.

This is in direct contrast with Anu, who felt strongly that her high school was not able to keep pace with her interest in math. Instead, she supplemented these experiences through university professor's online course pages and books on math and math history on her own time outside of the classroom. Anu and many of the women in the study seemed to display an exceptional amount of initiative in pursing their interests in mathematics and computing. While a lack of advanced mathematics courses in high school could have been a serious impediment to developing her interests, Anu's sense of curiosity about the subject led her to seek out other sources of information. In the case of Tina and Anu, who grew up during the influx of computing technologies in schools and workplaces, their parents provided the extra dimension of physical access by buying early computing technologies such as computers and game consoles for their children to explore at home.

The stories also illustrate the roles different aspects of these women's identities and social contexts played in obtaining physical access to technologies. The daughters of doctors, both Tina and Anu had families with the economic means to provide them with access to computing technologies. Both of these women lived time periods (the mid-to-late 1990s and early 2000s) in which access to computing technologies were widely available in the global consumer market to people of a certain economic class. This is in contrast to Flo who grew up during the 1960s and did not have access to personal computing technologies since they had yet to hit the consumer-level market.

Another interesting point of comparison is that of national identity. During their interviews, both Tina and Flo alluded to the British system that their respective K-12 educational experiences were based upon. Both women seemed to indicate that this system provided them with more preparation in science and mathematics than the U.S. educational system would have been able to provide. While the focus of this study is by no means placed on the incredible degree of variation across countries and school systems, Anu's experience in the U.S. educational system did not appear to have provided her with foundations or educational opportunities which Flo and Tina were able to receive. Anu's story, however, points to another important factor in developing initial motivations to use technology that emerged in the stories of other women in this study: the importance of tinkering and self-paced exploration of various types of technology.

One of the most common ways women in the study first engaged with computing and other technologies was through tinkering. The experiences shared by Riley exemplified the process of tinkering. Fifty-six year-old Riley identifies herself as a lesbian, mixed-race woman who runs her own web design business. Riley engaged with various technologies during her childhood in the 1960s in a large, southwestern metropolitan area. While computing technologies were not widely available at the time, she worked on small engines and televisions:

> I was the sort of kid that, I would tear things apart. Taking radios apart, taking televisions apart, fixing TVs. My dad is a contractor, and so I got a lot of knowledge as far as putting things together. This sort of thing, logically, and being able to tear things apart. I guess I was the son he never had. I learned how to take apart car engines and those sorts of things. Yeah, when I was in elementary school, I built a telephone based on a design by Alexander Graham Bell. It was for a science fair, stuff like that. Built my own movie projector, because I wanted to be able to look at 8-millimeter movies. Didn't have a projector, so I built one.

Because of the range of ages within the sample, tinkering and exploration did not always occur with computing technologies. However, the experience of tinkering was important for setting the groundwork for later exploration of computing technologies once they became available. Riley was able to reflect on her early hands-on experiences taking various pieces of technology apart, putting them back together, and engaging in technology mostly on her own. This mirrors the self-paced exploration of mathematics Anu engaged in during her formative years. However, Riley also expressed that part of her motivation for engaging with these technologies, aside from her own intrinsic interest in building things, was building relationships as well. Her experiences illustrate yet another theme that emerged from the data.

Technology and Developing Relationships with Friends and Family

Expressing that she was "the son he never had," Riley indicated that an important part of her relationship with her father revolved around learning to tinker with various kinds of technology. Drawing on of his expertise as a contractor, she was able to learn more about various kinds of technologies and how they functioned through the process of building, tinkering, and modifying them with her father. Her experiences share some similarities with Tina's experiences learning to use computing technologies such as games with her father. Both women talked about learning basic skills and techniques from their fathers and then exploring and learning on their own through experimentation, tinkering, and pulling things apart. Riley felt these early tinkering made her more confident working with various types of technologies, contributing to her fascination with computers when she began learning to use them later in her life.

Van Dijk's (2005) concept of motivational access is helpful for identifying a spectrum of experiences that are effective in identifying individual factors that shape the desire to ultimately obtain and engage with computing technologies. These opportunities for access may shift and vary depending on changes in a person's context, economic, social, and educational resources. The motivational stage also provides some explanation of social factors that shape motivations to use technology such as norms of school technology access, as well as relationships and connections developed through technology use as in the form of family bonding. Tina and Riley both had fathers who were able to provide them not just with basic skills to manipulate and experiment with various types of technology, but also with physical access. Tina's father provided access to computing and game console technologies while Riley's father, in his line of work as a contractor, was able to provide her with access to parts, equipment, and workspace in which to tinker.

There are some important considerations around intersecting identities that need to be taken into account with the development of these relationships. While both Tina and Riley expressed close relationships with their fathers to some degree, each recounted stories about how expectations their parents had for them in terms of later career or college pursuits still had a particularly gendered dimension. These experiences must be further contextualized through the lenses of time period, social class, sexual orientation, gender expectations, location, and cultural differences. For Riley, these tensions can be seen in her later discussions of her relationship with her father:

> I know another big thing was when my father refused to pay for college because I was a girl. So I worked. [Laughter.] I think he would've done it differently now, but back then it was, "You're gonna get married," and I did. Then there's the gay thing. [Laughter.] That was always there.

Earlier, Riley explained that she was "the son he never had." However, his later actions of denying her financial support for college due to his beliefs that women were expected to get married, point to the complexity of their relationship. Her father's assumptions about appropriate career and educational paths for men and women, as well as assumptions about heterosexual married relationships encompassing the acceptable range of possibilities he appeared to believe Riley could aspire towards at the time, demonstrate the power of larger social patterns that privilege certain identities over others. Furthermore, these assumptions had a definitive impact on shaping the difficulties faced by Riley in her later educational and career endeavors. As a woman entering college during the 1970s, this context of gendered, heteronormative interactions colored expectations of faculty and internship supervisors of what she was and was not capable of doing. Riley discussed these barriers and how they impacted her educational trajectory at length. These issues will be revisited in more detail in Chapter 5.

Riley's experiences by no means were the only examples of expectations that posed roadblocks for women attempting to engage with computing technologies. While it could be argued that the time period Riley attended school was a major factor behind why she faced these sorts of barriers, younger women in this study also reported similar experiences of resistance from family members despite initial encouragement of their interests. This resistance was influenced by cultural expectations shaping ideas about appropriate career, educational, and occupational opportunities for women. Tina, for example, explained how although she initially went into computer science for her bachelor's degree, her master's program choice was in part influenced by her parent's medical careers. While still working with computing, she shifted her focus to healthcare systems. This shift from more abstract approaches to computing, such as computer science, to more practical, applied fields, such as medicine, is a trend reflected in some of the latest findings concerning gender distributions in STEM fields (Jesse, 2006). Anu related similar pressures from her family. She explained, "I really wanted to major in math, but my parents wanted me to be in the engineering school, so it was kind of a compromise. As long as I can do math, I agreed to it." While supportive of her interests in mathematics, Anu's parents pushed her to pursue computer science as they felt she needed to major in something more applied. Exploring how different women navigated these pressures provided some important context and revealed how factors like gender and culture shaped educational endeavors.

Another example that provides some context for how intersections of various identity categories can shape the experiences of women attempting to engage with computing at early ages are provided in Xena's story. Thirty-seven year-old Xena identifies herself as a woman originally from Iran who immigrated to Canada in her mid-30s. While trained as an electrical engineer, Xena utilizes computer technologies and programming on a daily basis to teach students fundamentals of electrical engineering design. She was selected to study electrical engineering at a prestigious state university in Iran due to her high academic ranking on the country-wide exams. She continued her education in engineering, eventually obtaining her Ph.D. She explained how her educational pathways were influenced not just by her initial interests in mathematics and science as a girl in high school, but also by her aptitude and academic achievement in these subjects. Despite her high levels of achievement on state tests ranking students throughout the entire country, she faced some family resistance to her desire to go into engineering:

> I told my dad I want go to electrical engineering. Then, when I go to my rank, I was like 400. My rank was 400 in the country and that's when we had 50,000 countrywide. I had a good rank. I could go to the major I like. My dad was so proud of me and he showed my rank to his colleague and he said, "Oh, no. That's not good for the girls. You should ask her to ignore this year and then go back and study to be a physician."

> Then, my dad came home and said, "Why is [this the] way to go, because engineering for women is not a good idea? Maybe better that you go and be a physician or pharmacist or dentist?" I said, "What? I hate those jobs!" I'd prefer be a good teacher in high school than to be a bad physician. My brother, he was a student in the pharmacy. He was studying that time at university. He came and supported me and said, "No. She wants that. Just support her." Then, they did. I just insisted that I hate that job. I love this major. I don't care. It was funny because I was 18, and I gave like a wise answer to my dad.
>
> I said, "If electrical engineering was not good for girls, why [did] God give me that talent of math and physics? If He give me that talent, that means it's good for me. I have to go into this."

It is important to consider Xena's context. She grew up in Iran, a majority Muslim, theocratic nation. Xena was entering university approximately ten years after the 1979 Iranian Revolution, the result of which (among many other things) was a segregation of genders in public settings such as schools. While her early achievement in mathematics was supported and encouraged by her family as a whole, and her father displayed a sense of pride showing her national exam score to colleagues at work, larger social ideas shaping notions of gender-appropriate work were brought up by one of his male colleagues. Challenging her initial aspirations based on a notion that engineering was "not good for the girls," her father reiterated his colleague's concern about her choice of electrical engineering. Drawing on her religious identity as a Muslim, Xena made a powerful counter-argument, questioning the underlying ideas about what women are capable of by asking why, if electrical engineering is inappropriate for women to study, God gave her an interest and ability in mathematics and physics. It is not clear if this argument alone was enough to sway her father's concerns, considering that additional support from her elder brother also seemed to make an impact. Being male and supporting his sister's aspirations may have been another important factor that convinced her father. Both her arguments based on religious reasoning and her brother's support assisted Xena in overcoming this potential barrier to her intended pathway towards mathematics, computing, and engineering education.

Hobbies and Leisure Usage

Throughout this chapter, several women have described their early explorations with technology in schools as well as in less formal contexts such as leisure time. Another theme that emerged was the role computing technology played in hobbies. Eight out of the ten women interviewed for this study expressed that they used computing technologies early on to help pursue initial hobbies and interests. The majority of the interviewees under age forty-five reported engaging with computing technologies through playing video games. Anu explained earlier that math history was a hobby of hers and that her use of the Internet to track down new sources of math history information and books were important to her. She also reported the importance of video games.

Other women reported enjoying using programs to create greeting and business cards, illustrations, and other forms of graphic design. Joey's story in particular provides some interesting context for the importance of hobbies. Joey is a thirty-one year old woman who identifies herself as

Latina, a mother of two children, and married in a heterosexual relationship. She is originally trained in IT and works as a coordinator for computing centers for public housing in a large southwestern metropolitan area. Building on her hobby of working in Adobe Photoshop, Joey explored computing technologies from a more informal context. This was incredibly important in further developing and maintaining her interests in computing as well inspiring later ideas for integrating graphic design into her job:

> I'm visual, so that's why I also love the web design portion of it. It's like I got to play with Flash and I got to play with Photoshop. I love Photoshop. [...] I always told people, "I don't have a hobby. People play sports and they go hiking and camping, and I don't do all of that." Then I just realized one time that whenever I do have a free moment, I love to just sit and Photoshop. I play with things and making things different and changing backgrounds. I love doing that! I actually came to work all excited, "I have a hobby. Oh, my god!" I just always considered myself not to have a hobby.

Joey's initial motivation to begin working with Photoshop came out of an interest in graphic design. She explained that it was a desire to balance out what she felt were the more tedious aspects of computer IT work in a way that allowed her more flexibility to explore and tinker with the technology on her own in a context she found more interesting. Joey and other women in the study often did not initially recognize these activities as hobbies, explaining instead that their use of these technologies emerged due to opportunity and time available to them to explore. An interesting example of how discovery of computing interests occurred through the development of a hobby related to computing is that of Riley:

> I had been in a pretty bad car accident. A couple of the bones that I broke in this accident happened to be in my spine and I had to have back surgery. While I was recovering from that, I taught myself the PC. It was my first adventure, as far as going online and that sort of thing, and just found a whole world that I could play with. The first thing I taught myself to use was Microsoft Publisher. […] That was the first thing that I really taught myself.
>
> MP had a few animated GIFs and these sorts of things and I thought, "Oh, this is so fun." I made business cards. I made greeting cards. I can take a piece of paper and fold it into fours and have a card. […] My friends and family would say, "You made this? You designed this?" I would give my mom one of those folded cards or something. "Oh, my God. You made this? Oh, this is wonderful!" So, that was the start of that.
>
> Then learning to deal with floppy disks and that sort of thing. […] Prior to that time…my first real experience with computers was—I have a degree in accounting. I was working for a company that had a room, probably at least the room was 12 x 12, easily—and it was filled with a huge IBM computer. […] It was punch cards. In fact, when I was in college, the classes that were offered, as far as computer science, it was programming and then key punch. That tells you how old I am. I mean, and that was it as far as computers. When I went to work, then we had these huge computers like this. There were no PCs. […] I worked for Grocery Store Corporation as an accountant there. I was there for a couple of years, and then they suddenly plopped these humongous PCs on our desks. No training whatsoever. Figure it out. They were DOS systems. […] Had to learn command lines…

Although Riley had opportunities to engage with earlier computing technologies during her bachelor's degree program in accounting and then again later during work, the experiences she identified as being the most formative were those she had tinkering with the PC while recovering from her injuries from the car accident. These moments of being able to explore the technology to pursue her interests, without external curriculum or any other influencing factors, allowed her to gain the familiarity she needed with computers in a pleasurable, low-stakes context.

All of the participants in the study expressed that this unstructured time pursing hobbies or leisure activities using computing technologies was incredibly important to developing their confidence, interests, and further motivations to continue working with computing technologies. While schools were the first sites where most of these women first encountered computers, a majority of them reported that these experiences were not enjoyable and, in some cases, actually discouraged them from using computers.

Computing in Schools: Early Structured Experiences

Biafra, a forty-seven-year-old woman who identifies herself as Caucasian, had a very different pathway towards computing technologies than most of the other women in the sample. She currently works as an instructional designer; however she earned a bachelor's degree in journalism and an MBA and MIM, and is a certified K-8 teacher. She never received formal training in technology in the form of pursing a post-secondary program in computer science or a computer-related field. Instead, she is completely self-taught, having gained expertise in designing K-5 technology curricula as well as designing curricula for higher education contexts using a wide array of complex computer software applications in her day-to-day work experiences. Her story provides a very powerful example of the ways her early computing experiences in high school and university were more of a deterrent to pursuing more formal pathways of computing education:

The only thing we had as the typing course. We actually had electric typewriters, which was older than the moon. At that point, all you did was you had a book, a flip book, hard, that would stand up. You would self-paced go through the lessons. It could be you're spending the entire 50 minutes doing nothing but typing A, S, D, F, G, H, J, K, L – it was repetition, repetition, repetition, which is what your brain needs to create those neural pathways. The typing teacher just sat and read a paper the entire session because there was nothing for him to do. It was just, what are you gonna teach? I mean it's just "put your fingers on the keyboard." [...]

I did earn my degree from the University of Pacific Coast West. What they had us doing was composing on the – and you don't even remember these, but they were these old Word Stars. That's all they did. They were word processors. They were a cross from a type writer. [...] They were nuts. I hated it. I hated composing on it. I hated it with a passion. Give me an old electric typewriter. I was, I could do things faster, and even that had command lines you had to do. I absolutely, it just killed the writing process for me, so that's how we did it. But it was only in one course because we were learning the new technology. I hated it with a passion. It was horrid! It was just the worst experience.

Then that DOS class. I really don't know why I took it, quite frankly, because by then it was just so, it was not pleasant. I withdrew. [...] It was a basic course. I just remember that the TA got up there and was talking about, "Turn the computer on." He was making the assumption that all of us knew how to turn the computer on. I had no idea where the on/off switch was. I remember being extraordinarily scared that I was gonna break the machine. [...] It was command lines. [...] I thought, "I don't get why would I do this." There was no context in which to make any of what we were trying to learn make sense. To make matters more difficult, the TA for the class was Asian and his accent was extraordinarily thick. I just was so frustrated, so I just withdrew. I didn't need the course. [...]

I went to grad school for International Management. [...] I loved it. [...] They had a quasi computer lab. I went in there a few times because I didn't own a computer. [...] Then, during that time my husband and I got married and we bought our first 286 computer. [...] I needed the computer…for the MBA program. [...] At that point, I really started to get into, I actually enjoyed learning about config dot sys, and I started to be able to do some rudimentary, I don't know, systems management. Just again just kinda messing around, just playing.

Biafra's pathway to technology use in her career as an instructional designer was greatly impacted by the early experiences she had with other kinds of technology in primarily school-based settings. Her experiences with early technologies, such as electric typewriters in high school and Word Star word processors in college, were very unpleasant and boring for her. Rote memorization and drills characterized much of the classwork, with little to no interactions with instructors or peers. Towards the end of her university career, she enrolled in a beginning programming class on DOS and felt incredibly intimidated and frustrated by the whole experience. During her later graduate school experience, her interactions with computing technologies were much more contextualized. She learned more about word processors like Word and Excel spreadsheets in the context of completing her MBA coursework and began to develop an interest in computing technologies as she explored their capabilities on her own. This issue of technology learning being incredibly de-contextualized was a major concern that stayed with Biafra, leading her to make concerted efforts to ensure that her K-5 students would not have similar negative experiences with technology. Her experiences teaching and designing curriculum to deal with barriers to learning technology are discussed further in Chapter 5.

Another interesting example illustrating the diversity of experiences in school and universities with computing technologies is provided by Nikky, a thirty-seven year-old woman who emigrated from Vietnam to the

United States in her early 20s. She reflected on her experiences in the mid-1990s right as consumer-level Internet access began increasing. She explained the impact of moving to the U.S. where she first had regular access to a computer. She explained the initial context of social use of earlier technologies:

> Sher: Was there no tech or computers—nothing when you were growing up?
>
> Nikky: No.
>
> Sher: Like TV, radio, anything.
>
> Nikky: [Laughter.] TV. You know in Vietnam, they controlled TVs and every evening we had like about two hour, like from seven to nine. If you go out you better be home before nine or ten—and then periodically on Sunday from one to three or one to four, they have a soccer game or ice skating on. That's about it.
>
> Sher: What about radio?
>
> Nikky: No, not radio. We listen to the cassette tapes a lot. Believe it or not my dad was the one that loved ABBA and Beatles. He was the one introduced us to that. [...] They used to have VHS back then still—so those. Still, it's come pretty—it's like a privilege thing. Even with movies, you can't just go rent it. There are certain place that have it and so many people want to watch it. Again, it's a control. The state control everything—so pretty much not a lot of stuff. As far as technology, it's not much.
>
> They didn't start having a landline phone until right before I leave, which was in '95. You have to have money and for a phone line. [...] I remember the whole neighbor or subdivision, we only had one family that still have a phone line, so that's their business. You go there to call people or you have people call them and then they come and call you, then they come to your house and tell you. We don't have our own phone or we have to drive out the way to get to a phone or you have to go to the post office, out the way. I remember we have to go to the post office to fax a document from

> Vietnam to California for my aunt when my grandpa was in the hospital.

Nikky explained that technology use in her experiences in Vietnam, even in more densely populated areas such as the cities, was a very community-based affair and influenced by economic and political considerations that shaped technology use on a number of different levels. On the one hand, economic costs for owning, maintaining, and installing landline phone service at that time were prohibitive for many families. Serving as a small business opportunity for community members with the means to invest in the technology, phone service was maintained and installed by a wealthy family in her neighborhood as a messaging service for the community. This allowed for phone access for other families who may not have had the economic means to own their own landlines. Another factor that influenced the deployment of technologies in various forms (especially media such as television and radio) was political regulations, particularly strict enforcement and regulation of media content and timing by the state.

Van Dijk's (2005) conceptualization of a spectrum of access is helpful for understanding motivational access to technology in some cases but may not encompass the differences in the quality of motivational access in varied types of contexts. This is because the model, as it currently exists, tends to assume individual factors are the main influence affecting motivational access. However, individual-level factors may not encompass larger structural and social forces that shape technology access, such as broader state-level policies and even micro-entrepreneurial models that tend to re-appropriate technologies to fit within a locally-based economic system. Community connections and social ties may be influencing technology deployment in various contexts that might not be accounted for in the model of motivational access van Dijk sets forth.

Nikky's experiences in an international context provide some important examples for changes that occurred over time with her technology use. These changes speak directly to motivational access. She explained how she initially began using computers once she got to the U.S. for her ESL (English as a Second Language) coursework. She first relied exclusively on computer lab access at her community college campus. However, due to the drain on her already limited time, she explained how this increase in computer use through ESL classes had a major influence on her decisions to finally purchase a personal computer:

> Nikky: I enrolled in the fall of '95 for ESL class at Pacific Community College so then they have two segment. One segment is you write in—was it writing and speaking but then the listening part where they send you to the lab. That's when I start using the microphone, listening to the computer.
>
> Pretty much they have the program and you start or stop or pause but you don't really use a lot of hands-on with the computer 'cuz they set everything up for you. That was my first encounter into computers. Eventually after that fall I was—in the spring they go quarter—and I start taking the typing course. [Laughter.]
>
> Sher: When did you get your first personal computer in the home?
>
> Nikky: Oh. [Laughter.] I still remember the name. It was the Packard Bell, I think, and that was in '98. Pretty much just

> for homework because, like I said, I would start working full time and go to school full time and I spent—I remember after work and everything else, I spend hour after hour at the computer lab just to finish. [...]I was type really slow, so I spent so much time writing and then type it in. It just takes way too much of my time, so I said, "Okay, I will get the computer." I do this all at home.

Nikky explained that as she began working at ESL courses, she was required to utilize computer-based instructional programs primarily for listening, speaking, and recording course assignments. This was her first encounter with computing technologies. She also explained how, at first, the instructional technologies were set up for student use during class, but that as she progressed through the courses, she was required to access the technology outside of class time in computer labs and had to learn about how to use a computer. She indicated in this and in later discussions that as she progressed through coursework as well as on-the-job training at a silicon chip manufacturing plant, her day-to-day familiarity with computing technologies increased. Along with a rise in income and the increasing affordability of home PCs, Nikky obtained the means and the motivation to purchase a computer for home use.

Biafra and Nikky illustrate some important similarities and differences experienced while learning about computers. Both women are primarily self-taught, with some basic skills such as typing courses as precursors to learning more about computing technologies. Both women also began learning more about computing through technology use required in their respective jobs. However, there are some important differences to consider. Biafra, as a Caucasian, U.S.-born, middle-class woman with several advanced degrees (MBA and MIM), had a lot of different opportunities to engage with computing in a way Nikky was not able to experience in her educational pathways. Biafra was able to benefit from the opportunities to take computing and programming courses in her university and also benefitted from early computer programs run through companies like DELL that offered student discounts on computing hardware for university and college students. Nikky, while able to obtain a personal computer later on, had to delay her purchase of her own hardware as she was unable to take advantage of these assistance programs through her community college. Nikky faced the further obstacle of being a non-native English speaker and found that the technology, while helpful for completing ESL and typing assignments, took a lot more time and effort for her to master than other students. While she became proficient in typing in her native language, Vietnamese, she still struggled with speed and efficiency while typing in English.

Applications of Early Technology Use in Career/Workplace Contexts

Another theme that emerged from the experiences of the women in this study was the role workplaces played in providing them with opportunities to engage in computing technologies. More than half of the women reported having significant experiences with computer-related technologies in the workplace.

Nikky's experiences as a recent immigrant to the United States in the late 1980s and early 1990s working as an operator in a silicon chip manufacturing plant in the Pacific Northwest provides some interesting context for understanding how initial workplace experiences led to later, more advanced uses of computing technologies. As she advanced through the company, she was afforded opportunities to engage with computing technologies at more complex levels:

> Nikky: The reason I want to get a job there at first is because I know they pay for school, and I always known that I want it. I want to have at least a four-year degree college. [...] I am not a big fans of computer and science and that, I'm just not. But I know that it pay for school so I go there. So I start there, and I thought after the two year, I moving on with something else, but then within that time, --it's ironic, since I hate science and all of that technology-- but I'm so damn good at it so I keep moving up!
>
> I wanna learn, so I ask a lot of questions, and I always question all the engineers and all the scientists. They are the ones that create a program and make all of these recipes to manufacture the chips and troubleshooting tests and so I was probably one of the few operators that always ask them questions, like, "Why do we do this? How do you do this?" and, "What are you trying to prove or do?" Stuff like that. They saw that curiosity in me and ambition. [...] They just kind of take me under their wings...so eventually I got promotion. [...]
>
> Sher: So when you were asking all these questions, for the most part, were the engineers and programmers receptive to you?
>
> Nikky: Well some people at first...were just like, "Whoa, what, you want my job?" Also, most of them are guys. [...] But then eventually, they kinda know you're okay, because the thing is that if you have a good operator, the technician and the production technician, they have to do less work. [...] You just kind of have to prove it to for them that you can do it, so then they kinda start telling you all this trick and secret and all of this. [...]

Nikky explained how she moved from an operator, loading blank silicon material into reactors to create chips for computers and other electronics, to engineering technician. She was recognized for her productivity on the factory floor, but was also able to move up due to connections she made with the engineers and scientists designing programs to create new chips. Although she explained that she was never really a fan of science and technology more generally, she began to learn more about the company and how the chips were manufactured due to her curiosity about the processes that went into making the silicon chips. Although she faced some initial resistance to her curiosity, her performance coupled with her co-workers seeing her as a more "temporary" fixture due to her desire to attend school for a four-year degree, made them more comfortable engaging with her and less likely to see her as a direct threat to their own job security. Nikky was mentored actively while working at the company and developed important relationships with her supervisors. These provided her with opportunities to further her education and develop interests in computing technologies, science, and engineering. She was able to put some of this knowledge to work in other contexts as she moved up through the company.

Later on, however, she explained how this initial culture of mentorship began to change. Moving to the research and development arm of the company, Nikky's expertise gained on the job began to be questioned by a new White male supervisor who had more formal education in the field. Navigating the company's changing environment became challenging as it became more hostile. This experience is discussed more in depth in Chapter 5.

Biafra's experiences with technology became much more involved during her time as a K-5 educator in a small, southwestern charter school. While she had used various kinds of technologies for work as a manager of a healthcare company as well as for her earlier work in journalism, it was not until she began teaching that she was able to learn about it in a new context that was vastly different from her college programming courses. Keeping some of these early negative experiences in mind, Biafra was very motivated to ensure that her students would not be as bored, discouraged, or intimidated by technology as she had been when she first encountered it:

> Biafra: I taught fourth grade, and I taught fifth grade. I loved those, and I would have gladly stayed in those. [...] I ended up working at Sunset Peak School. By that time, I had my K-8 certification. My kid went in to third grade there. [...] When I started to work at Sunset Peak, I was a sub for the PE gal the first year because she went on maternity leave. You know teaching PE, although I'm an active, fit person was new, so I did a lot of Internet stuff on that. A lot of curriculum planning. Then, from there, I went into second grade. Loved it, but was doing a lot of different things, which again went more along the gifted line. I experimented with programs like Zooly and others that encourage lateral thinking and some things that were more into what I had done with a lot of my management and marketing background, and healthcare background. Brainstorming with the kids, and showing them how to take notes. You know, graphic notes and things like that, that were quote unquote non-traditional.

But it pissed off the principal because, well I've shown her. [Chuckles.] Actually, what it amounted to, I was showing up the other teacher. I was team teaching with Sunshine Smith who's the most incredible woman–amazing first and second grade teacher in the world! I love her to death, still see her now. She let me do whatever I wanted to do, and she could appreciate that. The other second grade teacher was an extraordinarily jealous and petty woman, and she was constantly complaining about, "She's doing this and the parents really like it, and I'm not doing that." And I was like, "I'll share with you. I'll show you what I'm doing. Take what you want. I don't care."

So the principal came down, and said, you know, "Thou shall not be different." I said, "Well that's kind of insane." Then I taught fifth grade. Loved that dearly, but at that point, the computer teacher decided that he–they had made him a computer teacher, although his degree was in history, and didn't really understand computers. They made him assistant administrator.... Unfortunately they asked him who knew how to use computers on staff, and my name came up. Oh, I was so pissed at him! I was so to the point where I'm going, "Damn you," you know I was just livid because it was like, "You jerk! I loved fifth grade!" Fifth grade is the bomb. So I ended up being told that I was now teaching tech. I said, "You know what? That's like Dante's Inferno to me." That's like the lowest level. I said, "If I do this, then I get to do whatever I want." As long as I exceed state standards, which were not difficult to exceed by the way. Still aren't difficult to exceed–

Sher: What are some of the state standards?

Biafra: The state standards then were "Explain a floppy disc." [...]They were old, old, old, horrendous! So I used the international standards of technology education. This was probably about 2005. I taught tech for four years. I spent that summer designing a curriculum that I would be happy to teach, and so I learned a lot. We did Excel, Power Point, and all that kind of stuff, but we also did robotics. We also did game programming. Funny thing is, I saw all this software going to waste that we [the school] were paying for. I thought, "This is the most insane thing I've ever seen." Mavis Beacon was crashing all the time, so I went, "Why are we doing this? The cloud is right there." There's lots of free stuff. So I found a number of, in fact they're still using a

> number of the programs I had found for them, Master Key Typing was one –I couldn't use it with the young kids so I started to use it with the fourth on up. Trying it with the third graders put them into tears, so I use Dance Mat Typing, which is a British one. Dance Mat is so much fun! You have dancing giraffes and hippos, but it's all structured. It was awesome! I found a whole bunch of free stuff, and so I designed it. You know, talking about curriculum mapping. Okay kindergarten, I'm going to start working on shapes. Kid Picks is great except Kid Picks is a paid program, so let's use Chuck's Paint. Let's use Power Point and start using the shape tool. They don't need to type, but we can use the, you know getting them used to the whole opening screen.

Biafra displayed an incredible amount of initiative and asserted her need for creativity and freedom to design technology curricula. She began teaching in part, to be closer to her children who were school aged at the time. By teaching in the school, she was also able to leverage opportunities for curricula for gifted and talented students offered by this particular charter school for her children. As a mother of children attending the school, she was particularly invested in the educational experience being offered. She enjoyed opportunities to design curricula for a wide range of subjects, drawing on her considerable initiative, skills, and creativity to design interesting and innovative class experiences. When she was selected as a candidate for teaching technology courses (despite her desire to continue teaching her fifth graders and her dislike of the existing technology curriculum), she applied her initiative and asserted herself in order to teach the class the way she wished to teach it. Drawing from her early, somewhat dismal typing and programming experiences, she was determined to avoid these same mistakes in her own courses.

Similarly to Nikky's experiences however, her positive experiences on the job teaching technology in a K-8 context were marred by having to navigate an increasingly hostile environment at the school. Some of this was directed at her by female co-workers; however the majority of this negative interaction came from her male supervisors and, in particular, the principal at her school. He continually questioned her methods of teaching and the content of her curricula due to her lack of formal credentials, despite the fact that her students were surpassing state standards for technology education and the overwhelmingly positive feedback she received from students and parents alike. Her experiences navigating this environment and hidden curricula structuring expectations of technology education are explored further in Chapter 5.

Joey provides another example that demonstrates how some of the women in the study pursued their own pathways in early experiences with technology education. Her case was particularly interesting in that she had initially started out pursuing an associate's degree in computer technology with an emphasis on network administration. However, as she began to encounter people working in the field, she soon changed her mind about the direction she wanted to go:

> Joey: I decided not to continue my computer-related field as far as my bachelor's. I love working on computers, but I want to continue loving working on computers. I think that if I pursued it as a career, I would probably end up hating it. I like having it more as a hobby or as a side job.

> Sher: What was it that sort of turned you off to the idea of pursuing further education?

Joey: People in those fields. Just meeting and working with those people, I don't think I've ever met someone who truly loves their computer-related job. I think in general they are underappreciated, underpaid. I just don't wanna be that person. I need to be in a job where I feel that I make a difference, where I feel that I'm useful. I cannot have just a job because there's a paycheck at the end of the week. I cannot do that. I need to have the variety, I think. A lot of those jobs are the same thing every day. I cannot do that either. I need to be a little creative. I actually did get a little bit into the Photoshopping and the Flash and doing that stuff. That allows me to be creative and do those types of things. I love being able to do those types of things. I did decide that was something that I liked to do on the side as a part-time, temping.

Sher: You found like sort of the business side of things and communications to be more interesting?

Joey: Yes. I actually took a couple communications classes just because I had to, and I loved being able to—just the analytical portion of being able to sit there, "Oh, that's why. Oh, that makes sense. I should really take that into consideration." I'm very blunt. I'm very transparent. What you see, this is me. I know that most people don't appreciate that. I think it helped. It actually has helped me in my job a lot. We work with public housing. The majority of those people are considered a vulnerable community, so I cannot always be as transparent and as blunt as I am in every day. It's helped me at work.

Joey initially wanted to go into a computing field, but as she encountered people working in various contexts, she became discouraged by what she perceived as the lack of connection and meaning in the work itself. She saw many of their experiences as repetitive, underappreciated, and generally unpleasant. Several times during the interview, Joey expressed the importance of having meaningful work, opportunities to be creative with work, and most importantly, opportunities to make a difference in her community through the work she did.

Her identity as a Latina and a mother were also an important part of what influenced her pathway towards working with technology in the context of public housing. She recognized the need for the low-income housing residents they served to gain experience working with computing technologies in order to assist them with things like job searching, professional networking, and increasing their level of communications both in professional and personal contexts. It was this desire that led her to use her computing degree to help manage and develop technology curricula for public housing residents (most of whom were primarily older, Latina women with limited English skills) that would increase their level of familiarity with technology while being contextualized through tasks and projects that were meaningful to them. Further exploration of the ways she drew on her later online educational experiences to develop curricula for the public housing residents are addressed in the following chapter.

Conclusion

This chapter focused on the early experiences of women engaging with computing technologies, exploring common themes that emerged. These stories varied in terms of context, particularly when considering time period, location, and the types of computing technologies widely available (or not) at the time. However, similarities emerged in terms of the ways women engaged with technology during these early encounters as well as in the quality of those interactions. Tinkering and open-ended, self-guided exploration were incredibly important for developing initial interests in computing. Family relationships also played an important part in developing initial interests, although these same relationships also became sources of tension at later periods when some of the women were making school and career decisions. Schools, while the primary sites where women first encountered technologies, often failed to excite or inspire technology use for the women in the study. Often these experiences influenced women to forgo further computing training until later contexts were able to re-ignite initial curiosity and interests these women had. Workplaces also emerged as some of the first sites for computing use, providing some of the most directly contextualized and applied uses of computing technologies for many of the women. However, it was the opportunity, space, and means to explore computing on their own terms, through hobbies and tinkering that made the most impact on women in the study. As a result of many of these experiences, some of the women went on to engage with computing technologies by pursing further education, in some cases, starting their own computer-related businesses or careers.

These early experiences and themes are an important set of findings to explore. However, they only paint half the picture of how women's educational pathways take shape. Once they have navigated these early experiences and have made the decision to pursue computing at later stages through further school and career opportunities, new challenges, patterns of usage and engagement emerge that are important to explore. The following chapter unpacks the role of hidden curricula in both contexts.

Chapter 5

FINDINGS: THE HIDDEN CURRICULA IN CULTURES OF COMPUTING

The previous chapter explored themes that emerged in women's early experiences with computing and other kinds of technologies. As the literature on the digital divide would suggest, early technology use had a definite influence on the motivations women developed for pursing later computing education. However, all of the women interviewed for this study ultimately made the decision to pursue computing in some form. Women's experiences navigating pathways through computing education and career contexts are the subject of this chapter. Expanding on these early experiences with technology, a new question emerged from the data: having decided to pursue technology education, how did women's previous experiences shape later relationships they had with computing?

The critical framework of hidden curriculum facilitates unpacking the ways in which an institutional culture operates to create different experiences for people in the same context depending on how closely their identity categories, behaviors, and performances align with underlying expectations. Because hidden curricula are not necessarily overt, intentional, or static in all cases, identifying how they operate and change remains challenging. However, despite this difficulty, scholars have developed some creative and innovative ways to explore how hidden curricula operate in a variety of contexts (Margolis, 2001). To this end, this chapter largely analyzes moments of disruption that occurred when interactions violated or challenged unspoken or unarticulated norms.

Analysis of the interviews conducted during this study revealed several major themes emerged when exploring women's experiences in the institutional cultures of computing programs. First, that computer science and computer-related post-secondary programs still remain primarily masculine cultures. Furthermore, computer science and computer-related programs remain primarily racist cultures. Next, women's experiences in these programs also indicated that computing programs reward primarily individual efforts. A hierarchy of fields in STEM, in which abstract technical knowledge is perceived as being more prestigious than applied computing fields, also impacted women's experiences in computing programs and workplace contexts. And finally, many computing programs tended to privilege traditional college students in ways that often resulted in the isolation women of color who identified themselves as returning students. This chapter will examine each of these themes in detail.

Computing as a Primarily Masculine Culture

In their experiences, these women commonly came to the conclusion that computing was still a primarily masculine culture. Regardless of context (school, workplace, informal settings, etc.), this feeling would manifest in a host of ways, from more subtle tensions to more overt regulations of behavior. Joey discussed how this played out during her day-to-day interactions at work, particularly when she was starting out as an IT professional.

> Joey: I use 'Joey' just at work and…people assume.
>
> Sher: People assume that you're a guy?
>
> Joey: Just the whole meeting face-to-face or actually speaking with me over the phone, I totally just get a kick out of, "Oh, you're Joey." "Yeah, that's right."
>
> Sher: You hear the surprise sometimes.
>
> Joey: Oh, definitely. […] They won't say anything, but just the reaction of, "That's you. Oh, okay." I kid with my husband about it. I don't know if it's, "Oh, you're a female," or "Oh, you're Hispanic." I don't know what the "Oh" is or if it's just everything. I just get a kick out of it.

Joey explained that she purposely used her nickname as opposed to her full name because of the ambiguity it caused for people. She explained that in this and other contexts, she experienced surprise from clients and supervisors alike when she worked on IT issues for various companies. The assumption behind the surprise, as she explained it, seemed to stem from an expectation about who can and cannot be an IT professional. This is an example of how a disruption of unspoken norms, revealed an assumption that IT professionals are usually White males. That is, while Joey never experienced any instances in work contexts that specifically forbade women from performing IT work, the assumption that this work was the domain of men only was exposed as clients and employers registered surprise in meeting or speaking with her for the first time.

Joey consciously chose to employ a gender-neutral nickname as a way to challenge expectations of the people she met. She explained that other people's reactions amused her. This amusement stemmed from the fact that she was confident in her abilities and had been trained the same as any men who had gone through her program, but was automatically subject to further scrutiny about her abilities because of her gender in a way that men in her class were not. In one respect, this can be seen as an assertion of an individual actor's agency in the face of larger, structural forces in the institutional settings. Rather than accepting a lack of space for her in the field, Joey challenged expectations about the identity of IT professionals. Furthermore, her deliberate use of a gender-neutral nickname assured her entry into certain job contexts through the assumption clients had that she was male. This forced clients to deal with her competency as an IT professional first.

However, while seeing her choice of nickname in this way can help explore the structure-agency debate within the scholarship on hidden curricula, the situation was more complicated. In the interview, Joey explained that she "wanted my work to speak for me, not my gender or race." That is, she also chose her nickname to initially disguise her gender and Hispanic background (her last name is Mexican in origin) until her expertise had already been recognized. She enjoyed challenging the narrow conceptualizations others had about her abilities. By first relating to others as Joey, she forced them to confront her identity as a Hispanic woman in a context where she was selected to do the work without the biases that could have influenced client and employer's decisions to choose her for specific jobs.

Joey's inability to separate interrelated, fundamental aspects of her identity was characteristic of other women's experiences in computing. How they navigated these various aspects of identity differed quite a bit depending on the context in which the women found themselves. As Wendy Hulko (2009) argued, various factors that make up women's individual identities (race, ethnicity, socio-economic class, gender, sexuality, dis/ability, religious affiliation, to name only a few) have more or less of an impact on women's experiences in different times and places, depending on the context.

Tina provides an important example of the salience of the context-dependent nature of identity categories. Having earned a bachelor's degree in computer science in India, Tina's experiences provide an interesting comparison to those of women who studied in the United States. While women have been conspicuously absent in computer science programs in the United States for decades, despite concerted attempts to attract, retain, and support women entering the field (Cahoon, and Aspray, 2006; Singh et al., 2007), other countries such as India made significant gains in recruiting and retaining women in their computer science programs (Klawe, Whitney, & Simard, 2009). Tina graduated from a computer science program in a heavily math and science-oriented university that was comprised primarily of women. She estimated that in her computer science classes, close to 80% of the students enrolled were women. However, despite the fact that the majority of her peers were women, Tina found that there were many aspects of her program that reinforced a specifically masculine culture that, in many cases, was overtly hostile towards women:

> Tina: There is a kind of competition between female students and male students. Female students, they constantly have to prove themselves, prove they are as intelligent as the male students. So I think that's one thing that keeps driving them to perform better and work harder. I don't see that here in the U.S. as much.
>
> Sher: There was still that competition even though there were fewer men in the program?
>
> Tina: Yeah, there was because even the instructors, they were a little biased, I guess. I wouldn't say biased, but yeah, there's this misconception that females are not really intelligent, as much as the men. A little bit, not much.
>
> Sher: So the male instructors, you felt like you had to prove yourself to them?
>
> Tina: Yeah. They were not direct, but there were one or two comments made like, the professor was like "Oh, this is not a girl's job" stuff like that or "You are girls, you don't know how to fix a computer." Something, if it broke, or if we had to open up a computer, or CPU, they would always call on a boy in the class to do it. I mean, they wouldn't say anything directly, like “I'm not going to call on a girl to do it,” but it's just obvious. They won't ask a girl to come and open it up.

Tina explained the majority of the prestigious colleges and universities in India place their focus on STEM fields, with emphasis on engineering, medicine, and computer science. In turn, these course offerings shaped educational choices made by students as they entered these institutions. However, even though men and women appear to be equally encouraged to enter computing and other STEM-related fields, there are still gender and cultural expectations that shape a student's experiences in Tina's program. Although women made up the majority of students in her computer science courses, all of Tina's instructors and professors were male.

Women were notably absent from positions of authority in the computer science program. Tina explained that the only women instructors she interacted with were in chemistry or biochemistry. Larger cultural expectations in her particular context in India appeared to shape ideas about women's abilities as expressed in the behaviors of her instructors. The professors, while never overtly saying or voicing a belief that women were not as capable as men when doing certain kinds of computing work, reinforced these ideas by exclusively calling on male students to participate in any kind of manual work involving computers. It appears that gender divisions regarding expectations around manual labor being the exclusive domain of men, were reinforced in subtle ways through these types of classroom interactions, indicating a type of hidden curricula operating within her program. Regardless of the fact that the presence of women had increased in the program, this was not enough to counteract power dynamics that privileged male identity in Tina's undergraduate program. She explained the differences between her experiences in her undergraduate program in India and her graduate program in the U.S.:

Tina: Here, the interactions between male and female students is a lot better than is there. Like there, I never talked to my male classmates. Like, if we were required to work in groups or do group work, then yes, I'd talk to them. But otherwise, no. It was a different atmosphere. I have more male friends here than in back in India. There, there were some incidents that were not so good. That creates bias in my mind. Men looked down at us there. One funny thing in India I remembered about the class: the class arrangement, there was a front row where all the girls sit and the back row with all the guys. It was never really told to us to do that, but people would walk in and all the girls would take the front row and the guys would be in the back. They would never talk to one another in the classes.

Sher: What about after classes, would you hang out or socialize?

Tina: Not much. No, we had like class get-togethers, that time we did interact, but on a daily basis, no. I don't know about other classes, but in my class, the guys were a little chauvinistic. They would say things that should not be said in social setting. They would say rude, sometimes cheap things. Mostly, directed at the girls. Some people would not find it so obscene or offensive. Catcalls, that kind of thing. I don't find that class of jokes or comments really respectable. They would get really nasty. I don't really mind things like people calling girls "chicks," that's normal, but sometimes it gets really nasty. It's more degrading.

Sher: Would there ever be instructors around when that happened?

Tina: No. Nobody would go and tell the instructor. It was all between the students. The girls won't really react. The norm there is to ignore. No one ever confronts them. It's mostly staring and rude comments. Some people might react, but mostly, 80% of the girls would not. They just ignore, it kind of becomes normal. [...] The worst thing is that you can't really do anything about it. Like, you would have to go through a lot of levels to fight it, and you wouldn't find a lot of support. It's sad, but some of my friends, they had bad experiences, and their parents told them to forget about it. They said, "Yeah, it does happen, you have to live with it."

Tina's experiences demonstrate the impacts of day-to-day micro-interactions on women's experiences in her program as they are influenced by larger norms governing behavior between men and women. Hidden curricula informed instructors and authority figures' behavior to reinforce ideas that women were inferior to men in terms of their abilities with computing. Furthermore, physical separation between the sexes reinforced the idea that men and women should not interact as well. While this segregation between men and women in their physical arrangements during classes as well as in social settings appeared to be self-imposed, Tina provides some important context behind why this occurs. As part of a larger cultural context where men's catcalling and verbal sexual harassment of women were commonplace, these sorts of interactions made the women in the program uncomfortable. However, the normalcy of this behavior within the larger cultural context made it something that was tolerated by the women in the program. Furthermore, lack of policing of this sort of interaction, lack of institutional sanctions, and lack of support for victims of sexual harassment made it highly unlikely that women who were victims of harassment, and in the case of some of her classmates, outright sexual violence, would feel empowered to seek out any support or take perpetrators to court. Several U.S. scholars have argued that increasing the presence of women in computer science programs would lessen and perhaps even make gender disparities insignificant (Cahoon & Aspray, 2006). However, Tina's experiences in her program demonstrate how simply increasing numbers of women enrolled in a program may not be enough to change an institutional culture. This may be especially the case in a culture that privileges male identity, assumes inherent differences in abilities between men and women, and exists within a larger cultural context that privileges masculine identity, and sanctions public harassment and violence towards women. Simply diversifying the student population without similar changes being made to the diversification of professors and administrators does not change the hierarchy or culture.

The differences in gender distribution experienced by Tina are directly contrasted with experiences of women studying in the U.S.. Anu, a student at Greater Western University (GWU), reported that out of her computer science classes of several hundred students, only a handful were women. Computer science is an area in the STEM disciplines that has come under particular scrutiny concerning the persistent gender gap. Due to this scrutiny, many programs have been compelled to combat the negative images of their programs in order to increase the retention of students more generally, in addition to increasing the enrollment and retention of women and students of color. However, Anu's experiences provide important context for understanding how these efforts, however well-intentioned, can be undermined by resistance from the larger entrenched masculine culture in computer science programs. In the interview, Anu said:

> There are two lecturers who are part of the freshman retention initiative. Both are female, one is Iranian and the other is Japanese. And they're great. They're lovely women, very friendly to everyone. But as soon as you get past their classes, it's terrible! Like they retain you as a freshman, but after that, they don't even try! It's like a token freshman retention program. […] And I think they have to do that because the first year CS program is also required for math, engineering, and other STEM disciplines have to take the first year of CS courses for their degree. So they don't really benefit from having scary people in the first year. They have this attitude like, "Now that the rest of the university doesn't have to look at us anymore, we can drop the act."

Anu explained that these positive experiences helped to retain her in computer science initially. She was excited that the courses seemed like they would continue being interesting, with approachable and invested instructors who were eager and enthusiastic about teaching the subject matter. However, as Anu progressed through the program, she noticed that the majority of her instructors were male and primarily from either East or South Asian countries. Furthermore, the majority of these professors seemed to view teaching as a chore that detracted from their research efforts, and often were unprepared, un-invested in the course materials, and dealt with the students in a manner that displayed contempt for their confusion about the subject matter. Many students began to drop out of the department because of this, finding that the initial expectations that were set up by the two lecturers (who were some of the only women of color in the program) were not at all characteristic of the environment in later courses. Anu explained:

> I've had lecturers as opposed to TAs and professors. I prefer the lecturers. Their lectures were really professional, they'd done this a lot of times before, they knew exactly what they wanted to talk

> about that day. They knew the questions students would have, before they even asked. They were very prepared, very tailored to the audience. They seem very knowledgeable and approachable. I visited them for office hours and they were really helpful and nice.
>
> I think the other professors in the third year of the program, sometimes they use slides from other professors they haven't even read before until they get to the class that day. East Asians. Indian, South Asian professors on a whole are terrible! They're not very nice. It's nothing but lecture, lecture, lecture, and if you don't get it, tough. Even if you go to office hours, they're not very helpful. They just tell you to look in the book. They explain it in such a way that it makes sense to them, and they don't know how to explain it in any other way. They teach like they're still in India. They're very authoritarian and strict. They go off on tangents. The task in class isn't related to the material we read in the book. What is going on here?! All the students fail the test, so they just curve it really hard, instead of just trying to teach the material better.... Some say "come to my office hours." Some say, "If you don't know the answer to that question, you shouldn't be in this class." [...]
>
> It's like, the people who are in the field feel like they've passed some sort of gauntlet that allows them to look down on anyone who is not on their level. Like they're in some sort of elite club.

The contrasts between the teaching of her two first year lecturers and the full professors who she encountered in her more advanced courses were demonstrated by a mismatch between the overt, stated curricula delivered at during her freshman computer science courses and the hidden curricula she encountered that highlighted a culture that emphasized male identity. Within this sort of an environment, Anu detected hostility towards her presence in the program by both male instructors and male peers:

> It was never overt or anything like that. [...]When I interacted with male instructors, particularly the South Asian ones, they would give me kind of a disapproving look. Just kind of annoyed to even have to talk to me. [...] And then the sort of self-righteous male computer science students (the vocal minority), who think I don't know anything? They're frustrating. [...]Like when they split up the work for the group projects, they'd make me do the paperwork. [...] I think it has to do with a lack of interaction with women in general.

> They're all engineering, math, and science majors. There's preconceived notions that women don't really belong there.

Anu expressed that retention efforts were not the result of a genuine concern about persistent gender and racial disparities in enrollments within the department, but rather a desire to put on a good face for the rest of the university and to increase freshman retention levels. Furthermore, the later approaches to teaching she encountered in the upper-division courses by the majority male full professors contradicted earlier expectations set up by the lecturers that instructors would be available, accessible, and enthusiastic about teaching their areas of expertise. On the contrary, she found that her interactions with the professors during her third and final year in the program were cold, aloof, and in some cases, downright hostile. Not only were her interactions with professors negative, but her interactions with the what she termed the "vocal minority" –male peers who dominated the little class discussion that was present as well as appointing themselves leaders in group work contexts— were also negative, with these peers delegating more menial tasks, such as preparing paperwork for projects to the women in their class groups. Anu also related experiences where any attempts she made to try and get to know other students in the computer science department were rebuffed or ignored, particularly by the male students.

This culture of hostility Anu encountered appears to have been a sanctioned part of the hidden curriculum that emphasized notions about women not belonging in computer science. Within the classroom and department, Anu encountered a rather chilly climate, which spilled over into extra-curricular activities. Interestingly, this experience happened in the extra curricular student organization called Supporting Women in CS at her university, ostensibly formed as a support for women in computer science. She explained:

> I tried to join the student organization for supporting women in computer science. I went to the first few meetings and just felt really annoyed. There were very few women in the group, of the women that were there, most of them were grad students. Almost all of the officers in the organization were men. The students in computer science just aren't very friendly. I just didn't feel welcome there.

Studies have advocated the need for support systems such as peer groups, mentors, and role models for women and students of color pursing computer science (Margolis & Fisher, 2002; Singh et al., 2007), and extra-curricular support groups and programs. However, there exist few larger scale studies that have examined qualitative experiences in these types of programs. Anu's experiences attempting to join the group provide an interesting context for understanding how hidden curricula can operate even in the less formally regulated spaces of extra-curricular groups. Women's right to be present in the classroom is routinely questioned within the larger culture of the computer science program through daily interactions which relegate their experiences to the sidelines. Through the combination of these interactions, the lack of presence of other women in the program and extra-curricular clubs, the chilly climate, and overt hostility, the message that computer science is not a place for women was clearly telegraphed.

The experiences of both Stella and Xena provide some interesting context for further exploring the presence of masculine culture in shaping women's experiences in computer science. Both women studied engineering and computer-related STEM fields in Iran during their formative years and for their undergraduate and Master's educations. In Iran at the time, segregation of women and men in public settings was commonplace, particularly in K-12 contexts where girls and boys attended single-sex institutions. While both men and women attended public state universities, the social segregation of men and women was still strictly enforced. However, Stella and Xena explained that the segregation of men and women in their university educations affected them very differently.

Stella explained that segregation of the sexes was not so much of a problem for her during her undergraduate degree as she preferred the experience of interacting primarily with other women. Stella first pursued her undergraduate degree in Electrical Engineering and then her Master's degree in Control Automation and Communication Systems. She explained how she and the other women in the program became close during her bachelor's program:

> In my bachelor's degree, we were eight girls and 120 boys. In my bachelor's degree, I had friends, but in master degree— I was the only girl. [...] The girls in the bachelor's degree program, we were very close. We became very good friends. All of them, almost, I would say all of them moved out of

> country… after a Bachelor Degree. They went to different countries.

Segregation of the sexes did not initially appear to pose a problem for Stella since her small cohort of female colleagues banded together. However, this segregation became more difficult while further pursuing the study of computing in her field of engineering since fewer women did so at higher levels. As a result, she found herself much more isolated. She was unable to draw from the social support she had when she began her bachelor's degree program. However, due to the close bonds she had formed with her female classmates during her undergraduate work, she kept in touch with many of these friends, explaining that even years after they had finished school, they remained close.

Xena's experience was similar to Stella's during her bachelor's degree program in that she had a lot of female friends from whom to draw support. Like Stella, she also reported becoming close to the women in her bachelor's degree program, remaining in contact with several women in her study group for decades after she finished her degree. However, it was when she began working at a research center at one of the universities in Iran that she began to experience more isolation and, in some cases, hostility around her. Part of her isolation stemmed from the cultural context as well as the fact that she was the first woman to be hired by the research center:

> Xena: I found a job in a very special place. It was a research center inside a university. […] I was the only female to enter that

place. Before me, nobody— I mean there's no female. No female could survive.

Sher: Why was it so hard for females to survive over there?

Xena: It was a kind of closed environment there. It's a different culture. You know what I mean? In my culture, especially after the revolution, they just separate men and women everywhere that they could. It was that kind of mentality. They couldn't accept women easily and women who go there to do research. They couldn't survive that closed environment, but I went there. I liked the job. I liked the work they did, and I thought that I should survive here and I should open the environment for other females. I did. [...]

In Iran, I had a problem for the first six months. It was hard for them to accept me even though I was kind of conservative and tried to be open and friendly. I tried to figure out how I should deal with them to survive that environment, but I feel like for the first six months was really hard for me. Then, after I just get used to it and they get used to me, then it just went down.

I tried my best. Sometimes, I complained from the VP to my director. Sometimes, when I complained from the director to VP, anybody just said something to me, to keep me quiet. I tried to fix it. Sometimes, I tried complaining to the other people. Sometimes, I tried just being silent. I try to find my way and how to be there because I really enjoyed it. All the people were really smart, and they were doing like awesome jobs. I didn't want to leave there. In that place, even though it was a little hard for me there, I loved what I did. Like for six months, I didn't ask for money because I thought that I'm having fun and then they're going to pay me. Wow. That was my feeling. I didn't care much about that kind of difficulty. I thought that after a while they gonna know me. Then, they're gonna respect me. Then, they did.

Navigating an almost exclusively male environment for Xena was particularly difficult after interacting primarily with women during most of her undergraduate career in her Electrical Engineering program.

During the first six months at the research center, Xena explained that her presence caused problems as her male colleagues tried to adjust. Being aware of her status as the first woman ever selected as a candidate for the research center position, she was very sensitive to the need to fit in with the norms of the center and to be perceived as “normal,” even if this meant downplaying parts of her identity and emphasizing others. For example, she explained that one way she did this was by adopting a more conservative form of dress so as not to draw attention to her gender and to invoke a more formal expression of the dominant religious affiliation in the workplace. By focusing more on outward appearance and conservative dress in accordance with religious traditions, she attempted to convey to her male peers that she shared something in common with them. She explained that this strategy was a way for her to avoid attention being drawn towards her identity as a female and therefore, away from her work, which she felt was a more important and valuable measure of her abilities. By trying to adopt the norms of the workplace culture and by showing her colleagues that she was able to produce work at a similar level to them, irrespective of her gender, she hoped this would increase the presence of and provide a more welcoming environment for women in the research center.

However, this was not enough. Xena also engaged in a number of different strategies in order to try to make connections with her colleagues. Employing a number of tactics—from registering complaints with other staff or ignoring behaviors to trying to adopt a more gender-neutral identity—Xena attempted to try to deal with the chilly climate she encountered in the research center. Unfortunately, initially, most of these attempts were often ignored.

Ultimately, she credited her ability to withstand the treatment she received during the first six months working to more fundamental characteristics she possessed. Xena said:

> Maybe it's like my personality that I don't see men and female. I see everybody like human beings. I don't care who is man, who is woman. In Iran, in that culture, I could survive that environment because I didn't care that I'm woman. I see everybody as a colleague. I don't care who is man, who is woman.

Xena asserted that it was a result of being unconcerned with gender, not drawing attention to her gender and inherent differences, and her love of the field which allowed her to be successful where no woman had before. Interestingly but perhaps not surprisingly, this practice of not drawing attention to gender, or actively attempting to downplay the importance of gender, was a main coping strategies employed by many of the older women in the study. This directly aligns with previous research findings concerning coping strategies relying on assimilation to existing cultural practices (Etzkowtiz et al., 1994). Hidden curriculum can also be helpful for understanding this tendency to adopt a strategy of assimilation to dominant institutional cultural norms and expectations that may not be directly vocalized or overtly stated.

The presence of women in computing post-secondary education experiences was, for the most part, a source of support for many of the women who participated in the study. However, there were some indications that interactions with other women in highly gender-imbalanced fields like computer science and math were not always positive or supportive. In fact, several women indicated that they felt an incredibly high degree of competition and hostility directed at them from male peers but also from other female peers. Anu explained the differences she experienced interacting with women in the math department versus women in the computer science department.

> Anu: So I mentioned a little bit, the whole "one of the boys," thing. I think that's also a problem with women in computer science. They have a superiority complex that says, "Look, I'm doing computer science, I'm better than those bimbos who are in biology." Look at how special I am.
>
> Sher: So they buy into the hierarchy of sciences?
>
> Anu: Or like the hierarchy of any particular STEM discipline that has very large gender divides. So CS would be at the top of that list. EEE, CS, and math. There's a pretty large gender divide in math, but it's not hostile. That's the difference. The 'One of the Guys' club thing is inherently based on competition between women. Like, "I'm better than women, because I'm in this boys club." And that whole, "I think I'm better than other women." The flip side of that is that you think women are bad, that men are better! That's sexism!
>
> Sher: Do you think part of identifying with men, or male identity, is about trying to get privileges?
>
> Anu: But even then you're not afforded those privileges! It's almost like…what's it called? Stockholm syndrome. Where they're identifying with the captors.

Anu's experience points to a disturbing cost incurred for women who do not choose to assimilate to the larger masculine cultures of computing programs. Anu explained that she was effectively isolated in CS from other women, who seemed to feel that her presence (and the presence of other women in the program) attracted attention to their gender. This was not desirable for them, particularly because of the ways in which they tried to downplay their gender differences by assimilating to more masculine identities or engaging in hostile talk and behavior directed at other women in order to fit in with the men in the program. The hostile behavior and interactions with female peers in the computer science program contrasted heavily with the experiences of positive peer interaction, friendships, and support Anu gave to and received from other women in the math department.

Computing as a Primarily Racist Culture

Race and ethnicity were also factors that deeply affected women's experiences while pursing computing education at post-secondary levels. Most of the women interviewed reported that there was an absence of historically underrepresented populations such as African Americans, Latina/os and Native Americans in their programs. While computer science programs are increasingly representative of international students from the Indian subcontinent and East Asian countries, these students do not share the same experience as other minority groups who are located within the United States context. In part, this disparity in experiences appears to be attributable to culture and location differences as well and the trend of international students choosing to returning to their countries of origin once they finish their educations at U.S. institutions.

Disturbingly, several women in the study reported hearing statements denigrating Black, Latino/a and Native American students from White, U.S.-born as well as Indian and East Asian international student peers in their programs. This sort of speech, in some cases, began even before formal enrollments in computer science programs. Anu's story provides one of the most visceral examples of how racist speech occurred. Anu related her experiences in a program, known as Mountain Engineering Camp, which was offered over the course of several weekends at a state park campground. Graduating high school seniors with an interest in STEM fields were invited to attend one of several weekend sessions to engage in activities, meet other incoming students from the state, and interact with staff, faculty, and current students enrolled in the program. Although it was created as a way to increase interest in freshman enrollment in STEM fields at GWU, Anu found the experience incredibly negative. She explained how casually racist statements were made by other program participants. Moreover, the lack of intervention by program staff made Anu incredibly uncomfortable:

Anu: It turns out a lot of engineers are just terrible people. It was weird but a lot of them are really racist. There were no Black people at the camp. There were a lot of Black jokes made. A lot of them are sexist but—we already knew that. They were just all around bad people, and it just left a really bad taste in my mouth regarding the entire School. [...]

I honestly don't know why it happened. I think it may have been—it might be something to do with a lot of engineers are introverted. They don't interact with people from other demographics, so they may have a skewed view of what other people are like. They would just say these jokes and, no matter what, someone would laugh. No one would say, “By the way, that's racist.” It made me feel uncomfortable.

Sher: Would any of the mentors or counselors ever intervene or say anything?

Anu: No. It wasn't just my experience either. I was talking to a few other friends who had gone other weekends and I was like, “Did you have the same experience? Were your engineers racist?” My friend Tim, he's Mexican, and he’s like, “Yeah, they're really racist.” I've never experienced that level of racism in my classes or—with my experience with engineers outside of MEC Camp, but at MEC Camp it was terrible.

Anu and her friends were disturbed by the casual frequency with which other incoming engineering students –who were mostly White, East Asian, or South Asian males— made racist or sexist jokes. Furthermore, the fact that camp staff and engineering school faculty were within earshot of these jokes and statements and said nothing to counteract them or reprimand students for this sort of behavior made Anu and other students of color attending the camp extremely wary of bringing up any complaints about the behavior. Later in the interview, Anu explained that she was appalled by this behavior but felt helpless to do anything about the situation for fear of being verbally attacked by peers or perhaps faculty and staff who seemed to condone this sort of behavior and speech due to their lack of intervention. Given the extreme discomfort these statements caused Anu, the later instances of hostility she experienced in the program from peers and instructors, and her subsequent decision to drop out of her double major computer science track to stay in mathematics, it is perhaps not such a stretch to imagine that incoming students of color faced with a similar set of circumstances may be discouraged enough not to persist in the program or avoid enrolling altogether.

Hidden curricula can provide an important framework for analysis of experiences such as those related by Anu in MEC Camp. As expressed in the invitations students received, the initial purpose of the camp was to encourage young people interested in STEM fields to get to know one another, to build community within incoming cohorts, and to have an opportunity to engage in a fun weekend about engineering and science topics with one another as well as the faculty in the various STEM departments. However, the on-the-ground experience, the delivered curricula, significantly differed from the overt curricula advertised in the initial invitation. Anu explained:

> I went to camp and I was trying to talk to other CS majors. I couldn't find any girls, so I had to talk to the guys, and they just didn't wanna talk to me. I'd ask them a question, and they'd answer yes or no, and then they'd turn away to talk to the other guys. It was very frustrating. It was before college started, and I was trying to make friends. [...]

Anu explained that during the weekend, most of the experiences were team-building exercises that had nothing to do with science, technology, computing, or engineering. Furthermore, comments made by camp staff and faculty and overheard by Anu seemed to indicate an underlying goal of getting students outdoors away from their computers. Faculty and staff members seemed to be operating on the assumption that STEM students lacked exposure to outdoor activities and thought this would be an appropriate forum to encourage more social cohesion.

Anu explained how the camp organizers seemed to have a fundamental misunderstanding of their potential students, explaining that she and other students interested in engineering were not necessarily interested in outdoor activities or camping in the first place. She said:

> They just don't understand the demographic. Why would we want to go camping? For most engineering majors, we don't wanna go outside. It's as simple as that. You don't wanna be outside. Why be in these forced weird social situations? There was no Wi-Fi.
>
> It was a weekend with people and no computers. [...] They were talking about the stuff they did, but they couldn't actually do any of it. I think what they were intending was, "Let's get them away from their computers and maybe they'll interact with each other."

As Anu pointed out, a camp with no Wi-Fi capabilities held very little interest for a group of high school graduates interested in games and computers.

Another mismatch in overt and delivered curricular experiences for students seemed to occur during the few opportunities for interaction with STEM faculty at the camp. Anu reported that during the weekend, interactions with GWU Engineering School faculty occurred very rarely. Instead, prospective students mostly spoke with upper-division undergraduate students who were acting as camp staff. Furthermore, the interactions with faculty during the formal dinner setting afforded students with very little opportunity to engage with their future instructors in a meaningful way. Anu explained that the experience was "weird" and awkward for most of the students. Along with her friends who attended the camp, she got the impression that the faculty would rather not have been there. The camp advertised opportunities for incoming undergraduates to get to know faculty in a less formal setting, and thus helped create an initial expectation that faculty would be accessible to incoming students during their program for mentorship opportunities. However, in practice, the experience in the camp itself seemed to reinforce the larger culture of the programs at the school, one that prioritized research endeavors as opposed to teaching, and collaboration with and mentorship of undergraduate students by faculty directly.

The women interviewed noted the conspicuous lack of certain racial and ethnic groups in face-to-face computer-related programs. In addition to their programs being almost exclusively made up of male students, they also noticed a conspicuous lack of Black, Latina/o, or Native American students. White and international students from East and South Asian countries made up the majority of the rest of the students in their programs. Anu's experience exemplified this trend. She said:

> There's one Black guy in my CS classes. He's in my year, and he's the only one. [...] It definitely is cultural. I don't know if it's because computing is a relatively new field? I don't know if it will change in the future, or if it will be a bastion of male superiority forever. I never see Black students, never see native students. There are a few, very few Latino students. It's White, Indian, and Eastern Asian. And Indian and Asian segments are mostly foreign as well.

Anu's experience was shared by other participants who attended U.S. institutions.

To explain why this might be the case, several of these women related that they had heard comments and jokes made by faculty, professors, instructors and peers that seemed to indicate assumptions about Black, and Latina/o students' abilities in STEM fields. Alice related experiences where she overheard instructors trying to explain that there were differences in math and science abilities of Black and Latina/o students as compared to White and Asian students. In another example, as an instructor, Flo explained that part of the reason there were so few "American Blacks" (a term she used to refer to Black and African-American, U.S.-born students) in computer science was due to the lack of math and science foundations they received in school. She argued that, as a result, "Black Americans, they have no interest in technology." She also went on to suggest that the international Asian students came to the computer science program with a much more solid foundation for math and science than Black American students. Experiences such as those related by Alice and Flo expose how pervasive the culture of racism can be in computer science. That the negative attitudes about Black and other underrepresented populations' abilities became adopted by women of color like Flo reveals how hostility in these contexts is perpetuated.

Computing as a Primarily Individualistic Culture

For all of the women interviewed for this study, whether in online or face-to-face contexts, computing programs were places where individual achievements and accomplishments were praised and highlighted. Flo explained that certain traits–the ability to work independently, to concentrate on one's own for extended periods of time, and to have strong self-discipline—were all important parts of succeeding in computer science. However, almost all of the women in the study explained that the most enjoyable and rewarding aspects of their computing education were opportunities to make connections with peers, instructors, and co-workers in the process of learning more about their respective fields. By Flo's own admission, her main pedagogical approach as a computer science instructor emphasized group activities and collaboration. Despite asserting the importance of individual traits, in her classroom, Flo employed mechanisms such as teacher encouragement, peer team building, and providing opportunities for informal interactions to foster connections among her students.

While some programs did offer opportunities to collaborate with peers, the experiences women had in these contexts were dictated by the larger department culture and norms concerning working together. As a dual math and computer science major, Anu provided one of the more drastic contrasts between different department cultures and their approaches to teaching. She explained how the emphasis on peer group collaboration and instructor interaction in the math department was preferable to emphasis on individual work in the computer science department. She said:

> Math students seemed a lot friendlier. They were more willing to work on their people skills at all. In the math program, the

> professors encourage you to work in groups and the homework. But in CS it's very, "Don't plagiarize, don't work together, ever, ever, you have to turn in your own work. Don't talk to each other." It's like they have this attitude that if you ever talk to one another ever, it will show up in your work that you plagiarized. In the math department, we were actually required to work in groups on homework. There were a few weirdos who really didn't like working in groups, but for the most part, everyone realized that this is necessary in order to properly understand the materials.

Anu explained that part of what she enjoyed the most about her math department curricula was the opportunity to work with other students on solving problems and learning concepts. At first, there was some resistance to the practice of group work, and although there were a few people who simply disliked group activities, the majority of the students she worked with in the math department came to realize the importance of group collaboration in order to succeed. In contrast, her computer science program did not emphasize group activities, and through the repeated emphasis on the problems of plagiarism, seemed to actively discourage even informal interaction with classmates.

Women in this study reported that a higher degree of individualistic focus appeared to result in hostile interactions among peers in their programs. Programs that emphasized competition among students in the form of practices like bell curve grading or discouraging students from working together were more likely to create a hostile or chilly environment. Interestingly, programs that had scholarships, fellowships, grants, and other financial support intended to retain and support underrepresented populations of students such as women and students of color were often perceived as the most hostile environments. Anu and Alice expressed that competition among the women in their respective programs was often very intense. Alice believed that the competition she perceived during her undergraduate program stemmed from the department's emphasis on individual effort and that competition for scholarships, grants, and fellowships were the main reason behind why the women in the program were not close to one another. While Alice noted that the interactions were never overtly hostile, Anu's experiences suggested that women's interactions in her program were highly strained because they saw other women as direct competition they had to defeat in order to gain financial support for school.

To be clear, the data do not suggest that the existence of this type of scholarships and fellowships in computing programs cause tension or hostility among women in the programs in and of themselves. In contrast, women such as Flo, Tina, Xena, and Stella all reported that financial assistance such as scholarships and fellowships based on merit and identity category membership were an incredibly important part of how they were able to attend school in the first place. However, these women had been educated in programs that did not have a culture that encouraged overt emphasis on individual effort alone. While financial support and incentives are much needed, they are not a panacea. Instead, they serve to emphasize the underlying problems within the institutional cultures of these programs.

Computing as Privileging Abstract over Applied Knowledge

Women's experiences of computing programs were often more focused on the abstract, less applied understandings about computing, particularly in face-to-face traditional four-year programs. Women who earned more applied degrees such as associates degrees or certification programs in online courses (as did Joey and Riley), found that their programs were much more focused on immediately applicable knowledge they could go out and use in their working lives. These women were not attracted to more abstract theoretical aspects of computing fields. In contrast, women with strong mathematics foundations such as Anu, Tina, Xena, Stella, Alice, and Flo found more abstract areas such as theory to be one of the more interesting parts of their programs. Tina, Xena, Stella, and Flo also expressed that their face-to-face programs required them to work on applications of the theoretical materials for class projects and during internship activities. However, Anu's experiences contrasted with those reported by Tina, Xena, Stella, and Flo. Anu explained that her computer science program was too broad, focusing on everything anyone might want to do with computers. She explained that other CS programs focused on separate streams of CS curricula, specifically information technology, software engineering, and computer science. She explained:

> CS can be application or just the theoretical and math-based. That's the sort of area where Artificial Intelligence is, cryptography, language development, and computation theory, complexity theory, determining the sorts of problems that computers can solve.

Anu and her classmates felt that the program, while trying to offer everything to everyone, short-changed the students in terms of providing a strong foundation in a more specific area of the computer science discipline. As a result, Anu felt that the major under-prepared her for either a more research-focused, theoretical CS graduate program or a more applied information technology or software development career. She explained, "You get a broad swatch of everything, but no preparation to actually qualify to do anything."

While this separation between the more abstract and more applied aspects of computing and computer science programs tend to break down somewhat by institution and degree type (e.g. associates and online programs attended by women tended to be more applied than face-to-face four year bachelor's degree programs), most programs emphasized both approaches to a greater or lesser degree. However, the more theoretical, abstract, and technical aspects of computing tended to be perceived as more prestigious by the students and given more priority by faculty and instructors in computing programs women attended. This was particularly prominent in contexts where the gender divide in the program was most pronounced. Women in the programs themselves often adopted this social hierarchy of various types of computing disciplines. Anu, Tina, Xena and Stella explained that this hierarchy tended to establish a pecking order in their programs where students enrolled in programs that were more technical and abstract tended to get more respect from peers and faculty than students who were enrolled in what were considered "softer" majors. Interestingly, the women noted that these "softer" majors were fields where there was less of a gender disparity. For example, Anu, Tina, and Xena all related stories about women being more likely to be found in medical and biology-related fields than in theoretical and abstract fields like electrical engineering, computer science, higher level mathematics, and physics. As women who were enrolled in these more abstract programs, Anu, Tina, and Xena all expressed a sense of pride that they were some of the few women who chose to continue in these fields. While many of the women in these types of programs adopted the hierarchy, they did not do so uncritically. Flo, for example, explained that the hierarchies surrounding more technical STEM programs and computing fields were slowly fading as more women entered these professions and as technology became more ubiquitous in all fields.

In addition to academic settings, this hierarchy of STEM and computing fields was also seen operating in workplace settings. During her experiences as a K-6 teacher at a charter school in a large, southwestern metropolitan area, Biafra ran up against these notions of computing social hierarchies. They emerged when she and the principal of the school began to disagree on her approaches to teaching computing classes. As explored in the previous chapter, Biafra felt incredibly frustrated with her early computing experiences and wished to ensure that her children and the students she taught would have a more favorable, contextualized introduction to computing knowledge. She worked diligently to design creative technology curricula building from foundational knowledge to advanced skills. By starting in kindergarten with age-appropriate internet safety concepts, learning how to build simple machines with Lego blocks, and beginning typing games and activities, Biafra laid a foundation for her students that taught the technical skills needed to operate a computer proficiently at later grade levels. Each grade level would build upon these foundational skills and add more complex concepts and activities to get the kids used to programming. For example, Biafra had moved from simple typing and programming drills to building complex, programmable robots and machines out of Lego with her third, fourth and fifth grade kids. The students were required to build the machines and then program them using a computer to run through a maze by calculating distances, speed, and trajectories to hit targets. They were then required to input data from their robot's performance into an excel sheet to run basic calculations in order to learn fundamentals of using database software. The final stage of the curriculum involved creating learning artifacts in the form of video and photo journals, blogs, as well as written and oral reports to share findings with the other students in the class.

The feedback from parents and students alike on the new curricula Biafra designed was incredibly positive. Furthermore, the standardized testing scores of her students improved drastically in the science and technology portions of the test. However, despite these gains and positive feedback, Biafra ran into a high degree of resistance from her principal and from a handful of parents who were engineers who felt that this emphasis on more applied aspects of technology education was insufficient. Part of this resistance stemmed from their distrust of Biafra in that she was self-taught rather than formally trained in computing. Interestingly, Biafra explained that these same complaints were not made about her male colleague who had taught the course before, who was also not a computing expert and was also self-taught. Much of the tension was felt from her principal, who constantly questioned her methods and approach to teaching despite the positive gains she had made in the classroom:

> What people don't understand about tech, particularly my later principal, was that tech transcends the curriculum. But it still needs to be actually taught. Because you cannot expect a K-6 classroom teacher to, number one, understand all there is about tech, and secondly, to be proficient enough that they can then, thirdly, teach it. I had to put in a lot of time learning these things myself. [...]
>
> They were so upset when I left, and I still kept running into parents who would say, "Oh we miss you!" [...] Here's the kicker. The principal thought we were just playing Legos. He didn't see the relevance, and so he and I butted heads a ton because he would say, "Well why are you racing balloon cars?" I said, "Well number one, like I said before, I'm covering all these international standards number one. Number two, the kids are actually engaged." I said, "Have you ever walked through to see what we're doing?" We're taking pictures of it. We're posting the stuff online. We're writing digital stories. He goes, "Well why couldn't they do that in the classroom?" I said, "I don't know. Why can't they?" He said, "Maybe [chuckles] you know this is a special ed thing" – now mind you, I have no training in computers. I withdrew from my one programming class in college. But I was completely self-taught, through books, the Internet, information I found on my own, and experimentation. I taught myself robotics and then I went to the ASU two-week camp.

Most of the parents were fabulous, but I did have, there's this engineer, there were a few of engineer parents who thought that learning the beginning programming language Scratch was a waste of time because it was learning objects. They wanted me to do service-oriented programming. But Game Maker and Scratch, if you go online, if you go to Nickelodian.com or even Cartoon Network, there are a ton of wonderful game design engines now. Batman games and things like that.

That's all still programming. The kids have to think of the parameters. They have to plan ahead. They have to story board it out. That's wonderful stuff. But these parents are going, "They're playing." Well yeah!

Sher: How do you get them interested though? Really, do you think some kid is going to want to sit down in front of like a Java or C++ book, and learn like that? Really?

Biafra: Yeah, that's what those few engineering parents and the principal wanted. They couldn't get it. That's not what engineering and programming is now, that's not how to teach it. They don't do that anymore. But here I am, an informally trained "non-computer" person, but I've done the research. I truly probably know more about the technology curriculums than most people in the state.

Biafra's interactions with the principal demonstrated hidden curricula at work. Her methods and approaches teaching K-6 children technology and computing literacy were questioned as not being technical or abstract enough. Familiar with computing fields and to some extent invested in the larger social hierarchy of STEM disciplines, the principal and some parents privileged more abstract over applied knowledge, and so were unhappy about what they perceived as a curriculum that was not rigorous enough to prepare their students for computing careers. This was in spite of evidence that Biafra's approach led to gains in student achievement scores on standardized state tests as well as retention rates for students in a program that previously had suffered from negative reviews.

Biafra's lack of formal computing training was also seen as a deficiency in her qualifications to teach the subject. However, the principal and parents failed to acknowledge the skills and expertise Biafra had as a classroom teacher. While dismissing her teaching methods as "just playing Legos," Biafra was drawing from literature which has shown that traditional drill and practice, emphasis on rote learning of programming languages, and lack of contextualization and collaboration are not the most effective ways to teach computing concepts (Margolis and Fisher, 2001). Instead, as suggested by the literature, she designed tiered levels of introductory computing knowledge, used paired and group programming exercises, and focused on contextualization of knowledge to line up with student interests. As the literature predicted, she found this method to be more effective for retaining students and engaging them with the field. Discounting informal knowledge and learning and the importance of teaching the skills students require to operate computers effectively created a source of tension between Biafra and her principal that led to her eventual decision to leave the K-6 teaching position for other opportunities.

Computing as Privileging Traditional Students

Experiences in the computing programs women attended tended to be geared towards serving more traditional-aged college and university students. These students are assumed to be between the ages of 18 and 22, single, without family or elder care responsibilities, and working, at most, part-time jobs. Class schedules and support services such as peer tutoring and office hours, tended to operate primarily Monday to Friday between the hours of 8 AM and 5 PM, and were located almost exclusively on the central campuses of most institutions women attended. The hidden curriculum can be seen operating in the design of when and where services were offered. While these services were convenient for traditional university students, for women like Alice, Riley, and Joey, who represented non-traditional students, access was much more difficult. Due to child and elder care responsibilities, concurrent full time employment status and financial concerns that would not allow them to attend school full time, these women reported having difficulties accessing the same support services.

Alice's experiences help to illustrate how the process of obtaining both formal academic support from instructors and less formal support from peers was challenging for her. Alice was working on her bachelor's degree in computer science, first at a large, prestigious northeastern university. However, she experienced financial difficulties and had to quit her studies to work for several years. When she was able to return to school, she supplemented her education with classes at a local community college before going back again to finish at the larger university. She recalled feeling very disconnected from faculty and students alike at the larger university and found that peer interaction was minimal due to students' self-segregation according to both gender and race. Compounded with her status as a full time working woman attending school part time, this made her experience getting through the program particularly challenging. Taking the initiative to seek out online sources of learning support, Alice, who identifies herself as a Caribbean woman of Black and Indian heritage, managed to navigate through her program:

> Alice: So I went to both Middle County Community College for an associate's degree, then Big Northeastern Metro University for the bachelor's in computer science. At BNEMU, it was mostly classes in a big lecture hall. [...] I mean there really wasn't much help. It's kind of like well when you get stuck on a programming assignment, you'd ask questions, but. [...] You were pretty much on your own, or you ask other students. You pair up with students who are really good in that stuff.
>
> Sher: Was that a pretty typical kind of a thing? Would the students tend to get together and study quite a bit?
>
> Alice: Yes and no because it came to —well, the guys were pretty much by themselves— guys with guys. There weren't any women in the classes. Being in an ethnic background like me, you kinda —you were pretty much on your own unless there were other people within your same ethnic background in that class. Then, you guys can kind of team up.
>
> Sher: There really wasn't a whole lot of interaction between the men and the women, or between different ethnic groups?
>
> Alice: No. I think it was that, but also the fact that I was an older student. I graduated in 2001. I had a late start in life with my degrees. When I initially graduated, I started out—I did Big Northeastern Metro University for one year when I graduated out of high school, but then, I had to drop out for financial reasons. I had to go back to work fulltime, and then I came back. [...]

> I really started computing there at Middle County College. Middle County, their classes were—I find a little better than BNEMU. Classes were smaller and you had more interaction with the professors. [...] They'd have lecture, and then they'd have time for you to do your assignments. Then, if you were stuck, you'd call the professor. "I'm stuck. Is this the right way?" Stuff like that. I think it was a better experience. For a computer science major, I think personal attention is key. Like I said, besides, if you don't have the professor helping besides other students helping you. Sometimes, they're on the wrong path, too. If they get a wrong answer, you're gonna get it wrong. The Internet is a good way to learn stuff, too, because right now, when I'm doing programming, if I'm stuck I go on the Internet. I find my own answers.

Alice's experiences with her peers and student self-segregation by gender or race were not uncommon experiences for women in U.S. computing programs. While there was no overt encouragement of this kind of segregation by faculty or staff, the hidden curricula that reinforced gender, racial, and ethnic self-segregation of students, particularly in primarily White institutions, often led to isolation experienced by women of color. This happened in part because of gender imbalances. Women like Alice, Stella, Xena, and Anu, who, as one of the few, and in some cases, the only women in their respective programs, were isolated from men in their programs. This was further compounded by a lack of other students of color as well, including men of color who were not international students. There were high numbers of White men as well as international male students from South and East Asian countries. However, the international students did not readily relate to U.S. minority students. Additionally, attempts to try to make connections with White and South and East Asian male students were often uncomfortable and chilly for many of the women in the study. For women like Alice, Joey, and Riley who were non-traditional students, they had an added age difference to contend with.

Many of these difficulties were largely counteracted by changes in pedagogical approaches. When Alice returned to computing in the community college context, she felt much more connected to the faculty in the program because they designed courses to provide more hands-on support and individual attention. Women like Alice, Riley, and Joey all related that their primary sources of support were other professionals and their instructors as opposed to peer interactions. These experiences led them to choose a different venue for their later technology education: exclusively online programs, a topic which will be explored further in the following chapter.

This chapter explored experiences women had navigating their computing programs in various contexts. Through their stories, it was revealed that computing remains largely masculine, racist, individualistic, and privileges abstract knowledge and traditional students. While these larger themes about institutional cultures and how they affect women's paths are important to explore, these findings provide insights into only a part of their experiences. The next chapter explores the various strategies women used to navigate barriers and hidden curricula they encountered while in their respective computing programs and career experiences.

Chapter 6

FINDINGS: STRATEGIES FOR NAVIGATING COMPUTING CULTULRES

The previous chapters explored themes that emerged when examining women's experiences with computing cultures. Their experiences showed that many computing departments were still primarily masculine and racist cultures, which emphasized abstract over applied knowledge, rewarded primarily individual effort and privileged traditional students over returning and non-traditional students. While these findings are important, identifying persistent barriers and challenges only reveals a portion of the story of these women's pathways through computing education.

In different ways, the women in this study encountered and navigated the hidden curricula in their various contexts. Revisiting some of the themes identified in chapters four and five, this chapter explores the strategies women used to address barriers and challenges they faced in their computing education and careers. When they encountered barriers, women in this study did not employ a single strategy, but often combined a number of approaches depending on a given context. One strategy was to internalize the dominant culture of computing programs and workplace contexts. Another major strategy employed by women, particularly those returning to computing disciplines after a career change, was choosing to pursue computing education in online contexts. Seeking out other sources of support via social networks or online resources was another strategy adopted by women in order to navigate challenging environments. Finally, another strategy that emerged in women's experiences was that of forging their own path, and defining their own conceptualizations of computing knowledge expertise and skill.

Internalizing Cultures of Computing

One of the most common strategies employed by women to navigate the chilly and sometimes overtly hostile climates in computing was internalizing the expectations set out by the existing culture. Xena and Flo, in particular, offered some interesting insights into this practice.

As discussed previously, Xena's experiences at the university research center exemplified this approach of internalizing the larger institutional culture. Although she reported feeling isolated and she was subject to hostile treatment from her male colleagues, Xena chose to try and navigate these situations the best she could without being too disruptive to the existing culture. Xena reported struggling during her first six months at the center, but believed that if she simply persevered despite the treatment she experienced, she would eventually be accepted. As the first woman at the center, she hoped that she could prove to the research team that she was just as capable of doing the work as the men. If she was successful, she believed that, eventually, other women would be encouraged to apply and would be hired. She imagined this would help foster a friendlier climate at the center. After the first six months, when it was clear that Xena would not quit, her experiences at the research center began to improve. She began to get very involved with the research and became a more integral part of the team. She happily related that when she left the center, they began hiring more women and eventually, women made up close to 40% of the new researchers at the center.

Internalizing the culture of the research center was a conscious decision Xena made in order to deal with being the first woman to work there. Without adopting some of the cultural norms, creating a sense of shared identity, and in some ways, downplaying other aspects of her identity, she felt that she would have been subject to even more harsh or unwelcoming treatment than she had been. For Xena, it was important for her to establish a connection with her colleagues based on her work and research interests, deflecting attention from her gender.

In complex ways, Flo illustrates the consequences of internalizing dominant cultures. Throughout the interview, she seemed to be reluctant to discuss the roles of race, class, gender, sexuality, and other identity categories in shaping students' experiences in computing programs. When asked what factors might be influencing the current gender and racial disparities in computing, Flo reiterated differences between the educational systems in the Caribbean and the United States. She explained that a lack of strong math and science preparation in middle and high school in the U.S. were at the root of why students, particularly minority and Black students, did not have the desire or skills needed to enter computing fields. She also explained how the focus on standardized testing robbed students of the opportunity to develop the critical thinking and writing skills needed for computing disciplines in order to keep pace with the rapid changes in technology.

Lauding the colonial British system in which she was schooled, Flo was only interested in bringing up systematic differences between education in the U.S. and the Caribbean. As a result, her critique of the U.S. educational system ignored the disparities that persist within it. As someone deeply invested in her field, she did not take the additional step of wondering why it was only particular students who were failed by the system.

A study by Henry Etzkowitz, Carol Kemelgor, Michael Neuschatz, and Brain Uzzi (1994) explore this phenomenon of adopting an assimilation strategy to deal with hostile cultures in STEM fields, particularly in the hard sciences and engineering programs at the post-secondary level. This strategy of attempting to internalize various aspects of computing cultures appeared to have provided some of the women in the sample, like Xena and Flo, with the means to survive within contexts that were overtly hostile towards women. This strategy of assimilation may be effective for those who are able and willing to subjugate certain aspects of their identities (such as gender, race, ethnicity, familial status, etc.) and draw focus more towards their work and research. However, this strategy entails an important cost: having to suppress, minimize, or in some cases, to outright deny aspects of their identities that may be important to them. During their interviews, both Xena and Flo related that, despite the difficulties, they felt their perseverance and commitment to their fields helped pave the way for other women and students of color.

However, younger women in the study entering computing did not experience similar success when attempting to internalize dominant computing cultures. Anu provides a counterpoint to Flo and Xena's assertions that developing strong math and science foundations are the most important factors for encouraging women and students of color to persist in fields like computing. Anu had these foundations. However, they were not sufficient to justify the decision to continue in the computing field in the face of chilly and hostile treatment she received from professors and peers alike in the computer science department. She explained her decision to ultimately drop out of her computer science program and continue on as a math major only:

> I felt a lot more comfortable in the math department than CS. People talk to me. I talk to people in my classes. People talk to other students in their classes! Professors in math make jokes, and they are engaged in their lectures, and they seem like they actually like what they are doing. In CS, it's more like, "I'm here to do research and they're making me teach." [...]
>
> In CS, even if I saw the same faces, they weren't friendly. In my math classes, if I say, "Hey, I've had you in one of my classes before." Then we make small talk, and I find out their name and where they're from. But if I were to do that in CS, say, "Hey, I've had a class with you before." They'd say, "Yeah." And that's it. And they'd turn away. [Laughter.] It's really awkward!
>
> I think Computer Science is fascinating, but I just don't want to work with those people.

It was not a matter of Anu being unable to handle the work in the computer science department. In fact, her deeper understanding of mathematics often led her to be able to handle course material with more ease than other students. Rather, the lack of social connections, the experiences of hostility and chilliness whenever she attempted to interact with peers and faculty, and the constant questioning of her abilities and, in some cases, her right to even be present in the department, were all factors that combined to influence her decision to drop the computer science major.

While many of Anu's negative interactions occurred in the computer science department, she also related informal social situations that compounded these experiences. While having to navigate a hostile climate in a professional setting posed significant challenges, having to navigate similar hostility in a less formal, social context demanded significant time and energy as well. This sort of interactions provided additional insight into the struggles Anu had internalizing the dominant culture of computing and accepting the standards by which she was continually measured by male peers. Even more frustrating was watching male peers in her social circle escape the scrutiny she was constantly subjected to. She related a particular incident that occurred with a male colleague when she first began socializing with a new group of friends in computing, engineering and math disciplines. She said:

> He went to an all-boys Catholic school. University was his first experience interacting with women on a daily basis. He's much

> better now, but before. [...] You had to prove yourself to him before he could accept you as a person. He one-ups people all the time. It's really funny. Probably, a couple weeks after I first met him, we were talking about something, and he was bragging. I had said maybe five words to him at this point. And I just got fed up, and I went off. I listed all the things I'd done, all my accomplishments, my high school GPA, all the colleges I got accepted to, and all this stuff because he was going on and on about himself. And then at the end, I said, "By the way. I'm 16. Now shut the fuck up!" He did not expect that at all. He thought he was such hot shit. It was really disappointing in some ways because I had to do that several times, with several different people in that group of friends, just to be accepted as part of that group.
>
> It's like I had to be qualified! But there were so many other people in the group who weren't "qualified" the way I was, and it didn't matter, because it was assumed they were okay because they were guys. It's exhausting having to deal with this crap in your social circle as well as in school. It's like you have to constantly be on the defensive.

Anu related the feeling that she constantly had to defend her right to be present and to interact with the group. She also had to be vigilant about protecting the social space she carved out for herself in these contexts. For Anu, internalizing the larger culture of her CS program would have meant giving up parts of her identity (being female, being a feminist, a woman of color, etc.) that she was not willing to compromise.

The strategy of internalizing existing cultures of computing programs was employed by almost all of the women interviewed for this study during at least a portion of their computing programs and/or career experiences. However, the degree to which each of these women succeeded in internalizing the cultures of their respective computing programs and career contexts depended on wide variety of factors. Time period, geographic location, the presence of alternate systems of social support, as well as women's own comfort levels and confidence with suppressing or subverting aspects of their identities, were all factors that influenced how women employed this strategy. However, the degree to which this succeeded depended greatly on factors beyond their control, primarily the degree of hostility they experienced in a given environment, and the degree to which their identity categories (primarily their gender, race, and ethnicity) were noticeable in a given context. This led some women to utilize strategies that would alleviate or altogether remove some of these barriers experienced in primarily face-to-face contexts.

Online Education as a Support Strategy for Non-Traditional Students

All of the women interviewed for this study had engaged in some form of face-to-face instruction in computing at some point during their post-secondary educational experiences. However, it is important to notice that almost half of the women in this study chose to pursue computing programs at exclusively online institutions later in their lives, particularly as they returned to computing disciplines from other fields. This tendency aligns with other findings in the literature (Jesse, 2006) that suggest online programs may be serving non-traditional students in computing more effectively than face-to-face programs, resulting in higher rates of retention and graduation for traditionally underrepresented populations of students. In the interviews, various themes emerged which suggest why this might be the case.

Riley, Alice, and Joey all chose to pursue degrees in their fields in exclusively online programs. They explained that online courses provided smaller class sizes, flexible schedules that would accommodate their full time work and family care responsibilities, and increased the quality of their interactions with instructors. Furthermore, while attempting to alleviate negative aspects of their earlier experiences in face-to-face programs was not explicitly cited as the major reason they chose online education, from the enthusiasm in their voices as they spoke about these programs, it was clear that their experiences were more positive online. When asked if they experienced similar hostility or negative interactions in online programs based on their various identity categories, each of these women explained that they had not. They explained that the online context provided a certain degree of anonymity that deemphasized characteristics like gender, race, and ethnicity in a way that was impossible in face-to-face contexts.

Riley provided a compelling case for why she felt that online education was more hospitable for her. To do so, she compared it to her experience attending a large state university for accounting during the late 1970s. She explained that as a woman entering what was a particularly male-dominated field at the time, she experienced overt hostility from peers and instructors alike while completing her bachelor's degree. She reflected:

> I think that early on, while I wouldn't readily admit it, as a younger woman, I think that I bought into the, "You can't do it because

> you're female." Even though I would go ahead and do it anyway, it was more, for the lack of a better term, it was more closeted, because I would do these things. I would gain knowledge. I went to business school at a time that women didn't go into Business College. [...] I felt as if I had to work so much harder. I really had the feeling that I had to be—everything I did had to be exemplary. It had to be above and beyond, and I think that's pretty well carried through the majority of my life in just about every endeavor. I don't know...it's been something I've had to struggle with. I don't find it as difficult now. I don't feel like I have this much to prove now, but I definitely felt that I wasn't taken seriously as a young woman. [...]
>
> There were many instances of, "Are you here to find a husband?" I would hear things like this. "You can't seriously tell me that you expect to be hired as an accountant." I would apply for jobs, and they would suggest that I would make a fine filing clerk. [...]
>
> From the time my daughter was a year old, I was a single mother. I had to pretty well claw for just about everything that I did, and was paid a whole lot less, and given fewer opportunities than my male colleagues. Yeah. It's hard for that not to factor into your identity and your feelings of self-worth. "Maybe they're right," but I knew in my heart they were wrong. I've never been a game player. Never could play the politics that were involved with that. It's really ugly, and distasteful, and I can't stand it. [...]
>
> It amazes me, because I see so many more opportunities now, and so much fewer instances. I mean, you see misogyny now and you know what it is. Back then, it was so commonplace. It's not that you would take it knowingly, but it was so commonplace that often you didn't realize that you were being discriminated against.

Riley had to deal with being a woman in a male-dominated field during her bachelor's degree program in accounting during the late 1970s. This powerful set of experiences, while at times made her doubt her own abilities, deeply impacted her view of face-to-face education.

Riley voiced a tension almost all of the other women in the study brought up: to justify their presence in male-dominated programs, women of color had to be exemplary in everything they did. Having to work harder than her male peers in addition to being subjected to hostile comments made about her motivations for being in the program (e.g. to "find a husband," or "make a good filing clerk," etc.) wore on Riley's sense of self-worth and confidence. This treatment was a reflection of a department culture produced from larger social norms at the time that made overt misogyny a common occurrence. This culture had repercussions for her beyond just school. Riley was not paid as much as male colleague and was offered fewer opportunities for advancement in a number of fields she worked in (accounting, then later physical therapy). She reflected on how the commonplace nature of misogyny in the larger culture at the time often compounded feelings of inadequacy and self-doubt as she internalized overt hostility.

As explained in the previous chapters, Riley moved towards computing after a car accident left her with significant recovery time which she spent teaching herself how to use the PC. As she moved beyond doing simple web design work for friends and family, she began to consider obtaining more formal education and training in order to further hone her skills. She explained how she weighed her options for computing programs in web design:

> I have to try to stay ahead, as far as new techniques, new technology. That's very important to what I do. We're moving into a new HTML version, as we speak. I am working towards certification in HTML5.
>
> I researched several ways to go about it. Certainly going to an institution, like a college, or junior colleges or university-level, there are classes available. For my personal needs, I need to be able to study when I can. Online courses offer what I need in that area. I researched several programs, and have used several different courses that are available or worked with eCourses available

> through a variety of companies. [...] Actually, you can receive that training through the local junior colleges here. [...] I prefer the online courses for the convenience of it. [...]
>
> I did consider face-to-face courses, but when weighing the time that would be necessary to actually attend classes, it just wasn't working for me. I was working full time while doing this training, plus doing the web development on the side all while taking these courses.

Online courses offered Riley more opportunities for keeping up with the rapid pace of change in web design technologies and standards, something she felt was essential for keeping current in her business. She explained that online programs often offered newer, more up-to-date content more quickly than did face-to-face programs she had researched.

In addition to a warmer environment, Riley, Alice, and Joey all reported other positive experiences in online contexts that had been missing during their experiences in face-to-face programs. For these women, the most important aspect of taking courses online was the convenience of doing so while working full time, particularly during the process of changing career trajectories. Taking courses online offered them a chance to minimize loss of income that would be incurred by returning to school full time, an option unavailable to many of them because of family care responsibilities. By catering to students unable to meet a traditional, Monday-to-Friday daytime schedule, these online programs attracted a more diverse range of students, which, in turn, worked to create new computing cultures that were more respectful of difference.

Women's experiences interacting with instructors were one aspect of this. Riley, Alice, and Joey all saw a major improvement in the quality of their interactions with instructors in online contexts. The online format allowed the women to concentrate more on asking questions and engaging with the instructors of their courses about work, techniques, and approaches to class assignments and problems in a way that they were not as free to do in face-to-face contexts. On the whole, Joey reported that her interactions with professors were much more in-depth and personalized than she had experienced in face-to-face lectures. She and other women in the study valued the emphasis on more interpersonal interaction with the instructor.

Another way this changed how the dominant culture of computing manifested was in increased opportunities for meaningful interaction with and feedback from peers. Riley explained:

> I have been absolutely amazed at the process online. It's impressive to me to not only be learning hands-on, but to have interaction with instructors, as well as other students—you know, feedback.
>
> For example, in one class that I took with regard to cascading style sheets (CSS), we would be given an assignment which we of course would complete and post online. This would be looked at for content and so on by not only the instructor, but by other students. Each would provide feedback…it was designed to be able to help others. If you did a great job, this is why it was great. If you did a great job, but maybe there were areas where you could improve—you would learn new techniques. That sort of thing, or maybe an easier way to get the job done.
>
> Somebody would try something, and maybe someone would say, "Oh, this is an interesting way to do it, but here's an easier way." […] It was more focused on technique, in that particular class, but certainly design factors into it because CSS is about style. It's about elegant code. […] I would say the most useful, to me, was their ability to offer constructive criticism.
>
> In that context, it would be, "I see where you're going with this. What you have done perhaps is not completely wrong, but let me offer you a different way to look at solving this situation."

Though Alice and Joey were not as enthusiastic, Riley felt peer interaction was incredibly helpful for learning about new techniques and approaches to web design. The input provided new perspectives and helped create connections between students that led to increased feedback on new design approaches. This quality of interaction sharply contrasted with the earlier experiences of these women in face-to-face contexts, where their presence in their programs was questioned by both instructors and peers.

Pacing of content in online classes was a key concern among the women attending online computing programs, specifically, the ability to work ahead. This was one of the aspects of online programs that many study participants explained that would either make or break their experience. For example, Alice explained:

> I liked online classes because I get to work with it at my pace. [...] I can log on pretty much anytime I had time as long as I did the assignments within the deadline. I was cool with it. My only peeve was that sometimes, you didn't really get feedback from the professors. [...]
>
> I guess sometimes it's frustrating because, in classrooms where if you have a student who didn't get what the teacher is trying to lecture, and they keep asking the same questions over and over again. It's like, "Can we just move on please?" It's like, "I get it. Everybody else looks like they got it, why is this one—why are we wasting the whole class period for this one student?" With the online, you don't really see that.

Joey agreed:

> I cannot do an in-person class. I get bored. With online classes, I like that I can do things at my own pace. I hate having to be in a classroom with a bunch of idiots, I'm sorry. [...] For the most part, I get it. If you explain it to me—if I have a question, I'm very good at asking for clarification, "Okay, but this is what I'm getting." It would take two or three times back and forth and okay, I'm good. I cannot sit through another 30 minutes of the instructor trying to

> get that through the person-next-to-me's head because they're just not getting it. I just cannot do that. If I get it, I need to continue and move on and go to the next thing. […]
>
> I got used to being able to start a class every week. You finish with one, you just start the other one and you finish. I think it works better that I can do two classes at a time that start every two weeks.
>
> I can do two classes at a time every two weeks, which still keeps me as a full time student. I'm squeezing in five or six classes every traditional semester versus having to deal with five classes at the same time for five months or however long a semester is.

For Riley, Alice, and Joey, rather than being just a byproduct of asynchronous communication, being able to work at their own pace meant having more time to attend to individual questions, to contextualize learning in other school or work-related projects, and to complete courses at a faster pace. That is, it was not just a solution to a logistical problem of scheduling, but also a response to a hidden curriculum which made traditional computing programs largely hostile to nontraditional students who are more likely to be women and students of color.

That said, not all online experiences were positive. Lack of planning for online courses, lack of curriculum alignment, and variability in course quality were problems the women interviewed had to navigate. Riley, Alice, and Joey all reported that they took some online courses that were not as well planned or organized as they would have preferred. However, all of these women reported that these issues were also present in face-to-face programs.

The women interviewed all valued being able to connect with instructors to receive constructive feedback and access support services that fit with their schedules. In part, the larger cultures of their face-to-face programs tended to discourage peer interactions, focused primarily on lecture, and in some cases, resulted in chilly or outright hostile climates for women of color and older, returning students. Online programs, they explained, allowed the focus to be placed more on their work and their own pathways through learning about computing and less on their appearance.

Seeking Out Other Sources of Support Online

While online programs offered women the opportunity for greater instructor interaction and the flexibility to study at their own pace, another strategy employed by women in the study was seeking out sources of support in online contexts. At various points in their educational trajectories through computing, all of the women in the study reported seeking out sources of information, support, and guidance online in less formal settings. Sources varied. Some women drew support from colleagues around the globe via online forums regarding web design, site administration, or network strategies. Others frequented blogs on Photoshop techniques, sites for cooking recipes, or discussion boards dedicated to critical feminism.

More generally, women who were engaging with computing in a workplace context such as Riley, Joey, Flo, and Biafra tended to utilize online support services in order to supplement their work projects. For example, Riley sought out support from message boards and forums for the open source coding community to learn more about new software options for her web design business, establish more client contacts, and develop new marketing strategies for her web design business. Flo reported relying on the large online networking system to help administer communications infrastructure for her clients when she worked towards her Microsoft certification. As teachers, Joey and Biafra both relied on the vast array of teaching resources available online to develop new content and approaches to teaching their students.

Being able to allow their intrinsic interests to drive online searches for support were particularly important for women as they navigated their programs. Furthermore, some of the women in the study reported that they were able to connect with larger communities of women and people of color via the Internet that helped support them through somewhat difficult periods during their computing programs. For example, Anu reported seeking out feminist spaces on the Internet via blogs and news aggregating services to find communities of women who were discussing issues that were important to her. She explained:

> I looked for spaces mainly on the Internet. Have you used Reddit? TwoXChromosomes, it's a subreddit. That's actually a really good community. Not specifically feminist, just for girls. [...] It's techie and it's girly and it's feminist-y. There're discussions about things you can't talk about in real life. [...] There're comments about general female rage and things that most women identify with but just can't talk about on the rest of the Internet. [...]
>
> I was actually there on Reddit when TwoX was created. I was commenting in that thread where they were like, "Let's create this community for girls." [...] The feminist Reddit has kinda fallen. It's not really there anymore since TwoXChromosomes is. [...] The general Reddit, so sexist, I hate it.

Communities like Food and Cooking, Music, those are a little more friendly. [...] The smaller subreddits are pretty reasonable people.

Anu explained that it was helpful to have an outlet to engage with ideas around gender discrimination and other social justice issues. While she explained that she was more of a "lurker" than an active participant in some of these forums, having access to the space provided an important sense of community with other women. However, she also lamented that these spaces constantly needed policing by members and forum administrators due to the fact that they were frequently under scrutiny, and sometimes even under attack, by male readers:

Anu: The TwoXChromosomes. [...] There's been an interesting discussion. Lot's of men have been reading it too. That's not necessarily a problem, but it is when they demand to dominate the discussion. But every time a woman's issue comes up on the subreddit, one of the top comments, is "Well, as a man, I feel this." And, it's just like, "I don't care!" The rest of Reddit is yours, please leave me alone!

Sher: Has anyone ever said that?

Anu: Yes, but there're so many men on Reddit, and even in a women's space, it's kind of dictated by what the men want to give up-votes to. Like, whenever the topic of rape comes up, one of the top voted responses is always, "Well, men can get raped to." And we're like, "We're not denying that is something that happens. But this is a women's space, and we're going to talk about women's experiences." Even if they're perpetrated against men, they're perpetrated by men. [...]

Sher: How have people policed these spaces?

Anu: The communities I think are run really well, there are always those idiots on there who are like "there's too much policing." Well, if that's the only way we can play nice, then so be it. [...] I don't want it to be censored, but I don't really

> want to see people all up in my grill, talking shit about you know, my issues.

Anu explained that regardless of the efforts to carve out feminist or women-identified spaces online, constant vigilance and policing was required in order to combat attempts to harass, intimidate, and silence women who wished to engage with topics important to them.

Developing Your Own Path and Expertise: Towards Social Justice in Computing

Finally, many of the women of color who participated in this study chose to forge their own pathways and develop expertise in computing in areas that were important for them. This was particularly the case with women who entered computing fields later in their lives. Riley, Alice, Joey, and Biafra all provided powerful examples of how women navigated their educational trajectories to engage with computing in ways that were important to them and their communities. The ways they accomplished this ranged from starting their own technology-based businesses, working in social services, to becoming teachers. In many ways, the women using this strategy for dealing with the sometimes incredibly hostile climates they faced found it empowering. Such strategies helped to forge new ideas for how cultures of computing could become more inclusive of traditionally underrepresented populations such as women and people of color.

Both Alice and Riley took steps towards creating their own businesses. At the time of the interview, Alice was preparing to launch an online business and had just completed an online M.B.A. program in order to gain the skills to do so. While reflecting on her education, Alice explained that her experiences in the face-to-face programs in some ways brought her closer to her family. Being isolated in her department as a woman of color, she drew heavily on her family for support, often phoning them. As her connections with her extended family were strengthened, she became interested in genealogy and began to consider putting together a family tree to record the intriguing details she was learning about her family history. As Alice gained more knowledge about programming, her interest in genealogy aligned with her love of software development. She decided to follow her passion and returned to school to pursue her M.B.A. online in hopes of starting her own ancestry tracing business focused on creating and storing family histories online. Drawing from her own interests, experiences, and values, Alice created a unique relationship with computing that allowed her to navigate many of the hostilities she encountered elsewhere.

Similarly, Riley had found ways to engage with computers on her own terms. Before deciding to pursue a career as a web designer, she had worked in a few different fields. She began with accounting, then moved to physical therapy, and eventually, after discovering a passion for working with computers, decided to start her own web design business. As someone working in several male-dominated fields, she became very conscious about the need to create a work environment that would reflect her values. As discussed earlier, Riley explained that her early face-to-face educational experiences were often hostile. Later, when working for a large corporation of mega-chain stores, she encountered overt gender-based discrimination in pay and working conditions. She explained that having these experiences with blatant sexism drove home how important it was to create a working environment that provided her (and other women) with the space and positive environment needed to succeed and thrive. She said:

> After a while, either you buckle under and you accept that as, “Hey, it’s okay that I make $0.74 to every dollar a man makes. That’s okay. It’s okay if my male colleagues are making $20,000 a year more than I am doing the same work. That’s okay, sure. That’s okay. I’m just a woman.” No. When you know that you’re working harder, and you are producing more, and they want to pay you less, you don’t accept it. You can’t. If there’s any way possible, you find another way. […]
>
> One of the real great features about working the way I do is, I don’t see people very often. I love people. I really do, but I kind of let my work speak for me. In the context of web design, they see my work before they even see me.

For Riley, being able to engage with her business in an online context allowed her the freedom to pursue her passion for web design. By having online portfolios and primarily online forms of communication before meeting most potential clients in person, she was able to let her work be evaluated without having to deal with the preconceived notions people may have about her abilities.

While online environments may help shield women initially from hostile computing cultures, these are not, unto themselves, a solution to the inequalities women experience based on their various identity categories. The offline world always intrudes. Interestingly, Riley noted that when meeting some clients for the first time, they were surprised not by her gender or ethnicity but instead by her age. In the context of web design, clients assume most web designers and programmers are younger people. She explained:

> I have self-confidence in what I do. I know that I'm turning out a good product. I think people, generally—men and women—are generally more accepting of women in this business. At least, I've been pleasantly surprised, actually, at how well accepted I've been. I think that if anything, there's maybe a little age issue. It's kind of like when people meet me, they're kind of like, "Oh, what are you going to know, grandma?" It hasn't happened that frequently, but I think that I have felt it. There have been comments, and that sort of thing.

At 56, Riley feels she is older than most of her competitors in the field. However, since clients often view her portfolio of work prior to their first in-person meetings, instances of discrimination based on even her age were relatively rare. Furthermore, her confidence in her work and her ability to connect with clients over a shared commitment to social justice helped to build her business over the last ten years.

For Riley, finding another way through computing meant gaining the skills and expertise needed to start her web design business and implement a workplace ethic and mission that resonated with her deep commitment to social justice. After experiencing discrimination based on her gender and sexual orientation, building a business dedicated to creating web design services for social justice activists and grassroots organizations and others working to end all forms of discrimination was important to her. She explains:

> I kind of tend to attract people that are more socially conscious, let's say, who are working for justice, and that sort of thing. That's how I present myself. [...] This is what my work is about. When I'm talking with people that are involved in tech, these are typically the people. [...] they've already kind of got that consciousness. Yeah, so you're not gonna hear this, "They're thinkin' like a chick," views. Even the men that I work with. Same thing.
>
> The men that I've had to work with, absolutely—I don't know. Maybe it's just me, because I kind of command that respect, or demand it. I don't go out of my way like, "You're going to respect me." I don't put up with it. I own the business, and if they're going to do work with me, then—you better treat me with some respect. [Laughter] Yeah, it goes unspoken. I treat them with respect. I treat their knowledge with respect. I feel that I'm respected in return. [...]
>
> My mission, my emphasis is "Do no harm." I express this to people right before they start working with me. I let them know what I'm about, and what goals of my company are, and what they include. After they hear my goals for whatever project we're on, or whatever my interaction in the world of social justice and human interaction, if they can't buy into that, then we really don't have a whole lot to talk about. [...] I want to work with individuals that are making a difference in the world. That is my greatest joy. Being able to work with that. I don't know. I'm about respecting the individual, and no matter what—no matter what. [...]

For Riley, embedding her values into the core of her business was an expression of her commitment to social justice. Choosing to work with organizations that work on social justice projects was also a conscious decision, and Riley related several stories about how she worked diligently with grassroots organizations to develop websites and web presence to get their messages out while working within the constraints of their often limited budgets.

For Riley, the impact of working with a social justice ethic also extended to how she chose to mentor other women she worked with. She explained:

> I think anytime I've worked with women, anytime I've had the great pleasure of having women subordinates, I've always tried to help them. To be a mentor. That's always been important to me, to try to help other women.
>
> I really, really horribly dislike anytime I hear of other women not giving a hand up. They reach a certain pinnacle, or they break through the glass ceiling. "Hey, there is no room up here for you." I've seen that happen a few times. Quite a few times in my life. More frequently, I've seen women helping women.

Working to create her own culture of computing that directly counteracted the masculine, individualistic, hostile climates she had experienced was an important part of the social justice work Riley wished to embody in her business practices. Both as the owner of a web design business as well as in other work contexts, part of this practice was the importance of mentorship for other women. Breaking through the glass ceiling was not enough. Rather, Riley argued that those who broke through had an obligation to mentor and guide others through the process in order to work towards making these environments more hospitable to all kinds of people.

Using her computing expertise in social services, Joey provides another compelling example of how women of color created their own paths through computing. In doing so, her aim was to engage with communities she cared about and, by creating an environment that welcomed their perspectives and ideas, to encourage other women of color to learn more about technology. As a coordinator for computing centers in public housing developments in a large southwestern metropolitan area, Joey explained that many of the housing residents had extremely little contact with computers before coming to her the public housing computing labs. As a result, Joey struggled to create a computing environment that would encourage residents to become more empowered in their lives. She described her work:

> The idea is just training and education. It could be just as simple as showing somebody how to create an email or send a résumé online or even something a little bit more complex as to actually having to sit down and walk somebody through a homework assignment because they're taking online classes. [...]I think a lot of them are in there to do the job search.
>
> They're just intimidated because it's a lot of work. You have to create five different accounts on five different websites, and they're all different. None of them let you use the same password. You have to know how to, first of all, create your résumé and then save it on your email or on a flash drive. Then you have to learn how to extract that from your email and put it on somebody's website or upload it from your flash drive to somebody's website or open it on Word and then you can copy and paste it over to somebody's website. All of these different techniques, it's just overwhelming, especially for someone who is not familiar with computers.

After setting up some of the computing centers, Joey noticed they weren't being used as much as she had imagined they would be. As a result, Joey began soliciting feedback from residents and monitoring the ways they used the computers in order to better understand computing needs of this community. From these observations, Joey devised new approaches to teaching computing that would encourage reluctant computer users, particularly women, to engage with computing. This was largely in response to her observation that a majority of the housing residents she worked with were English language learners trying to improve their English skills after migrating from Mexico and other Latin American countries. This created a problem in that the computer labs were busy places, used by many different types of residents. Children completed school work while older residents finished their G.E.D. or online courses, searched online for employment, or created resumes. This mixed crowd meant that residents trying to learn English through software programs (which require users to speak aloud) had an audience. Designing the center to accommodate these different needs, particularly with residents who were intimidated because of their unfamiliarity with computers, was challenging. Joey explained:

> We actually ended up having to designate some timeframes of the day to where kids are only allowed in here after 3:00 or after 3:30 or whatever. In the morning, we're gonna do Rosetta Stone for learning English and at this time we're gonna do GED and at this time we're gonna do job search.
>
> We had to break up the day and designate those types of things. That and also because, again, people are intimidated. They didn't wanna come in and do Rosetta Stone when I have a bunch of kids or when I have other people who are doing other things, because of the pronunciation and they have to sit there, "Girl, girl, girl." It's very particular about how. Knowing that everybody there is doing the same thing that you're doing was just better. More people came in to learn about how to use computers.

Being able to identify barriers keeping public housing residents from using the computer labs was important to Joey for finding more ways to encourage them to engage with computers. By working closely with her residents, building rapport and trust, Joey was able to develop a schedule that accommodated the needs of a majority of the residents she worked with.

Joey attributes this desire to build a more community-based computing culture to lessons she learned from her experiences in her computing programs. In particular, she attended to what worked and did not work for her during her experiences in both face-to-face and online programs in order to develop services that would help break down barriers the residents had to using computers. Being conscious of how her negative experiences impacted her initial perceptions of computing, Joey felt it was very important to develop her resident's computing skills at their own pace and to contextualize their learning by drawing on their personal interests and motivations. She related stories about her efforts to engage with some of the women who were homemakers and how she began holding computing classes during the day while their children were attending school:

> I think with them is that they're all homemakers. I asked them once. I said, "Why did you start coming? Why here?" They've always wanted to learn. They've always been intimidated by it. They actually always said that my patience with them, not to toot my own horn…. It made a difference. They always did tell me, because I wanted to know what I needed to continue doing or stop doing…. They said that I was—not my words—able to dumb things down for them. […] It was just, "You spoke our language. You made it to where we would understand, to where it didn't feel like if I came back tomorrow you were gonna give me this pop quiz of everything." It's like, "No, I understand that you don't understand. I understand that this is all new. Even though I covered it today, we're gonna do it tomorrow and the day after." It was just repetition, repetition, repetition. I made the mistake of initially I'm gonna teach 'em email and I'm gonna teach 'em folders and I'm

> gonna teach 'em Word and I'm gonna teach 'em—That was very overwhelming. [...]
>
> That was a no go. It was too much. It was just we're gonna learn email today for the next four weeks. That's how long it took them to understand. That's how long it took them to get why it was used, how it was used, what the benefits of it was. They needed to see why they would want to use email and how it pertained to them.

While many of the women she worked with were intimidated, they were curious to learn more about computers.

As evidenced above, Joey had a keen sense of how to develop her client's initial motivations to use computers. She understood that, as recent immigrants, her housing residents were very invested in trying to find more cost-effective and intimate ways of communicating with their family members in their countries of origin. Joey was able to leverage this desire to garner more interest in computing among her residents and to use this motivation to teach them new computing skills. She said:

> They have families that don't live here. The majority of them are undocumented. I hooked onto that very quickly. It's like with the computer, you can communicate with your family. You can show them over the phone how to create an account. Once that's established, we can talk to each other, we can Facebook each other, we can email each other, we can Skype. [...] We get all of those free things. Yes, you're paying the $30 a month for Internet or whatever, but how much are you paying on those little calling cards that you guys buy or however it is that you communicate with them? [...]
>
> You can see their new babies. You can see your grandmother. Just touching onto that—through Skype, at that point is when they were in my pocket, because that was important to them. [...] They were very exciting to come in the next day. They would give me their stories of them talking to their families that they haven't seen in years. We played with Windows Movie Maker. [...]
>
> That was my intermediate class. I had them bring in pictures. They scanned them all in. They created a little photo collage. We were at the point where they understood what we were gonna do with it. [...] They understood what the end result was going to be. They were more than willing to bring in their pictures, because they

> knew what we were gonna do with it. They made that little move collage type thing. They did the transitions. They even added music to the background. They cropped their pictures. They zoomed in on some of the pictures. They went through the whole process of creating their movie. […] Learning the extensions of if it's a Windows Movie Player they have to have the software. Otherwise, you can kind of just create it into an .AVI and burn it onto a DVD. That's what we ended up doing, and they made a little DVD out of it. They mailed their DVDs to their family. They were very excited.

By contextualizing learning about computers within the housing resident's desire to communicate more frequently and cost-effectively with family members who lived far away, Joey was able to develop a rapport with the women she worked with. By building on basic skills like email, word processing, and creating and setting up accounts, she was able to advance to more complex projects such as using and manipulating photographs and video media to help the women create projects documenting their lives in the United States to send back to their families in other countries.

For Joey, forging her own path through computing meant that she engaged with more vulnerable members of her community and assisted them with leveraging technology for their own goals. To this end, she worked with them to develop skills to communicate with their families and use computers for job-related purposes. Most importantly for Joey, she helped her residents become more self-sufficient and empowered to seek out more knowledge. As discussed above, Joey felt a career in a straightforward computing field did not present enough rewards to merit continuing to put up with the negative experiences she had encountered as a network administrator during and after her associates' degree. Instead, she explained she needed her work to be meaningful and have an impact on the larger community she lived in. By redefining what computing meant in a context she cared deeply about, Joey forged her own pathway through computing and began educating other women of color about technology in a way that respected and valued their identities.

Finally, some of the women in the study attempted to directly address issues they had experienced in their own computing education by becoming teachers themselves. In this regard, Biafra's experience as a K-5 technology teacher offers another compelling example of women forging their own path. As discussed in the previous chapter, Biafra developed her pedagogical approach with a desire to avoid the negative, demoralizing experiences she had with computers when she first began to learn about them. As a K-5 teacher, she became acutely aware of the level of frustration some of the girls in her classes were experiencing when engaging in computing. Biafra was determined to disrupt these experiences, and by collaborating with another parent and close friend who had a more formal background in computing, she was able to develop computing experiences that helped her students develop confidence. Relating an experience about teaching her students to program small robots, Biafra explained:

> We paired them up. I could tell that Allie and this other little girl were getting really frustrated. [...]
>
> On the playground, I had sketched out a little pathway that had some turns. [...] Not too many turns 'cuz, you know, they're

> third grade. But it had to stop without going over the line. They had to start at the start, then they had to program to go here. Then they had to program the turn, and so you had the radius on the wheels.... So math was involved. They had to go here, and then they had to do another stop turn. [...]
>
> It took us probably about five class periods for the kids to get all the robots programmed correctly, so there's a lot of engineering in computer programming concepts, then you're not gonna be successful the first time.... We would sit there, and they had, they would be programming the robot, getting it uploaded. Then they would run outside to the playground, run it through. "Oh, crap. That didn't work." Then run back in the classroom. "Do it again." [...]
>
> Oh, they were so extraordinarily into it! That's when those girls turned around. I think it was us just working with them, so that, you know that frustration point that I had in my bachelors program where the guy said, "Turn it on." I'm going, "Well, crud. I can't even figure out how to turn it on. What a fuck up I am." We were able to sit with them, and go through it with them. There were boys too. Billy was beside himself. Once Allie knew what she was doing, we paired her with Billy. What a great – Because, you know, to be able to teach someone else, that's how you prove you know it. She was so excited at that point to be the expert. I'm sorry. [Wipes eyes.] I just get –It was just an incredible, incredible experience.

Because of her earlier negative experiences with computing, Biafra understood how intimidating and frustrating learning about computing could be. Furthermore, because her return to computing came later in life, she was acutely aware of how she had been discouraged from learning about computing earlier because of her frustration. She was able to recognize this same frustration in her students and actively worked to provide role models, guidance, and context in order to counteract the tendency of the girls in the classes to give up. Understanding that with extra patience, time, and proper context, the students would eventually develop their confidence and skills, Biafra persevered in the classroom. The results of these efforts were very rewarding for both Biafra as she watched them become empowered to begin teaching other children in the classroom and demonstrate their learning in new contexts. For Biafra, this was an incredible victory.

The stories above help illuminate various strategies women employed to navigate through computing experiences in both educational and workplace contexts. The women interviewed employed a mix of strategies in different contexts from internalizing existing computing cultures to exploring alternative educational options with online education and seeking out sources of support and communities online. All of these strategies helped women navigate the barriers they faced in their computing paths. However, it was the in the ways that women forged their own paths, defined their own expertise, and implemented their own alternatives to the negative experiences they had with various computing contexts, that many of the women in this study began not only to survive, but to thrive in their fields. Furthermore, many of the women in the study forged new pathways through computing not only for themselves but also for other women and people of color in their lives.

Chapter 7

CONCLUSION

Revisiting the Problem

This study sought to explore the experiences of women and people of color pursuing post-secondary computing education in various contexts. A persistent gender and race gap still exists in many computing disciplines despite decades of research aimed at developing interventions to combat the problem. Underrepresentation of women and people of color in computing disciplines is an important problem to address for several reasons. First, the lack of diversity results in opportunity costs for the field of computing by limiting the pool of potential innovators who can help develop new technologies that reach more diverse populations of potential computer users. Having more women and people of color enter computing fields has the potential to help create new computing solutions that may not be developed if the talent pool is narrowly defined and limited.

Second, working to close the persistent gender and race gaps is imperative if the U.S. wishes to maintain its competitive edge in computing fields as they become more globalized. The United States Bureau of Labor Statistics' latest report on the occupational outlook in computer science predicted that this field will experience higher than average growth, with close to a 24 percent increase in demand between 2008 and 2018 (Bureau of Labor Statistics, 2010). Recruiting and retaining more women and people of color in computing will assist not only in meeting the demand for growth in this discipline but also assist in increasing the quality of life for populations engaged in these areas.

Finally, increasing representation of women and people of color in these fields is an issue of social justice. As Riley explained in previous chapters, the greater the diversity of perspectives, the more "elegant code" can emerge.

Summary of Findings

This study identified several key findings about the experiences women had while pursuing computing education in various contexts. Early experiences in formal and informal learning contexts as well as opportunities to develop initial computing interests through tinkering were all important parts of how women perceived computing early in their lives.

Having ultimately persevered and made the decision to pursue computing in a variety of contexts, it became imperative to explore women's experiences in computing programs and careers, focusing on the barriers and challenges they faced pursuing computing education. Here, we saw that the cultures of computing programs continue to be primarily masculine, racist, and individualistic. At the same time, they privileged abstract over applied knowledge, and create environments in which traditional students are made to feel most comfortable.

Computing remains, in general, a climate that is chilly and sometimes hostile for women as they grapple with experiences of overt and covert oppression. This remains particularly true for women of color and women who identify as returning students. In this regard, an interesting theme revealed by this study is how women had similar experiences with hostile climates and social isolation despite the differences in their social locations and national origins. Part of what may explain these similarities may be tied to the increasingly global scope of computing. Computing moved from a primarily Western, industrial technology into a post-industrial global phenomenon.

Additionally, while the nature of the hostility and chilly climates differ somewhat across contexts, despite attempts at changing the culture, little progress has been made. Anu's experiences with MEC Camp and the efforts her department made recruiting two women of color as instructors for the introductory computer science courses demonstrate how these efforts, while well intentioned, are not successful at mitigating the hostility and isolation experienced by women pursuing computing education.

The strategies women employed to navigate through various computing educational experiences were the subject of Chapter Six. Women in the study used a combination and range of strategies from internalization of existing dominant computing cultures, to choosing to attend exclusively online programs, to seeking out sources of support from informal online sources and communities, to developing their own paths and expertise in computing fields.

What Does The Current Study Contribute?

The study provided an important exploration of how hidden curricula operated in various contexts to fundamentally impact women's experiences in computing program cultures in ways that marginalize and isolate them. It also provided important contributions to the existing literature on the digital divide as it shaped women's early experiences with technology. In doing so, the study contributes important perspectives to existing literature on the gender gap in computing post-secondary programs. It also adds empirically, theoretically, and methodologically to existing scholarship.

Throughout the study, the focus was on experiences women had with program cultures they identified as "hostile" and "chilly." These terms were used by women when describing their experiences. I used the same language to ensure that the process of research honored women's individual perspectives and knowledge. However, this choice of terminology needs to be connected to scholarship that names these processes more explicitly in order to fully unpack and understand the implications of women's experiences. To that end, the terms "chilly" and "hostile" can be understood in this study as examples of covert and overt oppression as experienced by women and students of color in various post-secondary computing contexts. Sociological work by Rodney D. Coates (2008) synthesizes some of the major theoretical works on overt and covert racism. He explains:

> .[...] Covert racism refers to those subtle and subversive institutional or societal practices, policies, and norms utilized to mask structural racial apparatus. Thereby masked, this racial apparatus serves to restrict, deny, or otherwise distort the opportunities available to the racialized nonelite. (pp. 211-212)

The word “chilly” can be seen as an example of how covert oppression operated. For example, institutional pedagogical practices Anu discussed that emphasized individual effort over group and collaborative work resulted in a climate she characterized as “chilly.” However, her feelings of isolation and tension in computer science are an example of how covert oppression operates on a larger, institutional level. This further alienated students like Anu who were already experiencing marginalization because of being one of the only women and students of color in their programs. Programs with cultures characterized by isolation and pressures to assimilate to dominant cultural practices denigrated expressions of femininity or underrepresented racial and ethnic identities. This occurred in particularly male-dominated programs and sometimes resulted in a lack of solidarity with other women. As Anu’s stories of interactions with other female computer science students demonstrate, experiences of territorialism characterized by bullying behavior, further isolation of non-conforming women, and competition for monetary resources can be powerful institutional practices that reinforce existing dominant structures of oppression. Compounding this covert oppression, women also experienced overt instances of oppression based on their gender and race. As a result, they often characterized these situations as “hostile.” This was demonstrated most explicitly in Tina's experiences of verbal sexual harassment from male classmates and sexual assaults she alluded to when discussing friends in her program. However, covert oppression was more often discussed than overt instances.

This study provides theoretical and empirical contributions to both the scholarship on the digital divide and the scholarship on hidden curricula in higher education. Digital divide scholarship, particularly the work of A.G.M van Dijk (2005), was a valuable framework for understanding the nuances inherent in studying technology literacy and educational foundations more generally. However, in the process of conducting this research, a new perspective emerged. Specifically, van Dijk implies that the various stages of the digital divide are somewhat linear. That is, those engaging with technology must first develop the motivation to use it, obtain physical access to technology, develop pertinent computing skills, and engage in productive usage. However, within this research, I found the framework was insufficient to describe the empirical reality for women in the study. While van Dijk's (2005) model provided an important framework, much of the work he used to develop the model was based on secondary research. This study provided an opportunity to apply the framework in a qualitative context to understand how women's experiences can be understood directly through this lens. This is where the situation proved to be more complex than could be encompassed by van Dijk's model. For example, women like Anu, who had motivation, physical access, the requisite skill set, and productive usage of computers, chose to leave computing fields despite having bridged the gaps van Dijk's model (2005) identified.

This study contributed new empirical work on hidden curriculum in higher education. First, this study explored the various ways women demonstrated a sense of agency while still being constrained by larger social and institutional structures embedded in various computing program contexts. As such, the study added nuance to the structure-agency debate (Margolis, 2001) by exploring the real and perceived limitations women experience pursuing post-secondary computing education. While some of the examples of women's agency are laudable and inspiring, such as Riley starting a web design business with an explicit social justice mission, much of the agency women displayed occurred primarily outside of formal computing education contexts. Structural and institutional forces were incredibly powerful for many women in the study and in some instances, were not possible to overcome without leaving the institutional context altogether.

Scholarship on the hidden curricula in higher education contexts suffers from a lack of empirical studies of online educational spaces (Anderson, 2002). As discovered through the current research, women (and in particular, returning students) reported much more positive experiences in online programs than in face-to-face programs. However, it would be a grave mistake to believe online education is a panacea for solving the problem of gender and race gaps in computing. While many women reported that the experience online was positive and allowed them to have more direct interaction with instructors, there were aspects of the curriculum (isolation from peers, etc.) that are important to look at in more depth. Additionally, the project of online education cannot be understood as existing outside of a capitalist system of production. This study shows that the need for more empirical work on online education is necessary to fully understand the nuances of how social inequalities might be reproduced and reinforced in online spaces.

The study adds to existing literature on the gender gap by taking an intersectional approach. Drawing from more emancipatory methodological frameworks such as those of Patricia Hill-Collins (1990) and bell hooks (1989), this study adds to a growing and much needed body of literature that provides a way to vocalize and name structures of oppression that operate on sometimes hidden and covert levels to structure experiences of women and people of color in institutions where these groups are often marginalized and silenced. The process of naming and identifying the ways in which their social positions structured their experiences and led to marginalization and isolation is incredibly important for identifying the often subtle ways institutional cultures reinforce and more deeply entrench existing power structures and relations. For example, this can be seen in the tensions that emerged among women who internalized dominant cultures such as Flo and Xena and women like Anu, Riley, Biafra, and Joey who began to question existing practices based on their dissatisfaction with their computing programs, continued experiences of marginalization, and isolation. These negative experiences were due in part to the lack of connection they felt with other women in their computing contexts who were encouraged to adopt competitive and hierarchical modes of interaction in order to succeed.

The current study unpacks how, despite intervention efforts to address the problem, the fundamental issue of hidden curricula structuring experiences of post-secondary computing programs has yet to be addressed effectively. The existing literature on the persistent gender and race gaps in computing have emphasized the importance of increasing opportunities for women and girls to gain experience with computing at earlier ages, removing entry barriers to programming disciplines, modifying curricula and pedagogical approaches to adapt to varied learning styles, increasing the presence of role models and peer support, and increasing the quality of mentoring for women and students of color and student-faculty interactions (Cahoon & Aspray, 2006). Yet, as this study explores, the implementation of these recommendations may not be effective in various contexts. In cases like Anu's, some of these efforts may, in fact, be counterproductive since they allowed the department to fail to address underlying issues contributing to the hostility and chilly climates fostered by overt and covert experiences of oppression women face.

Using a qualitative approach to provide an in-depth examination of women's experiences on the ground, this study allows comparisons across a small, yet very diverse sample of women pursuing post-secondary computing education in various contexts. In particular, examination of the dominant cultures in the various educational contexts encountered by these women suggests that a hidden curriculum exists which asserts that computing knowledge, particularly the development of new technologies, is limited to a select group of people – White, South Asian, and East Asian males.

While this study focuses on a much smaller scope than a global lens, the use of hidden curricula as a theoretical framework is an important tool to help unpack a larger critique of this increasingly globalized computing culture. At root, scholarship on the hidden curriculum originates from a critical perspective focusing on issues of power. In this way, this study explores, on a smaller scale, how computing education is fundamentally about power and power relations. The data demonstrate how longstanding patterns of gender, racial and other inequalities continue to be reproduced and reinforced in various kinds of post-secondary computing contexts. Despite its outward emphasis on progress, computing remains an inherently conservative field. Progress in computing is marked by how much better, faster, smaller, and more cheaply computing can be made. In this case, progress is more about increasing efficiency (and thus profit) than about improving the quality of experience for the whole of society. Fundamentally, the field cannot evolve unless new perspectives, ideas, viewpoints, and values are given the space to develop.

Language in any setting is also a part of how power and social status are conferred and maintained. Exploring hidden curriculum and the digital divide as they emerged in women's experiences within various computing contexts underscored the way that programming knowledge is a language of power. Being able to develop a mastery of computer programming languages is the ability to be able to speak the language of power in computing—a language that now occurs within a globalized, post-industrial context. That the experiences of the diverse group of women in this study are still marginalized and discouraged through both overt and covert oppression implies important social justice concerns that still need to be addressed. That is, the gender and race gaps in computing education amount to a systematic denial of this language of power to women and people of color.

Computing history is dominated by some important tensions. On the one hand, computing cultures place value on a "hacker ethic," a core set of values informing the larger heterogeneous community of computer programmers and coders who encouraged openness, a culture of sharing, decentralization of knowledge, and free and widely available access to computing technologies in order to help improve the world (Levy, 1984). This ethic can be seen operating behind technology movements such as the free and open source software development movement. On the other hand, computing is also fundamentally tied to businesses and capital generation concerns that privilege standardization, prediction, and control.

The tension between these two tendencies in computing can narrow the range of possibilities of computing while still promoting an illusion of choice and diversity. For example, at the current time, emphasis on application development for mobile computing platforms has created a plethora of new opportunities for large companies and independent developers alike. However, because of market-driven dynamics, developers focus almost exclusively on three major mobile operating systems run by created and developed by two companies (Apple's App iOS and Google's Android and Honeycomb platforms).

These larger tensions connect directly with hidden curricula. Tensions exist in computing about who controls the language of computing. While there are a lot of languages in programming, which language will become dominant in different contexts is often highly contested. The hidden curriculum discourages women and people of color from pursuing computing and amounts to an attempt, conscious or not, to control access to the language of computing. Such social control is fundamentally about both money and power. Whoever is able to develop a mastery of the language of computing gains social capital. As Flo reminded her students, computing in ubiquitous and is becoming more so in various fields as they become increasingly technologized.

The end result of these tensions is a reinforcing of the digital divide. While the concept of the digital divide is politically used at the level of simple access, this conceptualization is a rather naive notion of democratizing technologies through increasing access alone, as van Dijk (2005) has argued. The digital divide remains a much more complex issue.

However, this study provides some encouraging findings. Some of the greatest successes were seen when women in the study took on technology education as their own projects. For example, on the face of things, it could be said that evidence exists in this study that shows how previously unconnected populations like low-income, undocumented immigrant women now have increased access to computers through public housing efforts in ways they did not have previously. However, before Joey was put in charge of the computing centers, the computers were rarely if ever used by these populations because of motivational barriers. Joey and other women in the study made concerted, conscious efforts to include the perspectives of women of color and worked diligently to remove the motivational, skills, and usage barriers they faced when attempting to engage with computing.

The efforts of Joey and other women in the study who chose to forge their own paths demonstrate the importance of encouraging women and people of color to enter and persist in computing fields. Their lived experiences directly informed their desire to alleviate computing barriers, particularly around gaining skills and motivation, in order to help close the digital divide in their various contexts. If there are not more concerted efforts to encourage women and people of color to enter computing fields, new approaches to technology and perhaps even the development of technologies themselves will not reflect their perspectives and motivations and the digital divide will continue to deepen. These findings echo those by Bowen and Bok (2000) showing that students of color tend to be more likely to engage in more service-oriented professions.

Intersectional Approaches

Another contribution the current study makes is focusing on intersections of women's various identity categories and how they interact in different contexts. Previous studies of the gender and race gaps in computing fields had a tendency to study identity categories as separate, discrete phenomena (Singh et al., 2007). In this study, I chose to take a more holistic approach and tried to explore intersections of women's multiple identities as they pursued post-secondary computing education in various contexts.

An intersectional approach helps this study provide an important contribution to the literature. Although the dominance of a more positivist approach has shaped much of the trajectory of research on the problem of the gender and race gaps in computing fields, the recommendations made by these efforts have not resulted in gains that have been sustainable in computing fields (Cahoon & Aspray, 2006; Varma, 2007). However, studies such as this one provide an important set of tools for unpacking how nuances and shifts in women's positions in computing cultures are fundamentally tied to women's identities. Identity markers individual women claim with regard to race, gender, ethnicity, national origin, and sexual orientation (to name only a few) in this study cannot be understood without considering the elements of social structures that foster inequalities as they are embedded within their respective computing educational experiences. These tensions can operate in ways that, at first, might obscure marginalization and oppression women experience in these contexts. Furthermore, these tensions can play a major part in how women experience attempts at recruitment and retention efforts as more or less effective and sincere, as was illustrated by Anu's experiences with contrasts in teaching approaches by the first year lecturers and upper division classes. What is most valuable about the intersectional approach for this particular study was the ability to focus on women's on-the-ground, lived experiences as a way to unpack how marginalization and isolation occur in subtle, and often undetectable ways.

The act of naming their experience speaks directly to existing literature on emancipatory research. This study attempted to unpack the meanings women gave to their experiences in computing programs in order to provide a better understanding of how social inequalities impacted their experiences of learning. This is particularly important to do given that, according to Hill-Collins (1990), "Groups unequal in power are correspondingly unequal in their ability to make their standpoint known to themselves and others" (p. 26). She reiterates that because of the existing power imbalances, a major role research on social inequalities must serve is an emancipatory one. Her observations can be said to be true for many of the women in the study as their attempts to address their concerns were often met with the continuation of their experiences of isolation or overt hostility which served to effectively silence their concerns. Yet during the process of conducting this research and talking with women about their experiences, almost all of them expressed that the opportunity to share these experiences with someone was of great importance to them. This study attempted to, as Dorothy Smith explains (1988), engage a feminist approach to research, one that, "creates space for an absent subject, and an absent experience, that is to be filled with the presence and spoken experience of actual women speaking of and in the actualities of their everyday worlds" (p. 170). Each of the women who participated in the study expressed that they appreciated being able to talk about and name these experiences without being subjected to ridicule, or told that they were just "imagining it," or were "too sensitive."

Attending to intersections of identity assisted in exploring similarities in women's experiences across different geographical locations, time periods, and cultural contexts. The isolation felt by Xena as the only woman at the university research center she worked for in Iran, a highly gender-segregated context shaped by religious affiliation and gender identity was very similar to the isolation felt by Alice as the only

Black Caribbean woman in her computer science bachelor's degree program due to her race, ethnicity, gender, and identity as an older returning student. While differences across time period were important for understanding experiences of hostility in various contexts, Tina and Anu's experiences in their programs over the past five years with male hostility were similar to the experiences of hostility Riley had during her experiences pursuing undergraduate education and in workplace contexts in the late 1970s and early 1980s. That is, an intersectional approach provided some important context for understanding how these issues are still manifesting here and now but also how they exist within a decades-old tradition and dominant culture of computing.

Intersectionality was also able to help unpack the lived experiences women in the study had of hidden curricula and the digital divide. For example, Anu identified not only how gender discrimination impacted her experiences in her computer science program, but also how racism colored experiences for her and other classmates attending MEC camp. Further complicating these experiences were chilly interactions with male classmates and professors, particularly those originally from South Asian countries. Although she identifies as a woman with Bengali heritage, she was raised in the United States, a difference that compounded her experiences of isolation with international male peers and professors.

For Anu, overt discrimination based on gender may have been a more subtle part of her day-to-day experiences. Given the increased scrutiny, computer science departments are more aware of gender imbalances in their programs. Overtly misogynist experiences such as the ones Riley had in her bachelor's degree program were not as present for Anu. However, the more politically correct interactions did nothing to alleviate the overtly racist speech Anu experienced in MEC camp. Furthermore, like the other women in the study, her day-to-day experiences in the department were marked by a series of more subtle interactions that combined to create a climate that constantly called into question her right to be present.

As an approach to analyzing women's experiences in this study, intersectionality opened my eyes to dimensions of the problem I had not previously considered. The effects of interlocking oppressions were sometimes surprising as combinations of identity categories such as gender and age came together in various contexts. For example, Biafra may not have been subject to as much criticism, in which not only her methods but also her qualifications to teaching technology courses were questioned by her principal and a handful of parents had she been a younger woman in that context. As Riley's experience demonstrated, assumptions of technology expertise being associated with younger people interacted with gender and other identity categories to compound barriers women faced to engaging with computing. Anu's interactions with East and South Asian male professors and classmates demonstrated the power of internalized gender discrimination and colorism as factors that increased her sense of isolation and disconnection with the program.

Another example of how intersections of identity impacted experiences of women in different contexts arose when taking into account gender and national origin. For example, in the current study, the experiences of women from countries outside of the United States, particularly those who had gender-segregated educational experiences in K-12 contexts such as in India and Iran, demonstrate how assumptions about women lacking the ability or talent for math and science are false. Xena, Stella, and Tina were women who were educated in countries that were highly competitive, having rankings on nation-wide exams that determined students' chances of getting admitted to prestigious institutions to study science and math. Each of these women was ranked at some of the highest percentiles on these exams and was able to attend the most competitive universities for math, science, computing, and engineering in their countries of origin.

Intersections of class, culture, gender, and ethnicity also were important for understanding how these factors interacted to shape early experiences women had with computing technologies. For example, both Anu and Tina came from families where both parents were doctors. While more generally, studies have found that women are not socialized to technology at early ages in the same ways men, Anu and Tina experienced a higher degree of computing access than others at earlier ages. Having parents who were highly educated and comfortably ensconced in an upper-middle-class background, Anu and Tina both had the means to obtain computing technologies. Furthermore, identifying themselves as being from South Asian backgrounds, they explained that social norms dictating acceptable careers for their class status (e.g. doctor, engineer, computer scientist, etc.) deeply influenced their parents to provide them with technology access (personal computers) at early ages so they would be socialized to use technologies important for these disciplines. Furthermore, their identities as Bengali-American and Indian also informed their family backgrounds with respect to technology use. That is to say, to understand their early experiences more thoroughly, it is not enough just to know that Anu and Tina are women. To gain a greater depth of understanding about the factors influencing women's experiences with computing education, it is important to consider all of these different aspects of their identities and how they interact within a given context.

Study Scope and Limitations

The scope of the current study focused on in-depth interviews with ten women that occurred during an eight-month period beginning in the spring of 2011. In a few cases, I had the opportunity to revisit interviews with study participants and obtain new perspectives on their experiences by re-interviewing them. I was incredibly fortunate to have interviewed a group of exceptional, driven, and accomplished women who were, in some regards, pioneers who forged new pathways and opportunities for women in computing in contexts that had not existed before.

Several possible limitations of the study are that all of the women interviewed for this study could be considered to have succeeded in pursing their post-secondary computing education. Women who chose to drop out of computing (with the exception of Anu) and women who never got past their initial motivational barriers to enter computing in the first place were not interviewed for this study. The small sample size is also a limitation of the current study. As such, there are limits on how the data can illuminate reasons and experiences that influenced women to choose alternative educational pathways to computing.

Furthermore, the wide varieties of social positions occupied by the women in the study have important implications for the limits of the findings in this study. Given the current study's scope, scale, and time period, one cannot generalize the findings explored here across all times, places and contexts. However, despite these limitations, it is apparent from the data that there are important common threads running through these women's experiences that need to be explored further.

Directions for Future Research

To help expand the current study findings and this body of literature, interviews with a larger group of women are needed. Gathering and analyzing perspectives from women and students of color (both men and women) who chose not to enter or who dropped out of computing fields is also important in order to gain a better understanding of the barriers most responsible for keeping underrepresented populations out of computing. Connecting to literature on the social shaping of technology will be important for understanding how non-user experiences shape their perceptions of technology fields.

Approaching the topic from the other side, examining experiences of online and face-to-face program instructors and curriculum designers can provide new understandings of how unarticulated assumptions inform experiences of computing in different contexts. Literature on the hidden curricula in online educational contexts is severely lacking and requires more research. It is imperative to understand how hidden curricula operate in online contexts in order to unpack how social inequalities present in face-to-face contexts may be reproduced online. As of the current publication, only a single study was found that looked explicitly at hidden curricula in online post-secondary programs (Anderson, 2002). While his study is an important contribution establishing the need to explore hidden curricula in online spaces, Anderson's work cannot represent a full exploration of all online contexts by itself. Indeed, while the women in the current study reported more positive experiences in online programs than in face-to-face programs, online education should not be assumed to be value-free or immune to the social forces that shape face-to-face contexts. On the contrary, it is this very lack of scholarship that makes increased scrutiny all the more valuable. To that end, more in-depth ethnographic studies of computer science programs, particularly online programs that serve non-traditional students, are needed to expand understandings of how experiences of women and students of color are impacted by these contexts. Ethnographic studies will also allow a more rich and nuanced understanding of on-the-ground experiences of these women, something which can be difficult to elicit through self reports in interviews.

Finally, a body of scholarship I became acquainted with during the final stages of writing this study could be explored through future research. The concept of microaggression focuses on small, brief, and commonplace interactions which send denigrating messages to people based on their membership in racial groups: “Microaggressions are often unconsciously delivered in the form of subtle snubs or dismissive looks, gestures, and tone. These exchanges are so pervasive and automatic in daily conversations and interactions that they are often dismissed and glossed over as being innocent and innocuous” (Sue, Capodilupo, Torino, Bucceri, Holder, Nadal, & Esquilin, 2007, p.273). Future studies exploring this problem will benefit from this promising area by integrating a more complex analysis of day-to-day interactions, particularly in future ethnographic research on the problem of persistent gender and race gaps in computing.

How Does This Study Help Us Understand the Problem Better?

The current study helps to establish that for this small but diverse group of women, the experience of hostile and chilly computing climates is still commonplace. Along with previous reviews of the literature (Cahoon & Aspray, 2006; Singh et al., 2007), my findings suggest that much more study is needed to understand the complexities of how the gaps persist in computing.

This study also helps us understand how women's experiences are much more complex than simply being tied only to race and gender categories. While such an approach might not be appreciated by quantitative researchers attempting to limit variables in order to produce neat causal models, for qualitative researchers, it helps us get closer to the reality of these women's lived experiences with all their complexities and contradictions.

Furthermore, this study helps unpack the role various contexts have in shaping women's experiences in computing. The stories of the women in this study demonstrate that the effects of primarily masculine, racist, individualistic institutional cultures are present in computing contexts outside of formal computer science departments as well. As computing becomes ubiquitous across many different kinds of fields, opening up new and alternative pathways into computing for increasingly diverse populations of learners is central to the larger project of moving towards a more socially just world.

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