Sociocultural Influences On Undergraduate Women's Entry into a Computer Science Major

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Abstract

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Computer science not only displays the pattern of underrepresentation of many other science, technology, engineering, and math (STEM) fields, but has actually experienced a *decline* in the number of women choosing the field over the past two decades. Broken out by gender and race, the picture becomes more nuanced, with the ratio of females to males receiving bachelor's degrees in computer science *higher* for non-White ethnic groups than for Whites. This dissertation explores the experiences of university women differing along the axis of race, class, and culture who are considering majoring in computer science in order to highlight how well-prepared women are persuaded that they belong (or not) in the field and how the confluence of social categories plays out in their decision. This study focuses on a university seminar entitled "Women in Computer Science and Engineering" open to women concurrently enrolled in introductory programming and uses an ethnographic approach including classroom participant observation, interviews with seminar students and instructors, observations of students in other classes, and interviews with parents of students.

Three stand-alone but related articles explore various aspects of the experiences of women who participated in the study using Rom Harré's positioning theory as a theoretical framework. The first article uses data from twenty-two interviews to uncover how interactions with others and patterns in society position women in relation to a computer science major, and how these women have arrived at the point of considering the major despite messages that they do not belong. The second article more deeply explores the cases of three women who vary greatly along the axes of race, class, and culture in order to

uncover pattern and interaction differences for women based on their ethnic background. The final article focuses on the attitudes and expectations of the mothers of three students of contrasting ethnicities and how reported interactions between mothers and daughters either constrain or afford opportunities for the daughters to choose a computer science major.

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Ethnographic work can only be conducted with the willingness of a great number of people to share their experiences and life stories with a researcher. I have been repeatedly astounded at the grace and strength present in the women's lives I glimpsed as part of this study. I am profoundly grateful to and awestruck by each of the participants. I would like to give a special acknowledgement to Raven Alexander, who not only was willing to have me conduct my research in her class, but gave of her own time and knowledge to support me in my work.

This work has been possible through the support of many at the University of Washington, particularly my graduate committee. Dr. Philip Bell graciously stepped into the role of advisor when called upon. Dr. Deborah Kerdeman consistently pushed my thinking in new directions as far as possible, thereby expanding my horizons. Dr. James A. Banks not only shared his vast knowledge and experience about multiculturalism, but did so with a twinkle in his eye. Dr. Sapna Cheryan gave me an entrée into graduate study on women in computer science. Dr. June Lowenburg provided her warm support at a critical time. And, finally, Dr. Angela B. Ginorio provided the heart that made it all seem worthwhile.

Many other faculty, students, and staff both at the University of Washington and elsewhere as well as friends and family answered questions, gave feedback, lent a listening ear, and generally cheered me on. I am grateful to all of you.

DEDICATION

To all those who have labored to bring forth the true Feminine:
Our ancestors, who created the ground
Our contemporaries, who are re-imagining the space
Those to come, who will create new tools

Introduction to the Dissertation

When sitting in classes towards my degree in computer science, I used to count the number of women and the number of men in each class. Why, I wondered, were there consistently only about twenty percent women in each of my classes? During my years of working as a software engineer and teaching computer science classes, I saw no improvement in this proportion. Later, while assisting in a social psychology lab researching the effect of stereotypes on women's interest in pursuing computer science, I discovered two interesting details: the proportion of women pursuing computer science majors has *dropped* from a high in the 1980s, and the ratio of females to males receiving bachelor's degrees in computer science is actually *higher* for non-White ethnic groups than for Whites. Returning to the university to purse a PhD, I decided to make this the focus of my research. I had experienced a variety of interesting jobs using my computer science degree—from product demonstrations at trade shows to team programming to teaching—and I believed that women were dissuaded simply through being unaware of all the possibilities open to them with a computer science degree. I was also convinced that scientific research into underrepresentation would uncover sociocultural deterrents to women rather than a biological basis for the inequality, thereby making possible changes that would lead to a more balanced representation in the computer science field.

During my years of doctoral coursework, I discovered that the computer science and engineering department at the university offered a seminar entitled "Women in Computer Science and Engineering" every academic quarter that was intended to provide information to new female programming students about computer science and related majors and to attempt to counterbalance some of the forces that conspired to push women away from computer science majors. The instructor for this course was a member of the academic advising staff of the computer science department who was interested in broadening participation in computer science and who had taken over the course, created by a concerned graduate student, some years before. With her full support, I decided to make the seminar the focus of my dissertation work. Since the power of an ethnographic approach lies in deeply understanding

sociocultural influences upon us and to tapping into the thoughts and feelings of participants, I chose such an approach centered on the seminar and the women in it.

Framing the Problem and Research Questions

The interest in, and therefore the body of research about, underrepresentation in Science, Technology, Engineering, and Mathematics (STEM) is enormous. Because of my background, I chose to focus solely on the field of computer science and the corresponding body of research, pulling only minimally from research on other STEM areas. I believed that focusing on computer science to the exclusion of other areas was appropriate, given that the research and literature from the other STEM disciplines cannot necessarily be applied to computer science due to a number of differences between computing disciplines and other STEM disciplines (Zarrett, Malanchuk, Davis-Kean, & Eccles, 2008). Patterns of participation, for example, are different between fields, with biological sciences attracting more women than men, while computer science and engineering not only attract fewer women than men but also attract a declining proportion of women. During the K-12 years of schooling, STEM classes such as math and biological or chemical sciences are required for all students, while computing classes are either not offered or are categorized as electives. One might conclude from course requirements that math and science are important while computing is not, which makes comparisons difficult. Computing is most closely associated with the math field, yet instruction in the two fields is quite different with computing being laboratory based. Wider student preparation is offered in technological fluency than in academic computing, while math and science courses are geared toward academic preparation for college. Therefore, most students enter college prepared for math and science courses but unprepared for computer science (J. Margolis, Estrella, Goode, Holme, & Nao, 2008). Due to these differences, research and literature on the wider STEM disciplines can only be used sparingly and cautiously in explaining the current situation for women pursuing and entering the computer science field.

Although there are a number of disciplines under the “computing” or “information technology” umbrella, the literature differentiating computer science, computer engineering, information systems, information science, and informatics is too sparse to make distinctions between the fields for women and

minorities (Cohoon & Aspray, 2008). However, I have chosen to focus on computer science for this study since it is a field that has a bachelor's degree offered at many postsecondary institutions and has interesting patterns of representation as well as being a field with a low representation of women. In addition, it is the field I am most familiar with due to my own background of a master's degree in computer science and a number of years working as a software engineer. Findings from the other computing fields are included when applicable in this literature review under the assumption that the issues raised are similar for women and minorities pursuing computer science.

Rom Harré's "positioning theory," borrowed from cultural psychology, gave a useful theoretical framework for data analysis for this study. Harré theorizes how interactions with others and larger sociocultural patterns influence the rights and duties given to individuals to act—in this case, to choose a college major (Harré & Moghaddam, 2003). Harré posits how interactions with others and patterns in society work together to give affordances or constraints to the rights and responsibilities that individuals—or even groups—have in a domain. Harré visualizes a "positioning triangle" in which the points of the triangle are formed by position(s), illocutionary force(s) (also called "speech and other acts"), and storyline(s) and in which the sides are the bi-directional influences between these points. In this triangle, "a position can be looked at as a loose set of rights and duties that limit the possibilities of actions" (Harré & Moghaddam, 2003), speech and other acts are "a socially meaningful and significant action" (Harré & Moghaddam, 2003), and a storyline is a taken-for-granted pattern of interaction. The process of positioning can either be explicit and deliberate or seemingly natural patterns of the way things are. Individuals can resist positions thrust upon them and attempt to reposition themselves, although success is not certain.

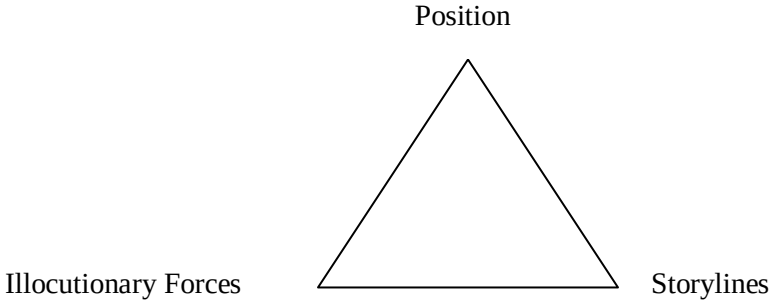

Figure 1: Harré's Positioning Triangle

With positioning theory, Harré breaks away from the laboratory setting of much of psychology in order to study meanings as understood by participants in their everyday settings. The focus of positioning theory is on episodes of social interaction and what is socially possibly in these interactions—usually a subset of what is logically possible—as episodes unfold following expected patterns or cultural storylines. The underrepresentation of women in computer science suggests that there are cultural and societal storylines in the United States that direct interactions and position women as not belonging in the field of computer science, and the purpose of this study was to explore interactions related to computer science with women interested in majoring in the field and to discover the storyline patterns guiding these interactions.

I have broken down the themes in the literature on barriers and supports to women and minorities in computer science into several sources of contextual and structural influence: the home/ethnic community of the student, schooling, the computer science culture, and the U.S. society at large. In the midst of these influences, women make choices and accept or resist the pressures put upon them; this study investigated this personal agency by women, focusing on those who are going against the norm. Miles and Huberman note that a "conceptual framework explains, either graphically or in narrative form, the main things to be studied—the key factors" (Miles & Huberman, 1994). The conceptual framework for this study includes a set of women and their interactions with parents, friends or peers, and instructors within the contexts of home and ethnic community, schooling, and computer science: all within the U.S. sociocultural context.

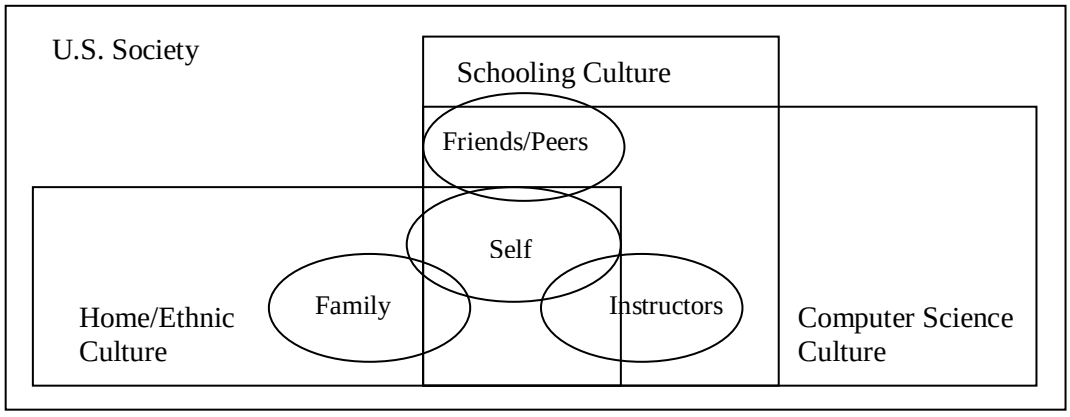

Figure 2: Examined influences on major choice

For each of the women studied, the influence of the home and ethnic background of the student showed up in how parents, friends, and the home culture served to encourage or discourage women from pursuing computer science. Once children begin in school, the culture of schooling and interactions with teachers and school peers can influence women strongly in decisions about what subjects are appropriate and interesting for the student. Beginning in high school and continuing through college into the workplace the culture of computer science and interactions with other computer science students and workers influence women's view of the field and their possible place in it. All of these contexts and interactions are embedded in U.S. society, with its stereotypes and messages about what is appropriate for men and women of various ethnicities. The woman herself sits in the middle of this sea of influences, either conforming to or resisting the expectations of others. This study investigated how these interactions and contexts affected the entry into a computer science bachelor's degree program by women of different ethnicities.

The Influence of U.S. Society

Tightly held beliefs in United States society serve to make the lack of women and minorities in computer science a natural, unquestioned occurrence. Stereotypes of what type of people are smart and who lacks intelligence mean that women and underrepresented minorities are seen as incapable of handling the rigorous work computer science demands. The search for the "best and brightest" minds to fill STEM fields allows inequities to be justified on the basis of so-called objective measures. The American cultural value of the pursuit of happiness enshrined in the Declaration of Independence can lead to a perception that personal choices are best based on individual interest. These three attitudes influence the representation of women and minorities in computer science.

U.S. society has strong stereotypes about the "innate" abilities of people of different genders and races that serve to privilege some groups in some arenas while excluding other groups. For example, the stereotype threat literature shows that the activation of the stereotype of women's alleged inferiority in math can lower scores on a math exam (Spencer, Steele, & Quinn, 1999), which may cause women to shy away from the STEM fields (Davies, Spencer, & Quinn, 2002). African American students, long

stereotyped as inferior at school subjects, have been found to perform at decreased levels on tests framed as diagnostic of intelligence (Steele & Aronson, 1995) serving as a barrier to rigorous fields such as computer science.

Some stereotypes, in contrast, may position groups as belonging in STEM fields such as computer science even when conflicting stereotypes would deny entry. As part of the stereotyped "model minority," Asian American women have been found to perform better on a quantitative test when their Asian American social identity, stereotyped as having superior quantitative skills, was made salient rather than when their female identity was made salient (Shih & Pittinsky, 1999). In spite of the problematic nature of the "model minority" myth, if Asian American women foreground their Asian identity over their female identity, perhaps this positioning helps them resist the stereotype threat that labels women as inferior in math, encouraging them to consider a computer science major.

In the United States, STEM fields are reserved for what government and university officials deem the "best and brightest" (NRC, 2006). However, by using a presumed objective yardstick of cognitive ability, such as SAT scores, to measure the "best and brightest," these officials conveniently ignore the outrageous inequities in schools and classrooms that lead to different outcomes for students of different social classes and ethnicities regardless of their cognitive ability as well as the cultural bias in most tests. Margolis et al. (2008) object to the "best and brightest" language used in works such as the "Gathering Storm" report (NRC, 2006), noting that who is allowed to be considered as the "best and brightest" is—in practice—based on faulty, biased measures.

As part of the value of individuality in the United States, the right to personal choice based on interest is held up as an ideal. Margolis and Fisher (2002) and Margolis et al. (2008) note how the lack of women and minorities in computer science is normalized by simply attributing it to a personal choice based on a "lack of interest" in computer science on the part of these populations. Their projects problematize this myth by showing how external factors serve to prevent minorities from access to computer science and to cause women to lose confidence in their computer science skills, both of which prevent or lower interest in pursuing the field.

Margolis and Fisher (2002) note that by using the way boys' interest in computer science looks as the measuring stick, girls' interest is unrecognizable by comparison. Girls' modest, gradual interest in computers is compared unfavorably with the gold standard of boys who seem to come out of the womb passionate about computers. For girls, an interest in computers and computing is often one interest among many, whereas boys' interest is all-consuming. Due to this plodding rise in interest sometimes indistinguishable from other interests, women are viewed as not being attracted to computing. However, Margolis and Fisher (2002) emphasize the danger of dismissing the lack of women in computer science as simply a lack of interest in the field. The perception of computing as "male territory" results in girls' interest rarely being kindled.

Any possible interest girls have in computer science can be nipped in the bud through a crisis in confidence fed by a lack of experience. Confidence and interest are tightly interwoven for girls (J. Margolis & Fisher, 2002). By high school, girls have lost confidence in their math and science ability, which could serve to make them disinclined to pursue subjects such as computer science that are seen as being math-based. Girls can become caught in a downward spiral of declining confidence and interest leading others to excuse their departure from computer science as simply a lack of interest. The drop in confidence in computer science for girls can be fed by the difference in computing experience between girls and boys. Before reaching high school, boys have had much more informal computing experience than girls, which serves to make girls feel inadequate in programming classes and to feel a lack of confidence in the field. Seeing boys take to programming with ease leaves girls thinking that it is something they cannot do well. Once they enter college, confidence drops for women again (Seymour & Hewitt, 1997), sometimes leading to less interest in a computer science major.

For minorities, the denial of access to quality learning experiences in computer science leads to inequalities in interest. Margolis et al. (2008) found that predominantly minority high schools in the Los Angeles area offered only technical literacy classes, not computational thinking or programming classes. For underrepresented minorities in majority white high schools, the computer science classes formed part of a school-within-a-school dominated by white and Asian males and unfriendly to minority students.

Because of this lack of access to classes at a critical stage, minority students never developed an interest in programming and in computer science.

The Influence of Home and Ethnic Community

The home environment, influenced by ethnic background and community, can manipulate the pursuits and interest of children (Bell, Lewenstein, Shouse, & Feder, 2009; Barron, 2004; Crowley & Jacobs, 2002). The accessibility of computers in the home, the role modeling of parents, and expectations about ability and interest all play a part in how girls see their relationship to computers and computing (J. Margolis & Fisher, 2002). Families of various ethnic groups can display different attitudes about schooling, fields of work and study, and gender roles; parents will then attempt to pass these on to their children, thereby influencing options and choices made in school and in the workplace.

At a very early age children begin to differentiate between toys that are for boys and toys that are for girls, and computers can become one of the toys that are differentiated (J. Margolis & Fisher, 2002). Where the computer is located in the home and the use it is put to can send a strong message to girls--a computer in the boy's room, for example, limits access to sisters. Who uses the computer in the home and how it is used gives subtle messages to children. Margolis and Fisher (2002) found that father/son apprenticeships on the computer may discourage girls who are left out of this bonding. If the father in the house uses the computer while the mother is uncomfortable or illiterate with computers, children may translate this to mean that computers are not for women. Access to informal computer usage in the household can have later repercussions when girls who are told not to mess up the computer take away the message that they lack ability with the computer. Barron (2004) found gender differences in computer use including fewer females having programming experiences and sources of learning about computers which discouraged their interest, while girls who have a parent that works in the computer science field encouraged their pursuit of computer science. If women are encouraged to use technology informally at home they may have experiences that pique their interest in the computer science field (Stout, Dasgupta, Hunsinger, & McManus, 2011). Seemingly small actions at home can add up to strong barriers for women to choose computing later in life.

As children move into their teenage years, the influence of their peer group can become important. For girls whose confidence is waning, expressed confidence by friends can prop up their flagging confidence and interest (J. Margolis & Fisher, 2002). Friendships around computing can be a particularly important support; boys often build friendship groups around the computer thereby reinforcing their confidence and interest while girls do not.

The ethnic background and community of the student can have important results in school success, particularly in STEM fields. Some Asian American groups have great schooling success due to the cultural influences on young people (Mordkowitz & Ginsburg, 1987). Ethnically Asian parents, for example, may expect their children to succeed within narrowly defined academic and career options (Dundes, Cho, & Kwak, 2009). Students coming from ethnic populations where school achievement in math and science are particularly valued are influenced to succeed in STEM fields such as computer science by their ethnic community.

Gendered expectations, varying by ethnicity, result in different outcomes for men and women. Filipino families, for example, have different expectations for girls in the home and school environments, viewing women as belonging in the home rather than pursuing an education (Maramba, 2008). With the strict prerequisite demands for a computer science major, girls who do not keep up with rigorous academic subjects in their K-12 years due to family demands will be unprepared to enter a computer science major in college. Ethnic groups that view computer science as an appropriate career path for women may suggest or encourage pursuit of the field in contrast to groups that do not see the field as properly feminine.

The Influence of School

School is an important site along pathways to computer science as it is where students with limited or no access to computers at home can have access to computers and where programming and computer science are first introduced to many students. In the lower grades the gendering of computers as male and who gets to use the school computers in practice can limit access to girls and minorities (J. Margolis & Fisher, 2002; J. Margolis et al., 2008). High school is an important site for formally

introducing students to programming, but the lack of classes, the poor pedagogy, and expectations about who is interested and able to do well in programming end up eliminating computer science offerings or making them segregated sites dominated by white and Asian males. College prepares students to enter the workforce in computer science fields, but a drop in confidence by women about their capabilities in STEM field upon entering college discourages them from pursuing computer science. At each of these stages the lack of women and minorities is considered a normal result of their "lack of interest."

High school can be a critical time for trajectories of girls and minorities along the computer science pipeline. It is in high school that students in some school districts can first be introduced to programming and to the field of computer science in school, particularly if they do not have computing resources at home, although minorities stuck in overcrowded schools may never get the opportunity to try programming even if they are interested (J. Margolis et al., 2008). For both minorities and women, the content of high school introductory programming classes can serve as a barrier to entrance into the field. Margolis et al. (2008) found that even when programming classes were offered in predominately minority high schools the poor pedagogy discouraged students from any further interest, illustrating that out-of-school time could be an important site for broadening STEM participation (Bell et al., 2009). Assignments in the class consisted of typing in pre-existing programs and running them; no critical thinking or problem solving skills were needed or encouraged. Students found the assignments boring and unrelated to their future plans, which caused them to drop out, in line with findings that relevance is key to engaging non-dominate youth (National Research Council (U.S.) Committee on Increasing High School Students' Engagement and Motivation to Learn, 2004). Margolis et al. (2008) found the curriculum distressing, as it hides the creative, interdisciplinary nature of the computer science field.

For girls the gender-specific high school programming curriculum, such as programs to calculate sports statistics, turned off their interest in the subject (J. Margolis & Fisher, 2002). In addition, the interdisciplinary nature of computer science has been ignored in high school programming classes in favor of the technical aspect of programming which favors the interest of many more boys than girls. These barriers can cause girls to choose other fields before they even explore computer science.

At the college level, the barriers to entry in engineering fields such as computer science such as "weed-out" classes and the drop in mathematical confidence discourages girls more than they do boys. Seymour and Hewitt (1997) note that the unofficial weed-out tradition of extremely difficult introductory classes paired with a lack of faculty assistance that serves to eliminate most potential majors is particularly strong in engineering and has a disproportionate impact on women as well as minorities. At the same time, women's confidence in their mathematical ability drops during the college years more rapidly than men's (Sax, 2008). College becomes another level of schooling where women and minorities are lost out of the computer science pipeline.

For women and minorities, respectful relationships with teachers can provide critical support in persisting in computer science (J. Margolis & Fisher, 2002). Zeldin and Pajares (2000) found that others' expressed confidence in women's abilities was a key characteristic of women who persisted in math-related fields, and teachers were often the ones that expressed this confidence. When moving into college, women interested in pursuing computer science can find themselves adrift without the close, encouraging relationships with teachers, and—failing to find someone who expresses interest and confidence in their computer science ability—they drop out (Seymour & Hewitt, 1997).

The climate of the classroom itself can serve as a barrier to women and minorities interested in computer science. At the college level, the "chilly climate" for women in STEM classrooms that Hall and Sandler (1991) found still persists. The existence of "microinequities" (Rowe, 1990) in the classroom can make the classroom an unfriendly place for women and minorities. Interactions with peers and teachers that consistently question the ability of female and minority students and their right to be in the class can lead women and minorities to feel uncomfortable and to conclude that they do not belong in STEM classes.

Computer science is built around adolescent male sensibilities (J. Margolis & Fisher, 2002), which can make the classroom at least an uninteresting and usually an unfriendly place for girls. More recently and earlier in the pipeline, Margolis et al. (2008) found that high school computer science classrooms were demeaning to and exclusionary of women. Males that have previous programming

experience were found to harass women in the class for their perceived lack of knowledge, to be disdainful of the questions girls ask and to dominate class time to show off their own knowledge and ability. The use of humor that references obscure computer knowledge can serve to make women feel out of place as well.

At the high school level, a deficit model held by teachers and administrators prevents minorities from even entering the computer science classroom (J. Margolis et al., 2008). School staff laments the lack of interest in learning in the home lives of students and parents that are indifferent to school. Underrepresented minorities are viewed has having an impoverished home environment that prevents them from excelling in school, particularly in a field where one must be smart to succeed. These low expectations can then discourage administrators from offering computing classes in predominately minority high schools and to steer minorities away from entering such courses even in high schools where computing classes are offered. Without exposure to programming, minorities can be prevented from developing an interest in the computer science field.

The Influence of the Computer Science Field

Although computer science began as a field friendly to women and unknown to outsiders, the building in the 1980s of a strong hacker and nerd/geek mythology around computer science may have served to become a barrier to the entrance of women into computer science (Misa, 2010). Computer science has become the domain of white and Asian males, and cultural and structural barriers have been put in place for those that do not fit the mold. From cartoon figures to Star Wars and Star Trek adulation to junk food, the very air that computer scientists breathe has become strongly stereotyped and discouraging to women (Cheryan, Plaut, Davies, & Steele, 2009).

The perceived all-consuming nature of computing fields from the university through a career can form a barrier to women and minorities entering computer science. Malcom and Malcom (2011) note the high cost of becoming a scientist in energy, commitment, and endurance that women and minorities may not be able to pay. Seymour and Hewitt (1997) note that women switch out of STEM majors because they think that continuing will come at too high a cost to other valued parts of their lives.

Upon entering the field, a further deterrent is the myth of the male computer geek that is damaging to women (Cheryan et al., 2009; J. Margolis & Fisher, 2002; Misa, 2010). Not only does this myth send the message that women and minorities do not belong, but they also must contend with the self-doubt that comes from peers questioning if they are smart enough for computer science based on their gender or race (J. Margolis et al., 2008). With the high price of pursuing a field that one does not fit into it is perhaps not surprising that women and minorities do not enter computer science in higher numbers.

Through finding other like themselves or who are supportive of their participation, women and minorities can inoculate themselves against the prevailing discouragement against pursuing computer science. Walton and Cohen (2007) found that a feeling of belonging may help underrepresented and stigmatized students have a more optimistic outlook on college experiences. Margolis and Fisher (2002) tell the story of a high school girl who created her own "posse" of support by convincing her girlfriends to take computer science class with her. Triesman (1992) noted the importance of peer study groups for Chinese college students and brought this support to African American students studying calculus. Having supportive computer science peers can foster a feeling of belonging and provide academic support for underrepresented students.

When women compare themselves to their male peers who have a burning intensity of focus and who complete programming assignments with ease they can become discouraged and disenchanted with computer science (J. Margolis & Fisher, 2002). The constant refrain of "you only got in because you are a girl" can erode women's confidence and encourage them to drop out of the field. Without a supportive group of peers, women and minorities can fall victim to a sense of isolation and continued comparisons that find them coming up short. The view of computer science as a "masculine" field (Misa, 2010; Stepulevage & Plumeridge, 1998) automatically excludes women from belonging in the field. For women to choose and persist in computer science, they must find a way to fit into the field, as their gender renders them automatically excluded from the norm. As part of this masculinity, computer skills are fostered by risk-taking behavior which is encouraged in boys but not in girls (J. Margolis & Fisher,

2002). Computing can also serve as a site where boys escape from relationship, which can discourage girls—socialized to value relationship—from being attracted to computers and computing.

The Influence of Personal Characteristics

Despite the strong barriers to women and minorities in computer science, some do persevere and go on to find pleasure working in the field. The agency of individuals cannot be discounted in exploring how some women and minorities experience success in pursuing and persisting in computer science. Personal traits can impact the choices women make along pathways to computer science majors and careers.

In studying women who succeed in math-related fields, including computer science, Zeldin and Pajares (2000) found that strong self-efficacy beliefs, especially through verbal persuasion and vicarious experience, facilitated women's persistence in male-dominated fields and were more influential than mastery experiences. Women gain a sense of efficacy through being encouraged in their pursuits and through seeing others whom they know succeed; such experiences help women feel a sense of self-efficacy that strengthens them to face day-to-day discouragement.

Stevens, O'Connor, and Garrison (2005) argue that identity, or identification, is a key in student development and keeping students in engineering majors during college. Even earlier, gendered identity regarding science influences the participation of boys and girls in scientific pursuits (Bell, Lewenstein, Shouse, & Feder, 2009). For women who major in computer science, their identity as "computer scientist" must be formed against prevailing stereotypes if they are to continue in the field. Stevens, O'Conner, and Garrison argue that identity, in contrast to "self," is both self-understandings and how one is viewed by the surrounding people and institutions. Women who succeed in computer science can take on the identification of "computer scientist," helping them overcome barriers to participation in the field.

In the case of computer science, a choice of major is often also a choice of career. Because of this, personal goals for a career are important in discovering why some women are attracted to computer science. Since job prospects are good in computer science (Bureau of Labor Statistics, 2009) and engineering students pride themselves on the perceived difficulty of their field and expect a comfortable

lifestyle as a reward for the hard work (R. Stevens, Amos, Jocuns, & Garrison, 2007), women who seek a high standard of living for themselves or for their family or community may not be deterred by the difficulty of computer science and may persist in expectation of positive future outcomes.

Personal views about intelligence and failure affect achievement. Dweck (2002) has found that students who see intelligence as fixed are less likely to persist in areas where they do not think they have the intelligence. Students who see intelligence as malleable, on the other hand, are more likely to persist and work harder to accomplish their goals. Dweck, Goetz, and Strauss (1980) found that there were gender differences in how students attribute failure to a certain cause. In particular, women were more likely to blame lack of ability than lack of motivation for their failures. If some women are more likely to see intelligence as malleable and are more likely to blame lack of motivation for their failures, they may be less likely to be discouraged when they have to struggle to accomplish tasks and they may be more persistent in the face of any difficulties they encounter in pursuing computer science.

Overarching Research Questions

The overarching research question guiding this study was: How does the confluence of gender, race, and class play out in women's decision to major in computer science? In particular, for women entering the university interested in majoring in computer science:

- How have their past experiences at home and in school afforded or constrained their motivation to major in computer science? How have their lives as part of their ethnic community and the U.S. society afforded or constrained their motivation?
- How have these women shown agency in their choices leading up to their pursuit of a computer science degree? What strengths do they draw upon to continue working towards a competitive, male-dominated major in college?
- As these women immerse themselves in lower division coursework at the university, how do the formal classroom contexts and informal study contexts position them in relation to possible majors? How are different contexts hostile or welcoming to the participants? How do

participants make meaning of their experiences in different contexts, and how does this manipulate their feelings of belonging and identity?

- How does the culture of the computer science field as experienced in lower division classes, in stereotypes, in interactions with peers, and in anticipated futures influence these women's feelings of belonging and identity?

Overarching Study Design and Local Context of the Study Site

The Women in Computer Science and Engineering seminar is open to all women enrolled in the two-quarter introductory programming sequence at the university. The seminar instructor emails all women enrolled in introductory programming classes before the start of each quarter to summarize the class and to invite them to enroll in the one-quarter seminar (see Appendix A). The seminar has several formats for class sessions, including small group discussions, panel presentations, and research demonstrations (see Appendix B). On the days of small group discussion, students are asked to read several articles on the topic, answer a series of questions relating the readings to their personal experiences and observations on the online discussion board for all to read, and then to discuss the articles and their postings in small groups during class time. On two small group days of the seminar, the articles and discussions were directly focused on the issue of the underrepresentation of women in computer science. I designed this study to document the Women in Computer Science and Engineering seminar, the students in it, and the academic surroundings for those students during one academic quarter. In preparation for the study, I observed several sessions of the seminar during the previous quarter. Based on these observations, I planned the videotaping of the seminar, discussed details of the planned study with the seminar instructor, and worked out interview protocols based on ideas gathered from seminar observations as well as previous research and my conceptual framework (see Appendices C to H).

The first day of the seminar, I explained this study to the class and gave all students human subjects forms that requested their participation at various levels (see Appendix J). The levels of participation included: a demographic questionnaire attached to the human subjects form, field notes during the seminar, videotaping of the seminar, class homework discussion postings on the seminar

online discussion tool, one-on-one interview(s), observation and field notes in other classes, observation and field notes in informal settings, and interview with the participant's parent(s). During the first class session, I also passed around a signup sheet for interviews, and a number of women in the seminar signed up for days and times to be interviewed in the first days of the quarter. In addition to student participation I also sought interviews with the seminar instructor, the seminar teaching assistant and introductory programming instructors. I acted as a participant observer in the seminar, joining small group discussions and posting answers to discussion questions in the online discussion tool. I never spoke or wrote first, always adding my voice in the middle of the verbal or posted discussions. I did not speak about research findings or my knowledge of the research on women and computer science, but instead spoke and wrote about my own personal experiences as a computer science student and software engineer in school and in the workplace. In general, students in the class listened to my contributions, but did not ask me questions about my experiences or my knowledge of the field. After interviews, a few students wanted me to tell them how to be accepted into the computer science major, and I directed them to the seminar instructor as I was not able to answer those questions with authority. Since I was participating in class as well as observing, an undergraduate volunteer research assistant from my graduate laboratory operated the video cameras and supervised the videotaping during the seminar sessions.

Generally the seminar of interest has about twenty or twenty five students enrolled each quarter, according to the instructor. For some unknown reason, before the quarter under study, almost fifty students had registered for the seminar by the first day. Due to this, the instructor moved the class to a larger room and pre-assigned groupings for the days when the class would have small group discussions. Otherwise the seminar was similar to other quarters, according to the instructor. By the end of the quarter, several students had dropped the class and enrollment was down to less than forty-five students. Since that quarter, seminar enrollment has descended to its more traditional size.

By the end of the quarter, data collected for this study included videotapes of each seminar session from three cameras placed around the room, demographic questionnaires from almost all seminar students, videotapes of interviews with twenty two seminar students, second interviews with five of those

students, three mothers, the seminar instructor, the seminar TA, and a CSE instructor, field notes from classroom observations in the seminar and five outside classes and two labs, and homework online discussion postings (see Appendix I). I did not collected any data from informal settings, as all the women interviewed told me that they were forbidden to work with others on introductory programming homework and I could not discern that there were any settings in which it would be instructive to observe the study practices of students. I interviewed and observed several class sessions for only one introductory programming instructor, a female, as the other two instructors, both male, were unresponsive or hostile to my request to observe participants in their classroom and/or to interview them.

For the most part, I arranged interviews and classroom observations by email directly with consenting students. For initial interviews at the start of the quarter, I emailed all students who had agreed to be interviewed that had not signed up on the first day sheet to arrange interview days and times. I was able to find agreeable days and times for most of the students; a few said they were too busy to be interviewed in response to my email. I sent email reminders to students one day before their scheduled interviews. I had collected a list of "other classes" in the demographic questionnaire at the start of the quarter, and I was able to use this to find math, science, and technology classes in which I could observe some students. I emailed instructors of these classes, and received permission to observe consenting students in one astronomy class, two math classes, and one informatics class over three days of each class and one lab section of informatics. Before my observations, I emailed participants to notify them of my schedule of classroom observations. I sat at the back or side of the class and observed and took field notes. I was only acknowledged and asked to introduce myself and say a word or two in one class, the informatics class. I also observed and took field notes in one introductory programming quiz section associated with the introductory programming lecture class I observed.

Format of the Dissertation

This dissertation consists of three stand-alone articles designed for separate publication. All of the articles are unique analyses of a subset of data collected as part of the larger dissertation research study. As described above, the larger study had a framework and design that encompassed more data

than could be analyzed and written up for one publishable article, but each article has its roots in the framing of the larger study. Due to the chosen format for this work, there is some redundancy between the articles, as each article contains its own framework and study methods which have similarities among them.

Article one focuses on inspecting the interests, beliefs, and experiences of twenty two women who were considering majoring in computer science and then recommending ways to attract more women to a computer science major. Article two closely examines the cases of three women who vary significantly along the axes of race, class, and culture and who are considering majoring in computer science. This case study explores the perspectives not only of the three women but also of their mothers on what barriers and supports the women found along their way to consider majoring in computer science. Article three investigates the perspectives of three mothers of potential female computer science majors who differ greatly along the axes of race, class, and culture. All three mothers were interested in their daughters' education, but the amount and specificity of the support they were able to offer to their daughters in a choice of major varied.

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Chapter 1:

To Major or Not to Major: Female Computer Science Students, Wherefore Art Thou?

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Abstract

Margolis and her colleagues laid a foundation for understanding underrepresentation in computer science through studies on differential preparation for high school students in readying them for a computer science major at the university and on why women leave computer science at the university. This study investigates the pivot point between these two works: how women who have adequate high school preparation to major in computer science are deciding on a major and the sociocultural influences on this decision. Rom Harré's "Positioning Theory" is used to foreground cultural and societal storylines that influence women in their choice of a major. This study used interviews with twenty two students to investigate how women are thinking about majors, to reveal the storylines based on interactions that inform their thinking, and use these storylines to draw conclusions and make recommendations for interventions to increase the representation of women in computer science.

To Major or Not to Major: Female Computer Science Majors, Wherefore Art Thou?

Foundational qualitative work has been done to understand underrepresentation in computer science, first exploring experiences of undergraduate women (J. Margolis & Fisher, 2002) and then experiences of underrepresented minority students in high school (J. Margolis, Estrella, Goode, Holme, & Nao, 2008). With a bachelor's degree the standard credential for obtaining many computing jobs (Goode, Estrella, & Margolis, 2008), who is obtaining these degrees becomes an important focus of work investigating the pipeline of women entering and persisting in computer science. This qualitative study provides an in-depth look at the meanings that women made of the factors that affected their choice of a major. Reasons that have previously been found to discourage women from choosing computer science were investigated with the study participants, but the nature of a qualitative study also persuades participants to reflect on their own experiences to uncover aspects that do not appear in earlier research. This study attempted to paint a detailed picture of experiences of over twenty women at a large, public university in the United States to illuminate the experiences that encourage or discourage women from considering a major in computer science.

Theoretical Framework

Rom Harré's "positioning theory," from cultural psychology, shaped the theoretical framework for this study and was the lens used to analyze the data. Harré theorizes how interactions with others and larger sociocultural patterns influence the rights and duties given to individuals to act—in this case, to choose a college major (Harré & Moghaddam, 2003). Harré posits how interactions with others and patterns in society work together to give affordances or constraints to the rights and responsibilities that individuals—or even groups—have in a domain. Harré visualizes a "positioning triangle" in which the points of the triangle are formed by position(s), illocutionary force(s) (also called "speech and other acts"), and storyline(s) and in which the sides are the bi-directional influences between these points. In this triangle, "a position can be looked at as a loose set of rights and duties that limit the possibilities of actions" (Harré & Moghaddam, 2003), speech and other acts are "a socially meaningful and significant action" (Harré & Moghaddam, 2003), and a storyline is a taken-for-granted pattern of interaction. The

process of positioning can either be explicit and deliberate or seemingly natural patterns of the way things are. Individuals can resist positions thrust upon them and attempt to reposition themselves, although success is not certain.

From this perspective, the choice of a college major is influenced by the interactions an individual has with others and the broader influence of societal patterns on these interactions, as well as the thoughts and beliefs of the individual herself. Harré's positioning theory gives a framework for investigating in what ways women are discouraged from or encouraged to pursue a computer science major through interactions with others and taken-for-granted storylines in the field and in society. In addition, the theory gives a way of seeing and understanding the strengths women draw upon to resist being positioned as not belonging in computer science. Using positioning theory allows the researcher not only to highlight predictable interactions and patterns, but also to uncover unpredictable interactions and covert storylines. Explicitly noting storyline patterns helps us draw conclusions about how women are socially discouraged from the field and to suggest interventions that may help us counteract the negative storylines.

The research questions guiding this study were:

1. What storylines regarding the suitability of a computer science major are suggested by personal statements made about how one should choose a major and the social interactions that women have with others?
2. How are these storylines involved in women choosing a computer science major, choosing a closely related major, or choosing a major unrelated to computer science?

Methods

This study is part of a larger ethnographic study. The larger study centered around a "Women in Computer Science and Engineering" seminar, including participant observation in and videotaping of the seminar, observations of seminar participants in other classes, interviews with seminar students, interviews with computer science instructors, and interviews with parents of students. This study is a qualitative work that includes data from semi-structured interviews with twenty two of the seminar students. Ethnographic methodology was the appropriate choice to understand how the participants made

sense of their world and their experiences that have been leading to a choice of major. Since I was interested in the natural history of the participants and what they perceived as the influences on their choice of major, in-depth qualitative interviews were the most appropriate methodology for soliciting the necessary narratives. I was interested in how my participants' beliefs influenced their academic paths. As Merriam states, "[t]he key concern is understanding the phenomenon of interest from the participants' perspectives, not the researcher's."(Merriam, 2009)

Settings and Participants

The research study was completed with students from a large, public university in the northwestern United States with a computer science program ranked highly in the nation. The Computer Science and Engineering major at the university requires application by and admission to interested students once they have completed the two-quarter introductory programming sequence, and admission is highly competitive. Exceptions to this admission process are the promising handful of students who are accepted either as "direct admits" out of high school or who are accepted through the "accelerated admission" process.

Since I was interested in women who had the educational background and the interest necessary to consider a major in computer science, I recruited participants from a seminar entitled "Women in Computer Science and Engineering" open to female students enrolled in the two-quarter introductory programming class sequence in the computer science and engineering department. Most of these women were at the beginning of their possible path to computer science, and I investigated what attracted them to the field. For this study I included interview data from the seminar students that agreed to be interviewed. Participants volunteered to take part after the study was described to the students on the first day of the seminar of interest. Interviewed participants included women of different ethnicities at varying numbers of years in college with a wide variety of experience with programming (see Appendix A).

Data Collection Strategy and Procedures

Twenty-two women from the Women in Computer Science and Engineering seminar agreed to be interviewed, and I video recorded and transcribed a semi-structured interview with each participant asking

about their past experiences leading up to their current interest in programming and possibly majoring in computer science as well as their current experiences in classes. Interviews were conducted the first two weeks of the academic quarter. Five women agreed to be interviewed a second time at the end of the quarter, and I recorded and transcribed a second interview with these five women in which I asked about classroom experiences and changes in plans for a major during the quarter. I prepared questions on topics that the literature suggested may be influential to women choosing to major in computer science, and these questions formed the basis for the interviews. Question topics included what interest the participant had in computers and programming over time, the support received from others, and perceived barriers. I also, however, was open to informant stories that highlight issues not uncovered in previous literature that opened new areas of inquiry. Interviews were necessary for this study because I was "interested in past events that are impossible to replicate," (Merriam, 2009) and in how each participant currently interpreted the world around her. Each interview lasted from about thirty minutes to over an hour.

Data Analysis

Several steps were taken to analyze the data for this study. All interviews were recorded and then transcribed to provide a word-for-word set of data, and responses to questions about what majors students were considering and associated influences were extracted from the interviews. Interview transcriptions were open coded using Dedoose software for five students to create an initial set of codes related to choosing a major. Codes included such items as "who majors in CS" where women described the qualities of people that major in computer science, "parental guidance" where women described interactions with their parents and the influence of this on their major choice, and "classroom experiences" where women described experiences and interactions in introductory programming classrooms and laboratories. These codes were then grouped by similarity to create six groupings (previous experiences, influences on major considered, images of CS majors/careers, experiences as a woman in a male-dominated field, who majors in CS, and usefulness of programming outside of CS). The remaining transcripts were then coded using these groups. Once all coding was complete, each group was examined to identify patterns identifiable in the quotations. In line with Harré's positioning theory,

these identified patterns suggested a set of storylines that surround the pursuit of a computer science major; some storylines aligned with findings in previous research, while others have not been documented elsewhere. Quotations indicating a similar pattern were grouped, the researcher labeled the storyline, and excerpts from the transcripts were used as supportive data to illustrate and contextualize each of the storylines. From these storylines, conclusions were drawn about how the experiences of women leading up to and including early years at the university likely encouraged or discouraged women from pursuing a computer science major. Implications for how to encourage broader representation followed from these conclusions.

Data Quality and Limitations

The design of this study allowed an investigation of the experiences of women who were enrolled in introductory programming classes, who may have been considering majoring in computer science, and who were interested in issues for women in the field. Because of time and resource limitations, the study design restricted possible participation to only women who enrolled in the Women in Computer Science and Engineering seminar during a single academic quarter. The purpose of the study design was to allow a deep examination of the experiences of the participants in real world contexts related to the learning of computer science. What is documented may relate to more general issues of gendered professional socialization, but that is outside the scope of this study.

Students who participated in this study were self-selected both in terms of their enrollment in the seminar and then their volunteering to be interviewed. The instructor of the seminar emailed all women enrolled in either the first or second quarter of the introductory programming class before the quarter began to tell them about the existence of the seminar, and the women who enrolled did so on a voluntary basis. In any given quarter, about five to ten percent of all women in introductory programming choose to enroll in the seminar. During the first class day of the seminar I explained this study to all the students and asked them to fill out human subjects permission forms that included an item asking if they would agree to be interviewed. I contacted these women and scheduled interviews; their agreement and schedules permitted twenty two women to be interviewed. Due to the self-selecting nature of

participation, participants may not be representative of the general population of women in the introductory programming classes at the university.

To minimize error and bias, the findings from this study have been member checked by the participants to ensure that my understanding matched what the participants meant during the interviews. Other sources of data, including online discussion tool entries and small group discussions about majors, were examined for supporting or disconfirming evidence for data triangulation. Storylines were not always consistently held by all students, and disconfirming evidence or data points that did not match the prevalent storylines were noted in the findings and sometimes highlight important theoretical issues.

From my position as an upper middle class Caucasian woman with a master's degree in computer science and many years of working in the field, first as a software engineer, then as a computer science instructor, I was situated well to research this topic. I understand discussions of programming work and programming techniques that came up in interviews. I am able to understand the language of computer science well enough to be fluent in acronyms and technology subjects that come up in this study. I also have an understanding of the kind of work and the educational and day-to-day frustrations of being a female computer science student. I attempted to minimize my bias by supporting my findings with the unfiltered words of the participants themselves and by doing member checking with the participants.

Findings

The data from this study indicate a number of storylines about choosing a major, and a computer science major in particular. Foregrounding these storylines can help us discuss how young women are thinking about majors and to make decisions based on how we might want to either exploit or change the storylines around computer science majors. Figure 1 shows a list of the storylines uncovered in this work and the associated messages students read into these storylines.

Storyline	**Meaning**
Pick a major based on what interests you	Students without exposure to programming are unlikely to know that they are interested in computer science and are therefore unlikely to choose it as a major.

Computer science is for those who like to sit in front of a computer all day	In general, young women do not like to be on the computer most of the day. The stereotype that doing so is required in computer science careers puts women off of considering a computer science major.
Those who will do well at programming/computer science are those who love computers—and/or videogames	Computer science is viewed as a major designed for students who love computers, particularly those who love videogames. Many young women see computers as a tool, not a toy, and therefore believe that computer science is not for them.
Those who will do well at programming/computer science are those who have experience	Young women come to the university with no experience in programming, so they do not consider majoring in computer science.
Writing HTML to create web pages is not programming	Young women who come to the university with experience in HTML programming discount that experience and therefore do not consider learning to program and majoring in computer science.
Introductory programming is fun and cool	At the university where this study was conducted, students appear to tell each other that introductory programming is a cool class, encouraging a diversity of students to try it.
Listen to your parents' ideas about majors	Some young women rely on advice from their parents when investigating majors. Therefore, stereotypes and misinformation about computer science can discourage women even when they do not hold mistaken views themselves.
Computer science is a good major to combine with a second major	Some young women interested in or pursuing other fields of study have found that computer science can enhance their career prospects.
Women are more likely to get in to a computer science major and job because they are underrepresented	There appears to be a prevalent view that women (and minorities) are more likely to be admitted into fields where they are underrepresented in order to diversify that field. Young women find this encouraging when they are considering applying to a computer science major.
Academically-minded students are "geeks," "nerds," or "dorks"	Young women describe themselves as "geeks," "nerds," or "dorks" in reference to their interest in academics. Although this does not appear to have the negative connotation of a computer "geek," it does position them as belonging in an academically difficult field such as computer science.
Knowing something about programming makes me question what is happening behind the scenes	Even young women who come to the university uninterested in computers can become curious about how they work with programming experience.

Table 1: Storylines and their meanings

Storyline: *Pick a major based on what interests you*

Most of the women indicated that they believed a major should be chosen based on one's interests. Amalie, for example, said "I guess it would have to be kind of what you enjoy doing." Sally

states this even more strongly, saying "I think you really have to be passionate about it." For some women, interested is tied to ability; after noting that it is important to enjoy the major, Sandra goes on to state "And another thing is, like, well, you also have to be realistic and think 'will I succeed in this?' too. But I think that if you enjoy it, then you can succeed in it."

A second factor in choosing a major mentioned by participants was career or financial possibilities. For some women, this was a secondary consideration after interest; Emma notes

> I think it's important to think about what you're going to enjoy doing for the rest of your life. And then, like, how much money that is going to get you. Like what kind of career you would get from that.

For a couple of the women the career or financial factor was the only one mentioned. When asked what a choice of major should be based on, for example, Lucy replied "Definitely how much money you can make in the job and the actual, like, careers available."

Since girls generally have a moderate, gradual interest in computers that is just one of their many interests (J. Margolis & Fisher, 2002), this storyline positions women as not belonging in computer science. Most of the participants in this study arrived at the university with no programming experience, and their pleasure in learning to program was surprising to them. For many of these women exposure to the intellectually stimulating and enjoyable introductory programming class was their first hint that they might be interested in a computer science major.

Storyline: ***Computer science is for those who like to sit in front of a computer all day***

The overwhelming idea that computer science is for those people—usually male—who like to sit in front of a computer all day was striking. Also notable was the contrast that participants made between this image and their interest in humanitarian causes, helping people, and social justice. In some cases, the interest in people over technology had caused women to intend to major in the informatics or human centered design and engineering fields simply because they thought that these other majors would allow them to obtain careers in which their work would focus on people. Even for those women who loved to

code, sitting in front of a computer all day was the one downside they saw to programming or to a computer science major.

Job shadowing an engineer who sat at his computer all day in a dismal office frightened Mónica away from considering an engineering major, as "I was like 'oh, my gosh, I can't do something like that, like, just sitting in front of a computer all day long; that's going to drive me insane!'" Dissatisfaction with business classes her first quarter, however, caused Mónica to reevaluate, conceding that

> right now it's either CSE [Computer Science and Engineering] or informatics [I am considering for my major]. And so I feel like either one will help with what I'm trying to do or what I want to do. Just because I really liked it in high school. I liked the whole engineering part of it. But I didn't know that there was more to it than just program a computer. So I feel like I can go out to other places and help other people.

During high school and Running Start at the community college, Amalie "had never even stopped to consider that people could major in computer science, really. Like, it always seemed like something you just, like, 'oh, people just program in their basements in the dark.'" Amalie new feels that she has

> a very informatics kind of approach to computer science, but I really feel like that's kind of where I rest, in kind of the mix between the two, because I really do love the technical aspect of it, but I also always want to keep in mind that, you know, it's great to build this thing, but we're building it for a purpose and, you know, how can we create that purpose and make sure we're focused on helping make sure the person can use it.

Kelsey has found that "CSE has actually become more interesting for me, because of, I think there's a lot more you can do with it than I thought. So I really like to do, like, community service." By the end of the quarter that we talked, Kelsey has been accepted into the human centered design and engineering major, but

> the only problem with HCDE [Human Centered Design and Engineering] is that I don't think you do a lot of programming, and I have, like, found that I actually really like it, so if I went into the

> field and found out, like, you don't actually get to do that much, I don't know, I might not like it as much.

When considering a computer science major, Kyleah takes into account that she "really like[s] making the programs and everything," but she

> just [doesn't] know if I can see myself doing that. Because I like to be more, like, interactive with, like, people, I guess. And, like, I like to do something where I feel like helping some people that actually, like, need some help rather than, like, just, like, giving people more luxuries.

In addition, it worries her that she "just, like, [doesn't] like being in front of a screen all day, you know?"

Even the most die-hard programming fans do not relish the thought of being in front of a computer all the time. Paula anticipates that what she would not like about upper division coursework is "sitting in front of a computer for a long time." What asked what she predicts that she might dislike about working in computer science, Lily imagines it would be "sitting in front of a computer the whole entire day. Like, I love coding and all, but I feel like after awhile it would get boring."

Introductory programming classes can support the stereotype that computer science is a narrow, isolating field (J. Margolis & Fisher, 2002), which positions women who are interested in interdisciplinary fields that build relationships and serve people as not belonging in the field. Participants in this study indicated that they had a variety of interests, in line with findings by Margolis and Fisher (2002), and they were not interested in computer science if it meant that they would spend all of their time working on a computer.

Storyline: ***Those who will do well at programming/computer science are those who love computers—and/or videogames***

Attitudes about computers varied among the women studied, but they shared a common perception that loving computers—or, in some cases, gaming—is a prerequisite to majoring in computer science. Women that had been neutral or even adamantly negative about computers—or gaming—were surprised by how much they loved programming. Even fearful or reluctant students have found in introductory classes that they "love" programming, which has sparked their interest in pursuing a

computer science major. The majority of the students in the study liked computers—some were even gamers—but the exceptions hint that the storyline is not as true as participants believe.

> Kyleah reports that she is hesitant about a computer science major because she
>
> hated computers. Yeah. For a long time I just—I didn't like sitting in front of a computer or, like, a screen, you know, and I was, like, really bad about—I'm still really bad at computers, like, I don't, like, I think until last, like, January or last, like, February or something, like, last winter I, like, didn't even know how to, like, install iTunes on my computer. I didn't know how to, like, download things or anything. And I was, like, really, really bad with computers; I didn't like them. They, like, broke on me a lot, too, and I just—I pretty much just, like, hated computers. And I still really don't like computers at all. I just like programming.

She thinks that women may not be as interested in computer science

> maybe because we, like, didn't really grow up playing, like, a bunch of video games, or, like, not as many of us have grown up playing a bunch of video games so we're not that interested in, like, how it works, or, like, making one.

Lucy is interested in pursuing an informatics major instead of a computer science major because "I do not like video games, and I always feel that CSE is programming video games, and I don't like that." Victoria, a senior at the time of the study, never considered a computer science major, perhaps because "actually, like, when I was a freshman, a bunch of my friends were computer science majors. But they were all male. And they all liked to play video games in their free time." Erin reports that she and computers "did not have a very good relationship in the beginning." During the required computer competency class in high school, Erin "just kind of figured computers were probably not for me."

Marley, in contrast to some of the other women, was attracted to computer science through her interest in computers and in gaming. She told me that she enrolled in introductory programming at the community college she attended because she "liked playing around on the computer," and she also reports that she is "really into gaming" enough that she thought about "getting into game design."

Related to the storyline that computer science is for those who like to sit in front of a computer all day is this storyline, which indicates *why* computer scientists like to be constantly on the computer: they love computers and videogames. As girls are unlikely to feel this level of passion about computers or to see computers as a toy (J. Margolis & Fisher, 2002), this storyline positions women as not belonging in computer science. Several of the women in this study strongly contradict this storyline, as they were turned off by videogames and even computers, yet they are enthusiastic about programming.

Storyline: *Those who will do well at programming/computer science are those who have experience*

The perceived difference in experience level with computers and programming categorizes students based on the storyline that a computer science major is for those who already have programming experience. Jasmine notes that "the people who come into college with prior programming experience sort of think that they are really good at it. And so it makes them a little cocky." Kelsey has found that, in quiz sections, the boys are the most experienced students who, when they "go through our program, like, line by line, and each person says, like, one thing, and most [boys] can answer it right away."

Amalie was convinced that programming was not for her, because

> I definitely feel like at first I was very much resisting, like, any sort of computer, like, programming class because I was, like, you know, for me it was, like, 'I'm not going to be a good programmer. I've had no experience, and there are going to be these amazing programmers and I won't know what I'm doing.'

Amalie

> came into [introductory programming class] with no experience and I was actually, like, I remember just expressly, like, talking to my mom and being, like, 'I'm going to fail this class!' Like, 'this is going to be—I'm going to start, and I'm going to fail the class, and it's going to be horrible!' just because I had never had any exposure to it.

Due to her lack of experience, Amalie was afraid of programming class, saying she "was still just absolutely terrified for it. I was positive I was going to, like, fail one of my first classes at [the

university]. It was just—it was not a good situation. But it turned out that it was just—I had been missing a great love of all my life!"

The storyline that experience is necessary to do well in a computer science major positions women as not belonging in the field, as they come to the university with less experience in programming (B. Barron, 2004; J. Margolis & Fisher, 2002). Women who participated in this study reported that the tendency of males to ask questions outside of the scope of the class and to show off their knowledge in introductory programming intimidated them at times and made them question if they belonged. Instructors at the university emphasized that no experience is expected or necessary to do well in introductory programming, but the behavior of some males in class causes the women to question if what the instructors have told them is true.

Storyline: ***Writing HTML to create web pages is not programming***

Many of the women in the study reported that they had no experience with programming before enrolling in introductory programming at the university. A few reported that they had done some HTML work while creating web pages, but they did not count that experience as "programming." However, when prompted, three of the women agreed that some of the ideas or concepts from HTML programming helped them better understand the Java programming that they were learning in their introductory programming classes.

Alice reports that she did not learn any programming in high school classes; "just for web design it's just HTML and it's not programming." Sally told me that "it's not really coding, but when My Space was really popular I kind of taught myself HTML using the internet. So that kind of, like, piqued my interest, and I was, like, 'this is kind of fun.'" When I asked her if "any of the ideas [she] learned doing HTML transfer to programming now?" Sally responds that "Yeah. I mean, I think it's kind of—especially on the graphics, because that's mostly what I played around with on My Space: 'Ooo, let's make this background cool.' I think that graphics assignment was very similar to that."

Lucy had worked in HTML before arriving at the university, and her enjoyment of the task piqued her interest in learning to program. When asked if her HTML work was useful to her learning to program in Java, she responded

> I think so. Just, like, we'll learn that computers speak in a different way. And then, like, how you have to open things and close things and, yeah, I think it just helps with learning how they're not—you can't just write 'hello, how are you doing?' to them, you know. You have to actually use their code.

Emma learned HTML as early as third grade, when

> we learned HTML stuff and how to, like, design a web page. And I loved that in third grade. And then, actually, last quarter I was in a digital arts class, and that final was to actually make a website, and, like, show the art we made in that class, and I really liked that. I don't know—I don't have much experience with, like, what I'm learning in CSE right now, but I really liked that part of it, and I think that's also helped me decide to kind of go with computers and because I think it's cool to just be able to make something out of this, like, code and everything.

She has found that some of what she does in introductory programming is similar to what she did with HTML; "Some of the concepts are kind of the same, and it's, like, I'm glad that I have that prior experience to kind of understand what's going on in the class."

Although women in this study affirmed that previous experience with HTML helped them more quickly understand concepts in introductory programming, they discounted creating web pages in HTML as "experience." Therefore, even women with some programming-related experience are positioned as not belonging in computer science. In this case, the male computer whiz is held up as the reference (J. Margolis & Fisher, 2002) and women discount their own experiences as inferior, positioning them as not belonging in computer science.

Storyline: *Introductory programming is fun and cool*

Introductory programming at the university in this study appears to have a reputation of being a pleasurable class. Kelsey reported that she had "actually heard from people that they like it," and Erin

knew someone a year ahead of her in school that "had told us that it was a really cool class." Students reported that the female introductory programming instructor encouraged students on the first days of class by "talking about how, you know, like, this major was like solving puzzles" (Erin) and by telling students that "this is a class with no experience; and I was, like, 'Oh, good! Because that's definitely me!'" (Amalie) The likening of computer science to solving puzzles seems to have been picked up by many of the students, as several participants told me that programming was like solving puzzles. Lucy reported that "most people will take the CSE class, because they hear it's exciting and you get to do fun stuff sometimes."

Experiences in the classroom were reported on overwhelmingly favorably by the participants in this study. Kyleah, for example, thinks that "the classes are really, really fun." Kelsey "really loved the lecture" for introductory programming, finding the instructor "really engaging," including making "random jokes that are usually funny." Lucy describes the introductory programming instructors as "extravagant," which she explains as

> when they're really open and, like, entertaining rather than, like, 'OK, class, this is it' and, like, some teachers still try to be funny and, like, engaging, but they're, like—it's not funny; you know, you're not getting those vibes from the class.

Marley describes her introductory programming instructor as

> really enthusiastic and she just makes it, you know, so much easier to pay attention in lectures, because you can tell she really enjoys doing it, and she really has fun, you know, standing up in front of us and talking about it. And she's also really knowledgeable, so. And helpful.

One aspect of introductory programming that not all participants looked satisfactorily upon was the insistence on doing individual work. Participants seemed fearful of even discussing assignments with others. Erin notes that in the introductory programming classes students "are told explicitly not to collaborate." Amalie found that even in tutoring situations "it's kind of hard to get, like, help in [introductory programming], because they definitely want you to figure it out yourself." Kelsey was enrolled in a CSE lab and she

> thought that was helpful, because, like, I think, like, you know how they do studies about explaining it to other people helps you learn it? So if you know something, you can explain it to them. And then there's just people you can work with, and I like working with peers on, like, homework and stuff. 'Cause we're not allowed to that, really, in [introductory programming]. And this is, like the only exception.

Some students looked forward to upper division classes, where they anticipated being able to work more cooperatively. Alice anticipates that in upper division coursework she would take pleasure in "working with others, because at least, like, I'm not alone anymore." Erin also foresees that "once you get into upper division there are smaller classes and more collaboration," which she will enjoy.

The one participant who had taken programming in high school had taken a class with a curriculum based on the one at the university taught by an instructor trained at the university studied. She, too, found a love of programming through her introduction in a fun class. Lily reports that universities want students to

> take a lot of AP courses to make it look good on your transcript. And to make sure you 'tried hard.' So there was a new AP course and I found out about it just before I registered, and so I thought 'Oh, AP computer science' and I looked at it and was, like, 'no experience required,' so I'm, like, 'OK, I'm going to take it; I'm going to add on another AP load just for the heck of it.' And so I took it and I really loved it.

In contrast to introductory programming classes described by Margolis and Fisher (2002), participants at the university where this study was conducted reported that classes were enjoyable and creative and geared to their interests in pastimes such as solving puzzles. At this university, women seem to be positioned as belonging in introductory programming—and therefore computer science—through the curriculum at the school. Although the introductory programming classes do not offer information about the breadth of career options in the classroom, which would serve to further position women as belonging in computer science, individuals within the department have made efforts to inform female students in introductory classes about the variety of career options available to them.

Storyline: ***Listen to your parents' ideas about majors***

Most participants did not report being influenced in their choice of major by their parents. In some cases parents did not appear to give specific advice on majors, and in other cases participants did not pay much heed to parental advice. In a few cases, however, parental involvement and influence was notable, indicating a storyline among some that students should listen to their parents' advice about majors.

Lily tells the story of her parents' reaction to her love of programming when she was in AP computer science in high school:

> I started really, like, coding, and I told my daddy about it; I was, like, 'Daddy, daddy, I think I want to major in computer science!' He's, like, 'no.' And I was, like, 'why not?!' And he was, like, 'it's too hard and it's difficult and it's not easy to find a job' and he just shot me down right then and there. And I'm just like 'OK.' And so I was just—so I started thinking about other things.

Because of her father's negative reaction to her majoring in computer science, Lily entered the university intending to pursue a business major, but she found she did not like her business classes. Lily found that her interaction with her father

> was really ironic, because at the same, after we had that conversation and everything, and I talked to [my computer science instructor] when I started school and I told her about that, what happened, and she showed me the statistics saying there was even more jobs available, and I was just like 'Wow, dad! Way to go!' And because I was doing all these business-related things, I was thinking about business, but then my parents—my sister talked to my parents about computer science and how it was actually easier to find a job. And I should just, they should just let me do what I want or I'm going to regret it in the future, and just be, like, 'Ah, because I listened to you I hate my job now!'

After Lily's sister intervenes, Lily reports that her mother tells her that "you can do computer science now," which Lily felt freed her to pursue a computer science major.

For Amalie, it was her dad who spurred her to think about majoring in computer science. "My dad was kind of the first one to suggest that I consider computer programming or computer science; before that I was just like 'Oh, I enjoy that. It's my favorite class.' And he's, like, 'well, major in that." Paula tells me that her "parents definitely encouraged me to look into it [programming]. They are both engineers, so they know what's hot in engineering."

After a period of resisting, Kyleah finally enrolled in introductory programming on her mother's insistence.

> My mom, like, really pushed me towards CSE, because I was, like, really against it at first. But she really told me to just, like, try it out and see if I like it, because she thought I would be good at it and she thought that I would like it if I tried it. But she pushed me towards CSE because she thought that, like, I would be, like, everyone needs, like, programmers, I guess, and it was really a stable job and you don't have to go through, like, too much schooling and it would be too stressful later, and, like, I don't know, just something along those lines.

Although the findings from this study support Margolis and Fisher's (2002) findings that coming from an engineering family is not required for women's interest in computer science, this storyline indicates that parental ideas about majors and careers—correct or incorrect—can influence women's entry into computer science. Whether this positions women as belonging or not belonging in computer science depends on whether parents guide their daughters towards or away from majoring in the field. In addition, young women do not always follow the advice of their parents.

Storyline: ***Computer science is a good major to combine with a second major***

Several of the participants indicated an interest in a combining computer science major with a major in another field. Chanel reports that she plans to double major, and "maybe I will get a computer science plus statistics or the computer science plus ACMS [Applied and Computational Mathematical Sciences]." Crystal "actually want[s] to do, hopefully, CSE [Computer Science and Engineering] and interdisciplinary visual arts, actually. So a double degree, technically." By the end of the quarter in which we talked, Kelsey had been accepted into the Human Centered Design and Engineering (HCDE)

major but declared that “right now I want to, like, do a double major with computer science.” Paula had been directly admitted into an Electrical Engineering (EE) major, but is “very interested in the field of robotics, which is a really big mesh of the two disciplines [EE and CSE]. So I'm really thinking about either doing a double major or a minor in CSE.” Sissi is undecided about a major, but is thinking about “CSE and mathematics be the second choice. I may be able to do a double major or something.”

Two participants in this study were considering extending their time at the university to add a computer science degree to what they had already accomplished. In one case, Sally, who was a junior biochemistry major, was considering extending her stay at college to complete a second major in computer science; a tactic that her mother supported. Sally notes that

> if I were to double major it would take me an extra year. But my mom is really supportive of that because she thinks that I should just do something that I really enjoy. Because she's definitely, like, ‘OK, well, why are you insulting biochem?! Just switch.’

In a second case, Victoria, a senior psychology major, was considering doing a postbaccalaureate program in computer science after finishing her psychology degree; “I'm toying with the idea of, like, a postbaccalaureate program in CS. Because I think they offer that at [this university]. So it would be, like, two years, basically, but, I don't know.”

A number of the participants in this study were considering a double major with computer science as one of the majors. In some cases, the second major was closely related, but in other cases the major was quite distinct. It is possible that the idea that computer science is a beneficial second major positions women as belonging in computer science, as it allows them to express their interdisciplinary interests more fully.

Storyline: ***Women are more likely to get in to a computer science major and job because they are underrepresented***

Many of the women interviewed expressed the opinion that they would have an easier time getting into the major or getting a job in the computer science field because the university and companies would see them as a diversity hire.

It was an advisor at the university that told Mónica "being a girl you might have an advantage" being accepted into the highly competitive computer science major. Alice thought that "maybe I get higher chance to get hired because more people nowadays, they want to have, like, more variety." Sissi imagines that

> if a girl and a boy get an interview for Microsoft and the girl may be a little bit not as skillful as the boy, but they are just nearly at the same level I think Microsoft will take the girl

in an attempt to balance their workforce. Erin "honestly think[s] that because I'm a girl I have a better chance than some guys that have better grades" at getting in to the computer science major. Lucy thinks that gender makes a difference "definitely in applying to the major, because I feel like they want more women in there, and they have to make that balance, it's just—and sometimes you can play your cards right and make it work."

During the quarter I observed the Women in Computer Science and Engineering seminar, the instructor repeatedly attempted to debunk the myth that women were more likely to be accepted into the CSE major due to diversity goals. She informed students that state legislation made it illegal to give women preferential admittance at the university, and she opened up discussions and a sharing of ideas about snappy comebacks if the students were ever confronted by male students who positioned them as not belonging by saying "you only got in because you are a girl."

Storyline: *Academically-minded students are "geeks," "nerds," or "dorks"*

A prevalent storyline about computer science majors is the stereotype of the "geek" or "nerd." Kyleah reports that she was resistant to trying computer science because

> I thought it was, like, nerdy, you know, and I kind of wanted to avoid that and everything. But, like, now like, the nerdiness aspect doesn't, like, I don't really care about that any more. Like, that was in, like, high school or something.

Interestingly, several of the women in this study self-described themselves as "geeks," "nerds," or "dorks" as a label for those who are academically minded and who enjoy school, indicating a parallel storyline. Amalie said "I'm definitely a nerd…I'm kind of a big dork." Jasmine describes herself as

"kind of dorky." Sally feels as though she is "kind of a nerd." Paula is "proud to call myself a geek." Kyleah sees herself as "pretty nerdy, like, school wise." Perhaps for women who self-identify with these terms, the geeky or nerdy reputation of computer science is not as much of a barrier. Crystal points out that the computer science "geek" stereotype is "not necessarily bad since there could be worse things out there, definitely, since you're still viewed as being smart and intelligent."

Although Margolis and Fisher (2002) point out that the computer hacker geek mythology is more damaging to women than to men, there is an alternative view of a geek as someone who is academically minded. The hacker geek stereotypes women as not belonging in computer science, yet the academic geek seems to position women as belonging in academically challenging subjects at school, creating an interesting contrast.

Storyline: ***Knowing something about programming makes me question what is happening behind the scenes***

A few of the women in this study indicated that learning programming sparked their interest in what goes on behind the scenes in computers, and for some this led them to a more critical thinking stance about computers.

Amalie describes her youthful use of computers as

> a pedestrian approach to computers. Like, you know, I had My Space and Facebook because I'm a teenager. And so I'd, you know, I remember being very little and, you know, my parents let me have an email account, and that was huge, and I was just, like, typing away. And so I've always kind of used computers just as, you know, they exist in society, that, you know, they're pretty unanimously used. But I've never thought more than just, like, the user interface was just, like, how it was presented to me, and I never thought what goes into that or what goes beyond that

until she started to learn to program.

Jasmine finds computers less mysterious when one knows something about how they work.

> They are less scary and less frustrating if you can actually solve the problems, like, when something goes wrong it's not, like, 'oh, my gosh! What is it?!' It's more, like, 'oh, I know what it is. All I have to do is this.'

Victoria found that she began to think about how advertising was used by Facebook

> because I was really interested in Facebook. I just love Facebook. And I was doing all this poetry club organizing, and we use Facebook to advertise. And so I go interested in how they, like, get into advertising and, like, what—I don't know—I'm interested in that.

Crystal found the internet fun from a young age and finds programming "kind of like just looking more into, like, what's behind it, I guess, kind of thing." Erin has also become more interested in finding out what is behind the internet;

> now it's kind of this whole mystery that I never really thought about. Like working with the inner workings of websites; I'll think about that now when I'm online. It's, like, 'how do they make this work?' and search engines and that kind of thing.

The findings from this study lend support to the idea that learning to program can be an important part of education in today's world (Rushkoff, 2011). If programming were required in school, women might be more likely to re-position themselves as belonging in computer science, as they could be introduced to an aspect of computers that would be more interesting to them than gaming.

Conclusions

Based on the findings in this study, we can draw some conclusions about how women today are thinking about and choosing majors at one university. The women studied had come to an interest in majoring in computer science through "fun" classes at school rather than through informal programming on their own time. Participants viewed choosing a computing major as a range of choices, from computer science itself to informatics and human centered design and engineering, and they did not rule out choosing more than one major in order to envelop their collection of interests. Students have an awareness of computer science stereotypes, but are emboldened by their interest to persist despite the

differences between themselves and the stereotypes. Participants see programming skills as enhancing their income potential and as a way to understand more about technology.

Conclusion 1: Some computing majors are being unnecessarily "ghettoized." Interest in helping people, social justice, humanitarianism, and relating to others as well as stereotypes about computer "geeks" push women towards related but more applied majors such as informatics or human centered design and engineering. If these majors, lower in the hierarchy of "hard" versus "soft" majors and thereby with less lucrative career outcomes, fill with women we are once again relegating women to careers that are less respected and lower paying by leading them to believe that they will only be able to find applied careers where they can work with people outside of computer science.

Women who rely on the stereotype of computer science majors as geeky men without social skills who sit in a dark room and code all day are often put off of majoring in computer science, and without exposure to programming and information about the variety of possible career outcomes, women are far too often relying on the stereotype. A host of majors related to computer science have blossomed at the university and appear to be attracting women, but these majors have less rigorous requirements and may be pulling female students away from the more lucrative, challenging computer science major unnecessarily (Zarrett, Malanchuk, Davis-Kean, & Eccles, 2008).

Storylines from this study illustrate that students without programming experience envision computer science as a major and career where you sit in front of a computer all day. Even those women who have enjoyed related experience such as writing web pages using HTML follow a storyline that their experience does not count as programming, which eliminates their belonging in computer science based on the storyline that computer science majors are designed for people with previous programming experience.

Conclusion 2: Young women channel themselves away from a computer science major based on lack of experience with programming as well as computer science careers and their resulting reliance on stereotypes. Young women are not likely to envision the value and enjoyment of programming.

The storyline indicated in this study about choosing a major is most strongly that a major should be chosen based on interest. Many of the participants in this study viewed computer science as a major to be pursued by those students who like computers and like to spend much of their time on computers engaged in such activities as gaming. With girls less likely to want to spend their free time on computers,

and particularly gaming (J. Margolis & Fisher, 2002), they do not see themselves as potential computer science majors.

Although there appear to be differences in stereotypes labeled “nerdy,” “geeky,” or “dorky” between computer science majors and non majors, women describe themselves in these terms following the storyline that the terms apply to academically-minded students. Perhaps students who identify with the academics and schooling have a self-image that is closer to the stereotypical intelligence of computer science majors than those who do not so identify, so it is unfortunate that women appear to discount a computer science major based on a slightly different view of what constitutes “geeky” computer science majors.

Findings from this study indicate that, in some cases, parental influence is important for student major choice and that some students follow a storyline that it is important to listen to the advice of your parents. These findings are supported by work that indicates that parents can be instrumental in getting their teenage children involved in STEM (Barron, 2006; Harackiewicz, Rozek, Hulleman, & Hyde, 2012). In some cases misinformation, such as the idea that computer science majors have poor job prospects, or reliance on stereotypes incites parents to steer their daughters away from a computer science major unnecessarily, and young women who follow this counsel do not choose the major.

Conclusion 3: Positive experiences with programming and information about the variety of career possibilities for those with a computer science major can change women’s minds. Women who have discounted computer science as a possible major re-consider the possibility when they find that they enjoy programming and when they discover that career outcomes for those with computer science degrees include careers that match their interests. Caution is warranted regarding the prevailing myth that underrepresented groups are more likely to obtain entrance into computer science due to diversity goals.

With a storyline of majoring in what interests you and with young women less likely to envision enjoying computer science, attracting female students to computer science through making introductory programming fun is paramount. The university in this study has successfully created a positive buzz about introductory programming, according to the women interviewed, through creating an approachable, entertaining curriculum. Uniquely to this university, at least, women indicate that there is a storyline that introductory programming is fun or “cool,” although some of the women temper their enthusiasm by

noting the dictatorial emphasis on not collaborating on schoolwork. Findings from this study also imply that exposing students to the wide variety of career possibilities before and during introductory programming can be critical to broadening the participation in computer science by contradicting the storyline that all computing jobs involving sitting in front of a computer in a dark room twenty four hours a day (Dimond & Guzdial, 2008).

The university apparently views programming as useful for more than computer science majors based on the requirement of the introductory programming sequence for a variety of majors. Several of the participants in this study support this vision, as their increasing knowledge of programming has lead to their curiosity about what happens behind what appears on the computer screen and their beginning to critically examine the role of computers in our world. Students discover that knowing something about programming leads one to a critical thinking stance about computers as they deepen their computer knowledge.

Double majoring in fields both related and unrelated to each other appears to be popular among the women in this study and among college students (Selingo, 2012, October 11). Computer science as one of the two majors was desirable to the women studied due to favorable career outcomes and to an increasing understanding that careers in humanitarian and social justice work are possible with a computer science major, not just related majors such as informatics or human centered design and engineering. The storyline that computer science is a desirable half of a double major may be beneficial to encouraging women to pursue a computer science major.

Participants in this study overwhelmingly predict that they will more easily gain entrance into the computer science major and into computer science careers because of their underrepresented status and the need of universities and companies to diversify their student bodies and workforces. However, preferential treatment is currently illegal in the state in which this study was conducted and the university cannot base admittance into a major solely on diversification goals. In addition, seminar panelists of current CSE students reported that, once in the major, the myth that women are more likely to be admitted in order to reach affirmative action goals meant that they were bombarded with the refrain “you only got

in because you are a girl," incorrectly implying that the performance of female students was inferior to that of male students. Therefore, the storyline that women are more likely to be admitted should, perhaps, not be used to attract women to the field and, in fact, should be actively dismissed.

Implications/Recommendations

The findings from this study suggest a few recommendations at the university level and earlier of ways we might attract more women to the computer science field. Success with well-prepared, academically-minded women can come through introducing them to programming through enjoyable classroom experiences while assuring that they are exposed to career possibilities for computer science majors that involve helping people. We can scaffold women's learning to program from related experience while we encourage them to think critically about technology in our society.

Recommendation 1: Trumpet the lucrative, broad career opportunities available to computer science graduates.

Both university students and their parents appear to be misinformed about career possibilities for computer science majors, both in terms of the job prospects and the nature of the work itself. For the women and their parents who expressed the importance of a major for career outcomes we need to assure that they understand that computer science related jobs are growing. For the women and their parents who believe that careers should be based on giving back or on helping others we need to broadcast the varied job opportunities available to students who major in computer science and the profound social justice implications of the technology that they might well be creating.

Computer science lends itself to interdisciplinary study and to part of a double major. With the use of computers in every corner of life in the United States today, knowledge of computing enhances many other fields. We should make students in all fields of study aware of the advantages of the broader career prospects of adding programming and computer science to their portfolio.

Recommendation 2: Make introductory programming more intellectually enticing and enjoyable.

Billing introductory programming class as "solving puzzles" and "for those with no experience" as well as providing entertaining lectures and interesting homework projects looks to have successfully

created a reputation of "fun" classes at the university where this study was conducted. Women are less likely to have programming experiences that lead them to believe that they are interested in computer science, so making the effort to design introductory programming to be as fun as possible can have immediate benefits. This recommendation is supported by the efforts made at Harvey Mudd College, where female computer science majors have increased greatly when introductory programming classes were re-designed to make them more enjoyable for students (Klawe, 2012, October 16).

Programming knowledge should not be confined to those who will major in computer science. With the infusion of technology into virtually all facets of modern life, a critical thinking stance about technology is important for all educated citizens, and learning the basics of programming can spark such an attitude (Rushkoff, 2011). Women in this study indicated an interest in social justice, and understanding more about technology and the biases of technology could help them to promote social justice issues around technology.

Recommendation 3: Look for young women who are likely to enjoy and be successful at programming, and entice them to try it.

There are many majors at the university that are dominated by women. Students interested in these majors could be tapped to double major in computer science, thereby increasing female participation in computer science majors. If the previous recommendation of enlightening students and parents about career possibilities is followed, perhaps enticing women to broaden their career possibilities with a second major in computer science could be successful.

The "nerdy" image of computer science has been found to contribute to the lack of women in computer science (Cheryan, Plaut, Davies, & Steele, 2009). However, some women self-identify as intelligent and academic, which may make them less averse to the "nerdy" representation. Perhaps the stereotype can be co-opted, as it has been by "Nerd Girls" (Bennett & Yabroff, 2008), and broadened to include more women.

Findings in this study indicate that women believe that previous experience with programming is critical before considering a computer science major, while at the same time they discount related

experience. In the classroom and in our message to students we can incorporate what students already know to build confidence in women—traditionally a barrier—and to entice them to continue.

Although findings from this study indicated that pre-major women view the possibility of gaining admittance to majors and careers based on their gender, such practices can backfire for women later in their career. For female computer science majors or women in computer science workplaces, the prevailing idea that affirmative action goals are in place can incite the "you only got in because you are a girl" refrain from males. It is important that we re-educate the populace to the current illegality of gender-based preferences.

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Appendix A

Pseudonym; race; major(s)				
Experience	**Why intro prog**	**Why CSE (or not)**	**How to choose major**	**Notes**
Alice; Asian (Vietnam); CSE or psych				
HTML	was hacked into during a game	Confusing; hard to decide; enjoys computer & gaming	what you enjoy doing; like it	Interested in tech, but kept getting put in HS typing class
Amalie; White; CSE or info				
None; computers were masculine; left to brother & dad	required for info	Halfway through intro prog realized "loved" what she was doing; would rather do (CSE) than plan (INFO)	what you enjoy doing; what you are good at; job market	Running Start
Chanel; Int'l (China); CSE + stats or CSE + ACMS				
JavaScript for websites; VB & C (from books)		creative	interested in it; can do well in it	parents don't want her to do CS, since changes too fast; mom thinks females shouldn't think too hard
Crystal; White; CSE + interdisciplinary visual arts				
jr high took class where they did simple circuits; thought about learning C++; dad is EE		problem solve; get something to work a certain way; stable job	like it now and in the future	civil eng club in HS; HS offered a AP programming class, but she didn't take it
Emma; White; CSE or business				
3rd grade HTML & web pages; digital arts class webpage in college	sorority friend was CSE TA	learned to type early--made easier to learn computers	what you will enjoy doing the rest of your life; how much money; career	Running Start; mom worked in IT; not many Greek people doing CSE
Erin; White; math and/or CSE				

none	boyfriend/friends took the class	fell in love with CSE during first quarter intro programming	if you enjoy doing it and will for a long time; job market	
Jasmine; Japanese & Pakistani; ME or CSE or EE				
Matlab the summer before college; Lab View	a good skill to have	enjoyed programming Matlab	if you enjoy the major; what you are good at; can get a job	Running Start online; mom is an EE; mom doesn't like programming
Katya; White; masters student (Russian studies)				
web page creation	increase job skills	never considered CSE: didn't see it advertised; always interested in humanities		associated algebra with computing; started creating web page on her own
Kelsey; Filipina & White; HCDE (+ CSE?)				
none	required for engineering	found the field was broad and could be used to help people	opportunities available; what you want to be doing	AP CS offered at high school, but didn't want to be the only girl
Kyleah; Asian Am (China, Taiwan); CSE or psych or premed or predent or neurobio				
none	"on a whim" at mother's insistance	likes writing programs	what you want to do with your life; something you like to do; stability	indecisive about a major
Leona; White; HCDE				
HTML; VB; C++	required for HCDE	likes information & data, so not interested in CSE	read descriptions of upper division classes	re-entry transfer student
Lily; Asian Am (China, Vietnam, Cambodia); CSE or info or business				
AP CS in high school	loved it in high school	likes to code	passionate about the subject	
Lucy; White; info or CSE				
HTML	needed to learn to program for job	doesn't like video games, so prefers INFO to CSE	how much money you can make and careers available	
Marley; Native Am & Puerto Rican; CSE				
community college programming classes	intended to major in CSE at transfer	likes to program	what you are good at; what you are passionate about; what you like to do	transfer student

Monica; Latina (Mexico); info or CSE				
none	interested in learning to program when she saw a friend's app			
Nancy; Int'l (Hong Kong); physics or architecture				
none	programming is widely applicable		jobs available when you graduate	
Natalya; White (Russia); HCDE & PSYCH				
had seen Fortran and BASIC	required for the major	interested in people, so not interested in CSE	what you like to do	transfer student
Paula; White; EE (+ CSE?)				
robot C; OO programming; GUI programming	required for the major	robotics	what is applicable to what you are interested in	focused on robotics
Sally; White; biochem (+ CSE?)				
HTML	friend tried it, when looking over friend's shoulder, Sally found it intuitive	CSE is innovative, creative, the new frontier	what you are passionate about; career possibilities	junior
Sandra; Asian Am (Japan); CSE or EE				
none	liked games; interested in learning how things worked	very undecided about majors	you enjoy it; you can succeed in it	HS offered AP CS
Sissi; Int'l (China); stats, CSE, or math				
interest group in programming after school		likes stats because good at numbers, doesn't rely on English skills	you like it; job possibilities; suggestions from parents or friends	
Victoria; White; psych				
none	heard NPR article that said CS needs more women	didn't consider it, because friends that were CSE majors were male and liked video games; now interested in job opportunities	how useful it is	considering postbaccalariate in CSE

Chapter 2

“I’m All For Women Power!”:

Studying Computer Science at the Intersection of Ethnicity and Class

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University of Washington

Abstract

Computer science not only displays the pattern of underrepresentation of many other science, technology, engineering, and math (STEM) fields, but has actually experienced a *decline* in the number of women choosing the field over the past two decades after a period of increase. Broken out by gender and race, the picture becomes more nuanced, with the ratio of females to males receiving bachelor's degrees in computer science *higher* for non-White ethnic groups than for Whites. Foundational research has explored the computer science experiences of underrepresented minorities in high school and of university women majoring in computer science. This study addresses a gap between these two, exploring the perspectives about computer science of three pre-major women and their mothers in three case studies that differ considerably along the axes of race, class, and culture. Using Rom Harré's positioning theory as a lens, this study provides an in-depth investigation of the influence of schooling, family, ethnic culture, U.S. society, and computer science culture on the aspirations and motivations of three women to pursue a computer science major.

""I'm All for Women Power!": Studying Computer Science at the Intersection of Ethnicity and Class

Foundational qualitative work has been done to understand underrepresentation in computer science, first exploring experiences of undergraduate women (J. Margolis & Fisher, 2002) and then experiences of underrepresented minority students in high school (J. Margolis, Estrella, Goode, Holme, & Nao, 2008). With a bachelor's degree the standard credential for obtaining many computing jobs (Goode, Estrella, & Margolis, 2008), who is obtaining these degrees becomes an important focus of work investigating the pipeline of women entering and persisting in computer science. Statistics have shown that there has been a decline in the number of women obtaining computer science bachelor's degrees in the last two decades, but also show that the ratio of females to males receiving these degrees is higher for non-White ethnic groups than Whites, suggesting that the intersection of gender, race, and culture may influence the pursuit of a computer science degree (National Science Foundation, 2008). This qualitative work explores three case studies that fit in the gap between other works: three female pre-majors at the university who had been considering a first or second major in computer science and who have cultural histories that vary by race, ethnicity, and class. In this study, I investigated what inspired these three women—one Latina, one Pacific Islander American, and one European American—to take an introductory programming class and to consider majoring in computer science despite the pressures to choose other fields of study and work. As racial/ethnic background were of interest, both the perspectives of the women themselves and their mothers were investigated for two viewpoints on how these women arrived at this point, poised to possibly major in computer science. As described below, I used positioning theory, proposed by Rom Harré, to analyze the sociocultural settings, interactions, and self-positioning experienced by three women on the path towards a computing field.

This qualitative study was conducted in order to provide an in-depth look at the meanings that three women made of the factors that affected their choice of a major. Reasons that have previously been found to discourage women from choosing computer science were investigated with the study participants, but the nature of an interactive qualitative study also encourages participants to reflect on their own experiences to uncover aspects that do not appear in earlier research. To add an additional

point of view and for purposes of triangulation of the data, the mothers of the three participants were also interviewed about the pathways their daughters have followed. This study attempted to paint a detailed picture of experiences of three women at a large, public university in the United States to illuminate the experiences that encourage or discourage women from considering a major in computer science.

Conceptual Framework

Rom Harré's "positioning theory," borrowed from cultural psychology, gave a useful theoretical framework for data analysis for this study. Harré theorizes how interactions with others and larger sociocultural patterns influence the rights and duties given to individuals to act—in this case, to choose a college major (Harré & Moghaddam, 2003). Harré visualizes a "positioning triangle" in which the points of the triangle are formed by position(s), illocutionary force(s) (also called "speech and other acts"), and storyline(s) and in which the sides are the bi-directional influences between these points. In this triangle, "a position can be looked at as a loose set of rights and duties that limit the possibilities of actions" (Harré & Moghaddam, 2003), speech and other acts are "a socially meaningful and significant action" (Harré & Moghaddam, 2003), and a storyline is a taken-for-granted pattern of interaction. The process of positioning can either be explicit and deliberate or seemingly natural patterns of the way things are. Individuals can resist positions thrust upon them and attempt to reposition themselves, although success is not certain.

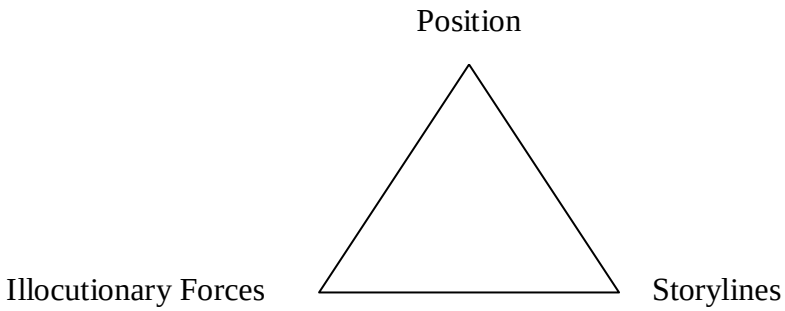

Figure 3: Harré's Positioning Triangle

With positioning theory, Harré breaks away from the laboratory setting of much of psychology in order to study meanings as understood by participants in their everyday settings. One focus of

positioning theory is on episodes of social interaction and what socially occurs in interactions—usually a subset of what is logically possible—as episodes unfold following expected patterns or cultural storylines. The underrepresentation of women in computer science suggests that there are cultural and societal storylines in the United States that direct interactions and position women as not belonging in the field of computer science, and the purpose of this study was to explore interactions related to computer science with women interested in majoring in the field and to discover the storyline patterns guiding these interactions. In order to bring cultural storyline differences into relief, the researcher focused on three women of varying ethnic and class backgrounds.

Miles and Huberman (1994) describe a conceptual framework as an explanation of key factors to be studied and the relationship among them. As interactions and cultural storylines were of interest, following Harré's positioning theory, I solicited stories of interactions with others during interviews and observations. In this study I was interested in storylines about computer science that exist in U.S. society, in different ethnic groups, in school, and in the field of computer science. I therefore focused interviews and observations on interactions that participants had with family and friends, as representatives of the ethnic community and/or of U.S. society, and with peers and teachers, as representatives of the schooling and computer science communities as well as U.S. society.

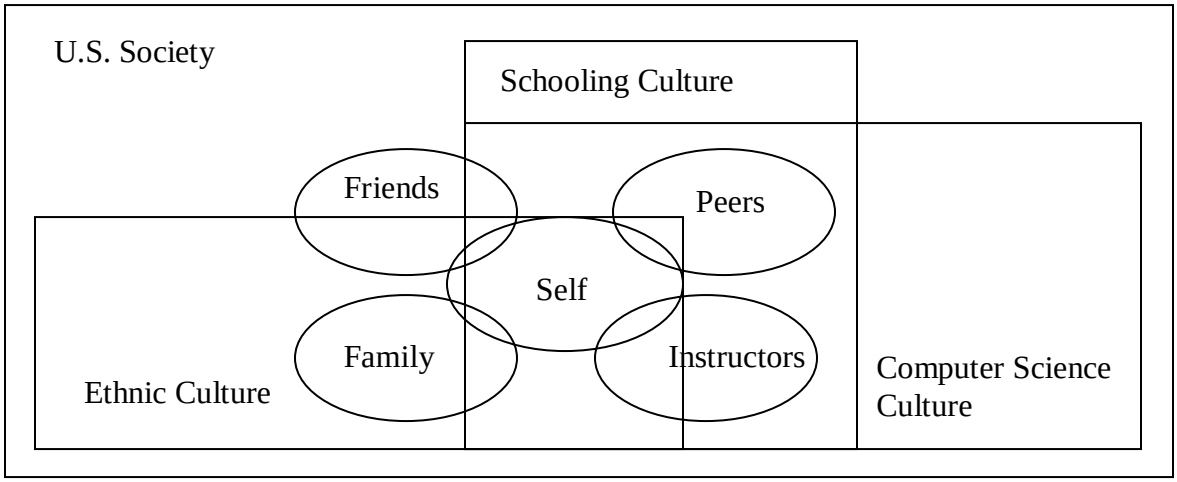

Figure 4: Conceptual Framework

These interactions provided a window into the underlying patterns or storylines about computer science that exist in the cultural surroundings of the student, including the culture of U.S. society as well

as the ethnic culture of the family and community. Since an academic major is formed by both schooling background and the culture of the field itself, reported interactions could provide examples of cultural storylines of schooling and the field of computer science. Making explicit these storylines allows us to better understand the experiences of women of varying ethnic and class backgrounds that may major in computer science and to explore ways to alter storylines to make the field more welcoming to a diverse set of students.

This study centered on each of three student participants and investigated the ethnic, schooling, and computer science settings each of them had been involved in as well as the interactions with significant others in those settings—including parents, teachers, friends, and peers. The conceptual framework formed the outline for interview protocols, as students and their mothers were asked open-ended questions about family and ethnic community, schooling preparation, interests, and interactions, and computer science experiences and interactions. The perspectives of mothers was solicited based on a pilot study that indicated sometimes strong parental influence on women's choice of major as well as practical limitations.

Although a wide range of positions are imaginable in terms of belonging in computer science, from a full participant with a high level of comfort to a complete outsider who may even be ostracized, this study focuses on interactions that either imply that women belong in computer science or that women do not belong in computer science in order to more clearly investigate what storylines are operating to encourage or discourage women from majoring in the field. The strength or degree to which women had been positioned as belonging or not belonging was not analyzed. According to positioning theory, the position of an individual belonging (or not belonging) in computer science is mutually constituted by the interactions an individual has with others, the influence of societal patterns on these interactions, and the (re)positioning of the individual herself. Since computer science is dominated by White and Asian males, I was interested to discover if a masculine culture of the computer science field created storylines that position women as not belonging in the field. I suspected that interactions often position women as not belonging in computer science, as their gender naturally renders them suspect. For women who do pursue

computer science, I suspected that they must vigorously reposition themselves as belonging in computer science in order to counteract the prevailing positioning thrust upon them.

The research questions guiding this study were:

1. How have interactions in home, ethnic, school, and computer science settings influenced women's preparedness and interest in pursuing a computer science major, both from the point of view of the participant and the point of view of her mother?
2. In what ways did women reposition themselves as belonging in computer science when interactions would suggest otherwise?
3. What covert and overt storylines are suggested by the interactions in home, school, and computer science, and outside settings that position women as belonging or not belonging in computer science?
4. What similarities and differences were found in the interactions and storylines for women who vary along the axes of race, class, culture, and ethnicity?

Methods

This case study is a qualitative work focused on the experiences of three students enrolled in a "Women in Computer Science and Engineering" seminar and includes data from an initial interview at the beginning of the quarter, a second interview at the end of the quarter, and an interview with the participants' mothers. Since I was interested in how the participants made sense of their world and their experiences that have been leading to a choice of major and what they and their mothers perceived as the influences on their choice of major, in-depth qualitative interviews were the most appropriate methodology for soliciting the necessary narratives. I was interested in how my participants' beliefs influenced their academic paths. As Merriam states, "[t]he key concern is understanding the phenomenon of interest from the participants' perspectives, not the researcher's." (Merriam, 2009)

Settings and Participants

The research study was completed with students from a large, public university in the Northwest with a computer science program ranked highly in the nation. The Computer Science and Engineering

major at the university requires application by and admission to interested students once they have completed the two-quarter introductory programming sequence, and admission is highly competitive. Exceptions to this admission process are the promising handful of students who are accepted either as "direct admits" out of high school or who are accepted through the "accelerated admission" process.

Since I was interested in women who had the educational background and the interest necessary to consider a major in computer science, I recruited participants from a seminar entitled "Women in Computer Science and Engineering" open to female students enrolled in the two-quarter introductory programming class sequence in the computer science and engineering department. Most of these women were at the beginning of their possible path to computer science, and I investigated what attracted them to the field. The case study participants volunteered to take part after the work was described to the students on the first day of the seminar of interest. For this case study I chose only participants about whom I had the most data—two interviews and an interview with their mothers. Interestingly, they varied widely along the axes of race, ethnicity, class, and culture.

Data Collection Strategy and Procedures

The primary data collected for this study was two interviews with each student participant and one interview with each mother of the participants. In addition, I had data from the larger seminar that I used for data triangulation, including video tapes of seminar sessions, assigned reading and discussion responses posted on the class online discussion tool, and video tapes of other student participants.

I video recorded and transcribed two semi-structured interviews, one in the first week of the quarter and one in the last week of the quarter, with each participant asking about their past experiences leading up to their current interest in programming and possibly majoring in computer science as well as their current experiences in classes. I prepared questions on topics that the literature suggested may be influential to women choosing to major in computer science, and these questions formed the basis for the interviews (see Appendices A and B). Question topics included what interest the participant had in computers and programming over time, the support received from others, and perceived barriers. I was

open to informant stories that highlight issues not uncovered in previous literature that opened new areas of inquiry. Each interview lasted from forty five minutes to over an hour.

I conducted one interview with each of the participants' mothers, two over Skype and one in person, that I video recorded and transcribed. I invited participants to sit in on the interviews with their mothers. During the two Skype interviews ("Guadalupe" and "Ann") the participant students sat with me during the Skype conversation. In both cases, the student sat quietly listening to my questions and their mother's responses without interjecting. In the interview with Guadalupe, Mónica translated one of my questions into Spanish for her mother when her mother did not appear to understand the question. During the in-person interview ("Teresa") the participant student did not attend. In all three cases, the mother seemed to speak freely about her daughter whether or not the daughter was present. Topics discussed included how the student had become interested in programming, the mothers' views on schooling and jobs, and how suited the students seem for a career in computing (see Appendix C).

Data Analysis

Several steps were taken in this study to analyze the data. All interviews were recorded and then transcribed to provide a word-for-word set of data. In order to differentiate between supports and barriers to women in computer science, all interactions referred to in the data were reviewed and coded with the positions of "belonging" or "not belonging." To differentiate between the sources of the positioning, interactions were then placed in a matrix for each participant divided into columns for "self-positioning," "interactions," and "storylines" with each of the two positions ("belonging" and "not belonging") under each of those three categories. Rows of the matrix represented sources of positioning formed from the boxes of the conceptual framework—ethnic community, schooling, computer science, U.S. society—as well as the notion of the self at the center of the framework.

The large matrix was then condensed into a more concise summary matrix. This summary matrix listed the position of "not belonging" with columns for interactions, repositioning, and storylines that these interactions suggested in order to highlight the ways in which these women were positioned as not belonging in computer science and how they resisted to reposition themselves as belonging. On a

separate sheet, the position of "belonging" had columns for interactions and storylines that these interactions suggested. Instances of women repositioning themselves as not belonging against belonging storylines was not seen and therefore not included on the table. Findings were detailed and supporting evidence quoted for each of the three case participants in the study. A comparison was built between the individual cases in order to begin to understand how the intersections of race, ethnicity, class, and immigration status influence the experiences of the women, and conclusions drawn from this comparison.

In the data analysis, interactions reported by both the student and her mother were analyzed together. In the write up of the findings, therefore, supporting examples for each storyline are supported with quotations from both student and mother participants. The text of the findings indicates whether the quotation was spoken by the mother or the daughter, and quotations are word-for-word transcriptions, with language errors included but connectors ("um," "ah") excluded.

Data Quality and Limitations

The design of this study allowed an investigation of the experiences of women who were enrolled in introductory programming classes, who were considering majoring in computer science, and who were presumably interested in issues for women in the field indicated by their enrollment in the seminar. Because of time and resource limitations, the study design restricted possible participation to only women who enrolled in the Women in Computer Science and Engineering seminar during one quarter. The purpose of the study design was to deeply examine the experiences of three participants in real world contexts to generate questions and themes about the choice whether or not to major in computer science by women of varying social classes.

Students who participated in this study were self-selected in terms of their enrollment in the seminar, their volunteering to be interviewed, and then facilitating for their mothers to be interviewed. The instructor of the seminar emails all women enrolled in either the first or second quarter of the introductory programming class every quarter to tell them about the existence of the seminar, and the women who enroll do so on a voluntary basis. During the first class day of the seminar I explained this study to all the students and asked them to fill out human subjects permission forms that included an item

asking if they would agree to be interviewed and another item asking if they would agree to have their parents or guardians interviewed. The three participants in this study agreed to be interviewed both at the beginning and the end of the quarter, and they arranged an interview with their mothers at the end of the quarter, and were the only three participants that did so. Due to the self-selecting nature of participation, participants may not be fully representative of the general population of women in the introductory programming classes at the university, although I argue below that the cases are theoretically informative.

To increase the social and interpretive validity of the study, the findings from this study have been member checked by the participants to ensure that my understanding matched what the participants meant during the interviews. The interviews with daughters and mothers were examined, looking for inconsistencies or qualifications of reports by the daughters. Other data—including interviews with other participants, online discussion class assignment postings, and in-class small group discussions—were used to triangulate the data. Any conflicts or qualifications were noted in the findings. In addition, this work has been internally peer reviewed by others at the University of Washington to check the consistency of the analysis.

From my position as an upper middle class Caucasian woman with a master's degree in computer science and many years of working in the field, first as a software engineer, then as a computer science instructor, I was situated well to research this topic. I understood discussions of programming work and programming techniques that came up in interviews and in classes. I was able to understand the language of computer science well enough to be fluent in acronyms and technology subjects that came up in this study. I also had an understanding of the kind of work and the day-to-day frustrations of being a female computer science student. My ethnic background meant that I have had experiences that align with those of some of my participants more than others, which likely blinded me to some issues of race, culture, and class while perhaps making others clearer. I attempted to minimize my bias by supporting my findings with the unfiltered words of the participants themselves and by doing member checking with the participants.

Cases and Findings

Case 1: "Mónica"

"Mónica" is a working-class Latina who was born in Mexico and who came to the United States to stay when she was five years old with her migrant farm worker mother, "Guadalupe," and her younger sister. Mónica—a first-generation college student—was in her freshman year at the university on a full-ride scholarship and she was considering majoring in either Informatics or Computer Science and Engineering at the time we talked. By the end of the quarter, Mónica was leaning towards an Informatics major.

Mónica: "Disidentification" Position

Interactions that Mónica had encountered often put her in the position of not belonging in computer science and suggested several storylines prevalent either in U.S. society or in her Latino culture or both. The storyline that computer science is for boys, and particularly for Whites and Asians, is prevalent in both U.S. culture and Latino culture. Storylines in Latino culture that positioned women such as Mónica as not belonging in computer science are that Latina women belong in feminine places and endeavors such as in the home or in jobs for women, that good students in school are the White and wealthy students, and that family comes first even if it is to the detriment of the pursuit of education. A storyline prevalent in U.S. society that set up interactions detrimental to Mónica's progress is the idea that everyone knows how to get to and be successful in college, including choosing a major, and that no help is needed in this endeavor outside of the home.

Storyline: *Computer science is for boys—particularly Whites and Asians who like to sit in front of a computer all day.* Mónica's experiences and interactions in different settings suggest that computer science is for boys, which serves to position women as not belonging in the field. The predominance of this storyline limits the field to women who are willing to spend time with mostly men, to mold themselves into masculine forms of antisocial and individualistic behavior, and to risk being treated poorly. Mónica resists being positioned as not belonging in male-dominated fields by her determination to prove that women can be successful in jobs labeled as "men's" work and by telling herself and others that she wants a change of pace by spending time around men instead of women.

The sheer numbers of men in the computer science classroom caused Mónica pause, as she found "when I took CSE [computer science and engineering] it was really hard because…I looked around and there was hardly any girls there, and so I felt like 'what am I getting myself into?!'" Mónica's friends from her hometown know that the field is dominated by men and wonder "don't you feel uncomfortable? Like, being around so many guys and everything?" Mónica responds by noting that "I was around girls, and sometimes I got tired of them. I wanted to be around boys." In her quiz section of introductory programming class, Mónica finds that she still feels out of place because, although there are a larger percentage of women than in the lecture hall, the women are not Latinas. "[In] my quiz section…there were more girls. The only thing is, like, they were mostly Asian…so I felt, like, left out, still."

Mónica was interested in and excited about engineering in high school until "I job shadowed this guy and he was always on his desk and so I was, like, 'oh, my gosh, I can't do something like that, like just sitting in front of a computer all day long.'" Comparing herself to the man she was job shadowing, Mónica thought "I'm a really talkative person sometimes, so I'm, like, 'I'm going to go crazy there!…I was, like, 'no, I can't do this!'" After this experience, Mónica looked back on her volunteer experiences and thought that maybe business would be a better major for her, but quickly found that this was not the case. "I loved volunteering, so I was, like, 'maybe I want to go into, like, the business part.'…When I started doing the classes here, I was, like, 'I'm not striving in these classes.' I was, like, 'I can't do this.'" Mónica then finds a niche for herself—out of computer science itself—through seeking information from acquaintances at college. "One of my boyfriend's roommates was in the Informatics field, right?... 'Maybe I wanna look up this Informatics thing. Cause it relates to computer science, but it also relates to more social aspect of it.'" When she checks the website for Informatics, Mónica is interested and pleased to find that "one of the first articles that popped up was when some of the professors here went down to Perú when the earthquake happened and they were helping the community there." With this information, Mónica begins to consider an Informatics major, since "I loved volunteering and everything in high school, and I was, like, 'well maybe I found something I like.'"

Mónica recalled reading an article when she was in high school that explained the lack of women in engineering fields such as computer science through attrition due to sexist attitudes in the workplace. She reported that the article noted that women "were slowly dropping [out] because of how the men would treat them in the field. They would say 'well, why am I going to listen to a girl?'" If she succeeds in obtaining a computer science job, Mónica is determined to prove herself. She reported that she would not like "the fact that sometimes people won't believe in you." She found that this "puts up a challenge, and so you're, like, 'OK, I'm willing to take the challenge on. And we'll see. We'll prove you wrong.' In her interview, Mónica repeatedly reported that "I'm not a guy, but I will prove that I can do the same thing that they can."

Mónica was interested in learning about women's issues and in proving women equal to men. Guadalupe had been a role model for Mónica in this area, declaring

> you know, like, I was single, like, with my two girls for almost 10 years, and I work like the same, you know? Like the guys. I learned how to drive trucks, and a lot of people said 'No, that job is for mens! Not for girls.' And I said 'it's a lazy job, I can do it!' Because, you know, it's easy. I don't know how the guys said 'Oh, I'm tired. I have a headache. I'm so tired!' And I can do it. And some of it you know, some of the jobs, we can do it. The girls. The womans. You know, like you don't need to be a man to make a hard work. But at the same time the mens, they need to know about us.

Mónica's historical perception that computer science was for boys was confirmed by the lack of women in the classroom when she arrived in introductory programming. Both she and her mother continue to be aware of and to fight the sexism they notice in school and in the workplace. Learning about women's oppression had whetted Mónica's appetite for more. When speaking with faculty about summer study opportunities, she found out about another class that focuses on women in business, which she hoped to take. The instructor "told me about her class, which now I want to take as an elective for spring quarter, which is Women as Leaders…So now I want to take that one. I'm all for women power!"

The way Mónica talked about her interactions in and beliefs about computer science indicated a taken-for-granted pattern in computer science: the storyline that the field is for certain boys. Mónica, her friends, and her mother all appear to expect computer science to be dominated by men and to be considered men's work. The storyline operating was that computer science is appropriate for boys, appealing to boys' interests, as found by Margolis and Fisher (2002), and a place that is comfortable for boys. The perpetuation of this storyline must certainly discourage women from easily identifying with the field and from automatically considering a computer science major.

Storyline: *Latinas belong in the home (or at least in feminine endeavors).* In her interview, Mónica spoke of the Mexican "machismo" storyline that limits the purview of women to the home sphere. Through many of her choices and actions, Mónica resists the "machismo" storyline that she reports is prevalent in her community, and her pattern of breaking away is one that she admires in and emulates from her mother. By resisting the "machismo" storyline, Mónica positions herself as belonging in school, belonging in a four-year university far from home, and belonging in STEM fields such as computer science and engineering.

Mónica sees that sexism is not solely a Latino phenomenon, as "in our culture the 'machisimo'—I feel like it's similar in some ways for other cultures. And I feel in our society it sometimes applies that men can do more than women." She also observes, however, that the culture in the U.S. is less restrictive than the "machismo" culture that her mother came from, and this requires a conscious adjustment on the part of her mother. "My family at first was very strict with me, but my mom finally...got into the zone of American style; she's like, 'OK, well, we have so many more opportunities; it's a different lifestyle.'" With this realization, Mónica's mother decides that "'I want all my daughters to have all of this,' so she started, like, letting us [Mónica and her sister] go, slowly."

Mónica notes that her mom, Guadalupe, is a big role model in her determination to resist the "machismo" sexism of her Latino community. Mónica tells the story of how Guadalupe ran away from home as a young woman and got married to escape being cast into the role of the oldest girl. "[In a] Latino family being the oldest you're in charge, basically; you're the mother—second mother—of all your

younger siblings. My mother didn't like that. So she ran away, got married, and then she had me." When troubles arose in her marriage, she came to the U.S. and continued her resistance to the restricted role of women. "She ended up moving over here. And she remarried. And so from there she started learning and everything." Although now in the United States, "machismo" still haunted the family as Mónica's Latino stepfather attempted to dissuade Guadalupe from furthering her education and from working. "My stepdad still has his old style Mexican ways: 'machisimo' and all that. My mother is trying to break away from that, too, telling him, like, 'I want to be able to make an income, too.'" Guadalupe insisted on persisting in school until she received her GED while continuing to "come home, clean, cook, take care of my [Mónica's] brother." Due to Guadalupe's persistence, Mónica's stepfather finally backed down, and Guadalupe not only completed her GED but also went on to complete a cosmetology in a short amount of time. Mónica was inspired by her mother's determination. "Seeing my mom succeed in that, seeing my mom break away from all of the obstacles, like, has helped me…When I went into the CSE, I was, like, 'OK, well, I'm going to prove everyone wrong.'"

Mónica credited her mother with where she is today, as Guadalupe resisted even her own mother to change how women were seen in their family. Mónica reported that her grandmother repeatedly said to Guadalupe that she didn't want her in the United States. "'I want you to go back to Mexico. You are not supposed to be here. You're supposed to be serving your man. You're supposed to be with your husband. How are you going to survive?'" According to Mónica, Guadalupe "took it offensively. She's, like, 'I can do this! I can do this!...I can do the same thing that a man can. I can be the daddy. I can be the mommy.'" Finally, Mónica's grandmother changed her mind, saying "'I'm really proud of you! You have overcome so many things, and you have done so much for yourself and your kids. You never asked for help from me or from anyone else in the family.'" Because of this, Mónica "feel[s] that my mom is another one of my big role models." With her mother leading by example, Mónica felt " like I can do it. Yes, I'm a girl. Yes, I'm going to struggle. I'll probably struggle more than a guy, but I can still do it."

Although Guadalupe left her family to follow her own path, it was difficult for her to consent to her daughter doing the same against the values of the community, even if it was to go to a better school.

Mónica reported that, in the Latino community "the daughters are supposed to be let out into the world only if they have a man by their side." When Mónica went away to college across the state, Guadalupe was scared, according to Mónica. "She was just scared to let me go, and she's still reluctant." Guadalupe described her reaction to Mónica leaving for school as a mixture of sadness and happiness, rather than fear. She said "I wasn't scared, but at the same time I was—I was sad, but at the same time I was happy because she has more than what I want when I was young." Because of the community valuing of girls staying close to home, Mónica and her mother disagreed about choosing a college to attend. Mónica reported that, when discussing colleges, Guadalupe told her "'you're not going anywhere; you're staying here'…She wanted me to go to a community college, right? It's close to town; like 15 minutes away." But Mónica responded "No, I'm not…let my fly!" Mónica also resisted the wishes of her stepdad when she went away to school, telling him "'You know what? I'm going to go live in [the city] by myself. I know I'm a girl; I know I don't have anyone over here, but I can do it.'"

In both her going away to school and in her interest in a computer science major, Mónica set herself apart from the Latinas she left at home who followed a more traditional pathway. Friends from her home community expressed surprise that Mónica was interested in a technology major, as her girlfriends "that are going to community college they're going more, like, into [elementary school] education…like, traditional male/female roles."

Although sexism and ideas about the proper roles for males and females are common in many cultures, the Mexican American culture that Mónica's family comes from follows machismo ideals of gender roles prevalent in the Mexican culture, in particular the place of women in the home taking care of family (A. B. Ginorio, 2013). The storyline that women belong in the home could cause Latinas to prioritize family obligations over schooling, which would impact their preparation to study a prerequisite-dependent field such as computer science. In addition, this storyline dovetails with the storyline that computer science is for boys, compounding the barriers to Latina women majoring and working in the computer science field.

Storyline: ***The smart kids who are good students are the White, wealthy students.*** Guadalupe and Mónica related difficulties in reconciling the two cultures that Mónica lived in during her K-12 schooling years. Mónica's friends had the same interest in doing well in school that she did, but this often meant that they were from a White, middle class or upper middle class background quite unlike her own. Mónica had to position herself as belonging with the good students against her mother's cautions and a storyline that positioned her as not belonging in academically challenging subjects.

Guadalupe first brought up this issue, saying "when [Mónica] was in high school she came and she said 'Oh, mom, I want this, or I want to go somewhere because this girl, her parents, they let her go.'" In response, Guadalupe reported that she told Mónica "This girl is White. This girl has different culture than we are.' You know? Like, they have different culture than us. And that's why they think different." Later, Mónica concurred with her mother's statement, noting that, as "my mom was saying, when I was in middle school I wanted everything that, like, my friends had, and most of my friends were, like, they were mostly the smart people. But they came from, like, a rich family." Mónica noted that she "was smart, but I was—I didn't come from a rich family. I didn't have the things that they had." This caused a conflict for Mónica, as her dedication to school immersed her in a culture different from her family's. Mónica resisted distancing herself from the White students, "because I felt like we were smart, like they spoke my language; we connected in that way." When she talked to other students, presumably with a background more similar to her own, Mónica would find that "I can't talk to these people, like, they don't know what I'm talking about. They may be going through the same situation,…but I feel disconnected."

Societal ideas about who is smart fall along racial lines (J. Margolis et al., 2008). For students such as Mónica who are not stereotyped to be smart, the storyline pattern discourages excellence at school and pursuit of a difficult major such as computer science. In order to persist against the storyline, students must fight an uphill battle to prove that they have the intelligence necessary to continue. In order to continue her interest in and pursuit of an education, Mónica surrounds herself with the good students and becomes an increasingly central participant in the youth practice of being good students in the manner of legitimate peripheral participation (Lave & Wenger, 1991).

Storyline: *Family first.* Mónica noted that part of the family obligation in her community is to financially support those family members who have remained in Mexico, and she realized that money her family might have had on paper was actually not available for expenses such as college tuition. A cultural value of putting your family first positions women such as Mónica as not belonging in fields such as computer science that can take time and money away from the family. Mónica had been able to resist this positioning through applying for and receiving an unusually generous scholarship as well as—as noted later—being protected by her mother from making family a priority over schooling. She was grateful that she had received a full-ride scholarship, as she questioned where and if she would be able to attend college otherwise.

Mónica observed that "for some reason, our culture we tend to still—I think it's just 'cause you remember the past, how people helped you in the past, and so my grandma always sends money to her family in Mexico," as does Guadalupe. Since "half or more of your paycheck will go to Mexico," Mónica finds that, by the end of the year, she wonders "where does the money go? Where does it go? We don't have it by the end of the year."

After her senior year of high school, Mónica had to make a difficult decision between accepting a scholarship that would introduce her to engineering before arriving at the university and going to Mexico to meet a great-grandmother who was dying. Mónica reported that Guadalupe "had a graduation present for me to go to Mexico, and I haven't been seen my family for like 12, 15 years." Since her great-grandmother had cancer, Mónica decided to take the trip instead of joining the pre-college engineering program, reasoning that "either her lungs were going to fail or her heart was gonna fail. And so I was, like, no I gotta go see my…great grandma. At least I gotta meet her." This decision to put her family first caused Mónica some distress when thinking about a major, as she felt "dang, I'm out of options, I don't know what to do!" Fortunately, Mónica later received a scholarship that covered her college expenses.

The cultural and family values of Mónica's community might have limited her college options if not for the scholarship she received. In a similar way to the Mexican American machismo cultural value,

the apparent value of family above education (Varma, Prasad, & Dapur, 2008), a pattern or storyline of family first, could have limited Mónica's ability to attend a four-year university both through the lack of money set aside by the family for higher education and family obligations that could conflict with educational opportunities.

Storyline: ***Everybody knows about college and majors.*** It was a struggle for Mónica to decide upon and to apply to college and to figure out what major(s) she might be interested in pursuing due to a lack of a family roadmap on how to get there. Mónica's experiences and interactions indicated that a covert storyline in the U.S. is an assumption that high school students know the process for applying to colleges and, once there, know the process for choosing a major. Mónica, through her own persistence and luck, was able to get the information she needed to attend a four-year university and was gathering information wherever she could about majors. However, she had to contend with not only barriers to getting to college, such as a lack of citizenship papers, but also a paucity of assistance targeted specifically for her needs. There were few educational opportunities in her small community, and those that were available were not well funded. Advice on choosing a college was one-dimensional: "go to an Ivy League school." After reaching college there was no additional, individualized help on how to choose a major. Mónica's understanding of computer science was vague in high school, and only recently has she begun to appreciate the variety of possible options open to those with a computer science major. However, the emphasis on critical thinking about the use of technology in introductory Informatics classes has lured Mónica to consider Informatics more strongly than Computer Science and Engineering as a major.

Mónica was happy and productive in elementary school with a goal of going to the "Harry Potter" university after touring the school and seeing the library that could be a doppelganger for the main hall in the movies. However, once she reached junior high, Mónica lost her motivation when she feared she would not be able to attend college. In her seventh grade year, she realized "'oh, wow, we don't have [immigration] papers. We don't have any of this. And, like, I can't go to college after high school. And so I started slacking off. I stopped caring anymore." After a "so-so" eighth grade year, "the summer

before high school, we got our papers…and so I got excited again, and I was like 'OK! I'm going to college!' And so I started doing good in school again."

Mónica thinks that her high school organizations were only of limited help to her in getting to college and choosing a major mostly due to limited budgets and few members. One organization "was academic based, and so some of the kids would struggle and so they would have to leave the group, and so we didn't have a constant number of people in the group." Because of this, the focus was on visiting state schools and "the whole purpose of that was just so students from the high school could get to college," which was no help to Mónica in choosing a college nation-wide or, once at college, choosing a major. Mónica took as much advantage of local groups as she could, involving herself in many organizations in high school.

Although Mónica received great help in high school from her teachers in her desire to go to college, sometimes their advice was misplaced for her. Encouraging her to apply to and attend Ivy League colleges demonstrated their confidence in her abilities, but did not take into account her feelings based on her background. Mónica ended up applying to colleges that had a reputation between the Ivy League schools that her teachers recommended she apply to and the community colleges her mother insisted she should attend. "My senior year when I was applying [to college] and everything, my teachers greatly pushed me towards doing Ivy schools. And I was always scared. I said 'That's so intimidating; I can't do something like that.'" Being a first-generation college student meant that Mónica "didn't know what college I wanted to go to for. Although the state university was "my dream school and everything, I was still considering [the land-grant university], just because I didn't have anyone to lead me." Mónica re-iterates that she did not want to go to a community college, but was unsure of the differences in opportunity. "I think it's just me, but I feel that community colleges don't offer the same opportunities that a university does. And so I feel that I would have more chances in a university."

When Mónica began searching for guidance in choosing a college major her high school teachers were minimal help to Mónica, her parents were unable to provide helpful advice, and there was little university-supported help. When asked about counsel on choosing a major, Mónica noted that she asked

the advice of "my past teachers, but they lean more towards 'oh, you should go into my area,' whatever they are doing." She found that "my parents can't really help, because they don't know anything about it. And so it's really hard for them, too. Tell me, like, 'oh, you should go into this.' No." Mónica found that her parents instead emphasized that she need to "'get on with it!' Like, 'get busy!' Like, 'you've got to get this done.'" Mónica solicited advice on choosing a major from several advising groups at the university, but said "I feel like I haven't had, like, a clear advisor. I go to people and I tell them, like, how I feel…But they don't really know what to say back to me." The university had an organization charged with assisting first-generation college students of migrant workers, but Mónica felt "that that was more just to get me through college, not so much for telling me, like, 'oh, what do you like? Let's find out what major you want to go into.'" Because of her experiences, Mónica feels "like I'm on my own, basically," as far as choosing a major. Due to the lack of specific help by university resources, Mónica is talking to peers about majors and paying attention to how much she likes her classes in order to decide on a major.

A computer science major could easily have been overlooked by Mónica through a lack of understanding of programming. Despite the work she had done to learn about engineering, Mónica did not know some of the most foundational ideas of computer science, such as the existence of programming "languages." She reports an illustrative example of her ignorance, relating that, upon arrival to the university, she attended

> a session or a workshop or something for the engineering department, and so I remember me and my friend were sitting down, and then the guy goes 'So, does anyone have any questions?' And so this guy behind us raised his hand and he asked 'oh, so what language is the programming going to be in?' And I turned to my friend and I was like 'well, in English, duh!' And then the instructor, he's, like, 'oh, it might be in Perl. It might be in this and that. We have a couple of languages.' And I'm like 'what are they talking about?!' I was, like, totally lost…So finally when we got to CSE I understood it. I said 'oh, so that's what they meant by user friendly languages!' So I knew very little. But throughout the course I started learning on my own and from what they were teaching, too.

Once in the introductory computer science programming classes, Mónica is surprised at how difficult the subject is for her. Although she likes working with computers, "once I got into CSE I sat down, and I was, like, 'OK, this is going to be easy. Simple, right? I can pick up on it. It's computers. OK. It's our generation.' However, she found out that "when I got into it, it was a lot more difficult than I thought it was going to be." Despite the difficulty, Mónica works hard to stay in and do well in the class, seeking at tutoring from three different tutoring centers on campus. She ends up doing well in the class, despite a major setback when she becomes extremely ill right before the midterm exam.

Although patterns Mónica encountered indicated that there is awareness that first generation college students need information and assistance in completing their college degree, some assumptions remain about student knowledge on choosing colleges and majors. Mónica's description of her struggles to decide what colleges to apply to and then how to choose a major signal that there is a covert storyline operating that assumes student knowledge about navigating these choices (Espinosa, 2011). Based on this storyline, work needs to be done to investigate how students can be assisted in choosing colleges and majors in the most beneficial manner. In addition, Mónica's experience indicates that we need to better understand the pathways of students through community colleges versus bachelor degree granting institutions to the successful pursuit of a computer science major.

Mónica: "Identification" Position

Mónica had support along her pathway to a technology major and interactions with others that suggested that she belonged in school and in a rigorous academic subject such as computer science. Her mother had provided both a role model and the discipline necessary to excel in school, her teachers expressed confidence in her abilities, her hometown community exalted her school success, and the Latino community at the university provided sanctuary to her when she began to feel out of place. Mónica enjoyed and excelled in math and science throughout her schooling years, putting her on a path to enjoy and excel in programming and computer science.

Storyline: *Schooling and hard work are the way to a better life.* Guadalupe had emphasized to all her children that an education and hard work are the keys to improving quality of life. Mónica said

that her "mom was very strict on school. She never had education like we did, and so she stressed it on us." When asked what she would like Mónica to learn from her life, Guadalupe accentuated that "she needs to work for the things that she wants. You know? Like nothing is free in this life… You don't need to steal anybody, or you don't need to tell anybody 'you can give me this.'" Guadalupe noted that she was adamant about working herself instead of relying on others, going against the norm in her community, saying "my life really was strong, and my parents didn't like that." Guadalupe insisted that Mónica accompany her into the fields and work side-by-side with her, telling Mónica "you need to work with me. You need to go sometimes with me and check what I am doing. If you don't like this kind of life, you need to study. You need to learn more." At the same time, Guadalupe relieved Mónica of her household chores, emphasizing that Mónica needed to focus on her schoolwork, not the housework. Mónica confirms this, saying her mother "would say 'I don't want you to come help me clean. I don't want you wash the dishes. I want you to go into your room, lock yourself, start doing your homework.'" In this, Guadalupe broke from family tradition, as her mother had made her do housework before homework. "When I was young, my mom, she don't care if I have a homework, she wants to, she wants to see that the stuff clean, the dishes and clothes and I don't like that for my daughters." Even when Mónica did not have homework, Guadalupe would insist that she do additional reading. "She would do that for us, too, so she would be around us having us read 30 minutes each day. And just read. Nothing else." For Guadalupe, education is the "principio," explaining it is "how to start the life, how to appreciate everything, you know? How to appreciate the people who help you or how to help the people who needs help."

Mónica realized how important her education was not only to herself but to her family when her grandmother gave Mónica her blessing. "When [my grandma] comes up to me, she never used to this, but when I go to college now, she, 'me persigna,' how do you say that? She does, like, a prayer on me right before I leave." Her grandmother's action caused Mónica to realize "'wow!' This is this big thing, not just for me, for my family—my entire family. And so I guess that's what keeps me going: being a role model to my younger siblings and the rest of my family."

Mónica received support from her teachers along her educational path, which may also have helped her value education. In junior high school, when she despaired of being able to go to college due to a lack of citizenship papers, Mónica's teachers "would stress about me and say 'come on, you know you can do this! We know you have it in you!' and everything." In high school Mónica's teachers were "really close" and would help her apply for colleges and for scholarships. The English teacher put a great effort into Mónica's application for the full-ride scholarship, helping her receive the prize, and Mónica felt close to her math teachers and continues to visit them on her trips home.

Public education in the United States was built on the idea that education was the key to social mobility. The value of individuality in the United States insists that hard work allows one to "pull himself up by his bootstraps." Mónica's mother and teachers appear to support these U.S. storylines, imbuing in her the values of hard work and higher education in order to create a financially secure future. Up to the point of this study, Mónica had taken advantage of the opportunities available to her to surpass the educational level of her parents and to appear to have a bright future; the storyline may guide Mónica on a path beneficial to her. The literature (J. Margolis et al., 2008) cautions, however, the limitations of this storyline, as an unlevel playing field can limit the ability of many to rely on hard work and education to improve their situation in life.

Storyline: ***In the Latino community, we celebrate and support the successes of our own.*** The machismo storyline that would relegate Mónica to the home is apparently put aside when her success at school garnered praise from her hometown community, and Mónica feels a responsibility to be successful and to be a role model for others in her community. In contrast to the years of K-12 schooling, Mónica found at college that she did not have to befriend the White, wealthy students to feel an intellectual connection with her friends. Other Latino/a college students with a similar background provided a respite for Mónica from the tiring immersion in settings dominated by non-Latinos, and the support of these friends who had been through similar struggles and who had similar aspirations inspired Mónica to continue with her schooling and to pursue a major that interests her.

Winning a prestigious college scholarship attracted the attention and accolades of the entire hometown community to Mónica at the end of high school. She reported first hearing the news about her receipt of the scholarship from relatives, saying “the day that I got the notice, I got calls from my aunts in [another town], which is like an hour away, and they were, like, ‘Congratulations! We just saw it on the news station!’” Mónica questioned “‘what are you talking about?!’ They were, like, ‘You got the [scholarship], didn't you?’ ‘Oh, my God, I got the [scholarship]?!’ And so I ran to the mail.” The word spread quickly, and Mónica “got support from everyone in the community. Even the Spanish stations were saying my name.” This attention inspires Mónica to “feel like I could not fail them. And I said, like, ‘wow, this is huge accomplishment.’” Mónica anticipates that majoring in computer science would continue garnering support from her home community, as they see it “is very difficult and they would be very proud because it's pretty hard to get someone to do something big from our community.”

Now at the university, Mónica sought out those who were most like her because she felt connected with them and they provided a feeling of home for her. Mónica felt the most comfortable

> with the Latino community around here. With girls, usually, because sometimes when I have a problem I feel like they would have the same problem. Also with, like, lower income. Because I feel if I go to someone in the Greek row, they won't understand how I feel. Because they have the money to be in the sorority. They have the money to do all of this stuff. To travel, and everything. And I feel like I don't have that. And so I don't want to feel less of a person from being around them. And so I feel like low income and any Latinos.

Even if she majored in computer science, Mónica was determined

> to hang out with the people that I hang out with right now. Because they are the ones I grew up with; they are my roots. And even if I meet new people with higher incomes, who are more diverse and all of this, I feel like I'm still going to be myself. I'm still going to have my comfort zone that I'm still going to be going back to. I may come out and, say, hang out with them and do a couple things. But I still feel like I'm going to keep going back.

Between the beginning and the end of the quarter Mónica had joined a sorority for Latinas. This had strengthened her connection with the Latino community on campus, which she described as

> the girls that I'm hanging out with. I, like, love them to death, and I've only known them for—what?—two, three months. And we bonded so much. Like, we have so much in common, and, like, our parents think the same way…Like, I feel like when I'm tired of, like, being over here in the science field with other people, like, I feel like I can go 'home' to someone who understands me… I feel like they're supportive to me. And so they're there for me.

This sense of support was not limited to women only, as Mónica had also noticed that an engineering fraternity brother of her boyfriend's was supportive and he "knows what I'm going through, 'cause he already did it. So he's helping me out." One way that Mónica felt supported in her college community was by the lack of surprised reactions when she announced that she was interested in majoring in computer science. Mónica noted that "here in the [city] they are more, like, 'oh,' like 'OK.' They are acceptive [sic] of it, and they are kind of more, they're, like, 'Oh.' They have seen people do it before."

The sense of connection and support that Mónica felt for other Latinos extended to non-Mexicans, but did not necessarily extend to those college students who did not come from immigrant, low-income families. A girlfriend from Mónica's hometown attends the same university, but Mónica reports that "her parents were born here, and she does not, like, have anything in common with us;…we'll be talking about this; she's like 'I can't even understand you.'" Eventually, this friend "moved in with one of her White friends, and she doesn't hang out with us anymore."

As a member of the Latino community who proved wrong the storyline that "the smart kids who are good students are the White, wealthy students," Mónica's community loudly celebrates and supports her success. Similar to the "volunteer immigrants" that Ogbu (2001) theorizes, the actions of the Latino community indicate that success in education is valued and praised. Latino students at the university create their own community that supports educational success.

Storylines: ***Computer science is for those who are good at math and science; Computer science is for those who like computers.*** In school, Mónica "really like[d] math and science, and those were the

main ones that I did not struggle in. I was, like, 'Oh, maybe this is my thing.'" Guadalupe reported that Mónica liked computers from the time she was small, and Guadalupe "think[s a computer major] is really good because she likes and she's really smart, you know, for make up projects on the computer." Mónica has a desire to know how things work, and when shown a computer program by a friend, she had no hesitation in "download[ing] the thing and I was completely lost. But I was, like, 'OK, I'm gonna work on this, because I want to find out how this thing works!'" Difficulties did not deter Mónica, according to Guadalupe, who said Mónica "likes the difficult things. She don't like the easy things so much. If something is easy, she is boring, or she wants to take different, you know?"

The prerequisites for computer science and the housing of computer science within engineering at many institutions signal a storyline that computer science appeals to those students who enjoy math and science. In addition, since programming is the foundation for the use of general purpose computers, enjoyment of computers and computer applications is associated with enjoyment of computer science. Although the association of computer science with engineering can discourage women from the field (T. J. Misa, 2010b), women who enjoy math and science may consider a computer science major based on its association with other STEM fields. Furthermore, an interest in or enjoyment of computers could increase women's interest in the field. More work is needed to understand how much the use of computers provides a basis for understanding programming tasks, as the pathway from computer use to computer science may vary based on gender and ethnicity.

Summary: Mónica

Mónica had consistently drawn upon moments where she has been positioned as belonging as well as resisted being positioned as not belonging in school and, in particular, STEM fields in order to persist in moving towards a technology major. Mónica was aware of the discrimination she continued to face, and was interested in participating in this study because "someone needs to let the entire world know" not only what women face who are interested in technology majors but also that women can be successful in these majors.

Many of Mónica's experiences were tied not only to her race and class, but also to her immigration status. Being the first in her family to grow up in the United States, Mónica and her family were close to their cultural roots from Mexico that were based in the working class. Most notably, Mónica mentions the version of the "machismo" culture that values strict gender separation with women responsible for and belonging in the home and men in the world of work. Although working class women often have to work to support families, the "machismo" culture divides up and labels work as for men or for women. Computer science would be considered men's work. The task of breaking from this culture and embracing more co-equality for men and women started in Mónica's family with her mother Guadalupe and is being continued by Mónica herself. Hardway and Fuligni (2006) found that Mexican students place a priority on family assistance, which lessens time that they have for other pursuits. Guadalupe experienced this in her family of origin, but has allowed Mónica to break away from this pattern by insisting that she do her homework before helping with the housework. It was only through Guadalupe's insistence that Mónica focus on schoolwork that Mónica had been able to excel in school and receive the early education necessary to give her the background required of computer science majors. Guadalupe's example of women continuing in school and doing what has been considered men's work gave Mónica a role model and a strong springboard to being in a place that would allow her to consider and be successful in a computer science major.

The close ties to her cultural background had provided Mónica with a sense of community and belonging in settings dominated by other Latinos now that she is at the university. Unlike high school, where the good students Mónica was drawn to were not of her ethnicity, at college Mónica had found large numbers of friends who not only share her Latino immigrant background and culture but also are academic and interested in intellectual pursuits. Among her new group, computer science was just one of the many interesting majors that any of them might consider.

Coming from a working class background and being a first generation college student had forced Mónica to find her way to college and to a major without a clear roadmap. Mónica had consistent educational support from her mother, supporting the findings of Ginorio and Huston (2001). Growing up,

Guadalupe emphasized reading and the importance of school in a general way to her children. However, she was unable to provide specific guidance to Mónica on choosing or applying to college. This supports findings by Yang (2009), which found that Latino/a parents use encouragement and discipline to support their children's education, but may only have vague higher education and career goals that may not be in line with their child's wishes and interests which make educational assistance less effective. Now that Mónica was at the university, Guadalupe was unable to help her choose a major. Mónica valiantly sought out help in choosing a major from everyone she could, including teachers and advisors, but she was often frustrated by the lack of assistance specific to her situation by those who assumed a certain amount of family knowledge about such issues as how to go to college and how to choose a major. This left Mónica and others like her a casualty of blind chance as to whether or not they discovered computer science and any possible interest.

Only through her receipt of a full-ride scholarship and only through her break from certain cultural values has Mónica been able to overcome the limitations of her working class cultural background in choosing a college and having a chance to successfully complete a computer science major. If Mónica had not received the scholarship, it would have been likely that she would have been able to afford the local community college as her only option. As are many Latino parents, Guadalupe was concerned about Mónica moving far from home to attend a four-year university instead of the community college close to home (A.B. Ginorio, personal communication, February 20, 2013). Mónica was able to use the scholarship to attend the university despite her mother's reservations, thereby avoiding the difficulties in attempting to transfer from a community college to the university and entering an extremely competitive major coming from another school.

For Mónica, gender, race, culture, immigration status and generation, and class intertwine to create many barriers to her entry in computer science. As a woman in STEM, Mónica faces consistently being immersed in settings dominated by men, with the accompanying glare of having every move being seen as representing all women. As an immigrant Latina, Mónica not only faces settings dominated by Whites and Asians, but also faces a clash between her home culture—which values family obligation,

hard work, and clear gender roles—and the culture of computer science—which values dedication to machines, withdrawal from the world, and being smart. Coming from a working class background could have limited Mónica's schooling options if not for outside financial help, and it does limit the settings in which she feels completely comfortable.

At the time of this study, Mónica had successfully overcome these barriers to be poised to consider a computer science major. Having a mother who broke from the community expectations for women not only gave Mónica a role model that she purposefully imitated in her pursuit of schooling success and her determination to prove that women could be successful in male-dominated fields but also gave her a shield from pressure to help out in the home to the detriment of completing schoolwork. When necessary, Mónica was willing to oppose her mother to align herself with students from other cultural backgrounds in order to continue her academic excellence. Her receipt of a full-ride scholarship had allowed Mónica to overcome the financial restraints of her working-class background and to select a university in which computer science was highly ranked. Once at the university, Mónica surrounded herself with high-achieving peers, including a boyfriend who was majoring in "math and biochemistry...he was studying for his MCAT last year, so this year he's applying to medical schools," and her boyfriend's fraternity brothers, some of whom were majoring in engineering. Mónica had also surrounded herself with people with whom she felt at "home" by joining a Latina sorority and socializing with other immigrant, working-class, Latino students. Mónica was able to seek out and evaluate advice and assistance from a variety of sources that had guided her on a path to a highly-ranked university and to her enrollment in introductory programming. Other students from a background similar to Mónica's may very well not have the persistence and luck that Mónica had in role models, advice, assistance, opportunities, and choices.

Case 2: "Kelsey"

"Kelsey" is a middle-class Pacific Islander American whose mother was born in the United States of Filipino parents and whose father is Caucasian. Kelsey was raised by her mother, "Teresa," and she identifies as a Filipina or Pacific Islander American despite the Scandinavian heritage of her father. She

was in her sophomore year at the university and was the first in her family to consider majoring in a STEM field. During the quarter that we talked, Kelsey was admitted into the Human Centered Design and Engineering (HCDE) major at the university, and she was considering a double major with Computer Science and Engineering (CSE) as the second major.

Kelsey: "Disidentification" Position

Kelsey's interactions suggest two storylines that position her as not belonging in computer science. The U.S. cultural storyline that computer science is for boys excludes her. In the Filipino community, computer science is not well known. Because of this, the Filipino community does not embrace computer science and Filipino parents do not suggest that their daughters major in computer science. Kelsey has resisted these storylines, helped perhaps in part by her distance from the Filipino community as a second generation American.

Storyline: ***Computer science is for boys—particularly White, introverted, insecure, experienced boys who like to sit in front of a computer; the only girls that excel have a personal, inherent knack for it.*** The predominance of men in computer science, the experiences of girls in the classroom, and the masculine qualities of those in the field all indicated that computer science is for boys in Kelsey's experience. Kelsey had noticed not only that there are few women in the classroom, but also that previous knowledge of computers is celebrated and that the vision of who belongs is a narrow one. Despite the barriers, Kelsey didn't "let people exclude me if possible" and she persisted in what interested her.

Although she had an early interest in computer fields, Kelsey was positioned as not belonging in computer science in high school by virtue of the fact that the advanced placement (AP) computer science class was exclusively populated by boys. Kelsey did not choose to enroll in AP computer science in high school because "there were no girls in it" and she "really didn't want to be the only [girl] in it, so I didn't take it." Kelsey thought that "not a lot of females know about it [computer science], because, like, in high school I was, like, 'oh, whatever, that's what, like, those guys in the computer lab: that's what they do.'"

One girl had taken AP computer science and done well in it the previous year, but Kelsey remarked that "everyone figured that she did well because she was, like, good at that type of thing."

Her senior year in high school Kelsey accepted an underrepresented minority (URM) engineering scholarship to the university even though she was skeptical about an engineering major being of interest to her. Kelsey noted "I got a scholarship in high school; an engineering scholarship to be an engineering major my first year, and so that's why I started doing engineering, and then I actually realized I like it so I stayed with it." Kelsey had found that she unexpectedly enjoyed computer programming, which had resulted in her resolving to pursue her interest even as she experienced being positioned as not belonging. She reported that computer programming was "required for, obviously, both majors [HCDE and CSE] I am considering. So I wanted to take it. But I've actually heard from people that they like it. So I figured I would try it, and I do like it."

The prevalence of computer science classrooms dominated by men serves to position women as not belonging. Kelsey believed that the low proportion of women in computer science was a chicken and egg problem where the scarcity of women

> imposes, like, the thought of 'I don't want to be the only one.' Like, people don't like to be singled out, so if you sit in class and, like, maybe people will be staring at you or maybe people will think that you're not good at it because you're a woman. Just being, like, in a welcoming environment I feel, like, if computer science was, like, 50 percent female, like, I feel like it would continue to be 50 percent female because, like, 'Oh,' like, 'it's normal for women to go into this field.' Like, 'I should think about it, too.'

Despite the low numbers of women, Kelsey had persisted, and she had a role model for women in computing, as not only did her mother "Teresa" work at home on a computer, but she had also learned to program. Teresa recounted that "from a very early age [Kelsey] was interested in computers;…you know: preschool." Teresa had a background in visual communications and graphic design and therefore worked on a computer at home, which she believed influenced Kelsey since "I would be working and she would kind of be sitting next to me or could see me from wherever she was in the room when I was

working," which "set the tone for, you know, that's something that you do…That just part of regular, you know, everyday life is being on a computer." Teresa learned to program "a looong time ago. Way back when I don't even want to mention what programs were. But, yeah, I had to have it for my degree."

Interestingly, although there were few women in computer science classes, they were not drawn to sit together nor support one another which might help them to position one another as belonging in the class. Kelsey had noticed that "there's not a lot of girls in my class, and they all kind of, like, sit really far spread out, because I don't think I have ever sat next to one." By the end of the quarter, this had changed, as she and another female student "met at, like, the [HCDE] workshop thing, and then I actually, like, and then we're like, 'Oh, hey! I actually know who you are!' So then pretty much since then we, like, sit next to each other."

The isolation that women may experience in the classroom by being surrounded by men is symptomatic of the computer science culture at this university, where introductory programming students are forbidden to work together and are competing with one another for the grades necessary to be admitted into the major. Kelsey had found an environment that helped her resist the isolation and competition; she enrolled in a one-credit computer science lab where students were given assignments on which they were allowed to work with others. Kelsey explained that, in the lab, "there's just people you can work with, and I like working with peers on, like, homework and stuff, 'cause we're not allowed to that, really" in introductory programming. She found the lab helpful, as "it's just nice 'cause if you get stuck on, like, one part,…you could ask people next to you if, while the TAs were, like, helping someone else, to see if they knew how to solve it." Kelsey was appreciative of this, since in STEM classes such as computer science "unless you're friends with people, people really aren't interested in helping you…because everything here is so competitive and since everything's graded on a curve…if it doesn't, like, help them specifically, like, they don't want to, like, help." Not being able to work with others spurred Kelsey to seek out additional help in STEM classes where she struggled. Teaching assistants for first-year STEM classes were available to help URM scholarship recipients such as Kelsey, and she had sought out tutoring through a minorities office and instructional learning center.

Experiences in the classroom serve to position women as not belonging in computer science; Kelsey had noticed that boys in the class treated her differently based on her gender, saying "I just notice, like, even if you just talk to people in class, like, they kind of treat you differently." Her attempts to be friendly were rebuffed, and she attributed that to being female. "I just try and say 'hi' and stuff before class, and, maybe because it's because I'm a girl, I have no idea, or maybe they are having a bad day or something, but they…don't say anything." She had also perceived a difference in the pace of the class for her compared to the boys in the class who were more experienced. She found programming "fast and difficult. I think, like, my class goes kind of fast, since I'm, like, have no experience at all, so sometimes it can be difficult." In "quiz section we, like, I don't know, go through our program, like, line by line, and each person says, like, one thing, and most people can answer it right away," and through this exercise "you definitely know that, like, most of the males in class are more familiar with it." In lecture, boys used questions as a way of showing off their expertise. Kelsey was impatient, noting that they "ask questions in lecture…where it's, like, not within the scope of what we are learning…'Could we do this really complicated thing that we're not going to learn?'" Teresa reported that Kelsey was someone who "pursues her strengths" and who didn't let the challenges of being one of few women in the field deter her.

The masculine stereotypes of who does well in computer science serve to position women as not belonging in the field. What came to mind for Kelsey when asked about the stereotype of a computer science major was White males, and she recalls that an assignment in her PEERs (Promoting Equity in Engineering Relationships) training class was to look up "pictures of, like, stereotypical engineers, and it was funny, because it was some, like, guy with a calculator just coding on his computer, like, by himself." Kelsey added that "the stereotypical image of a girl that's in engineering is basically the girl version of a guy that does engineering. So, you know, like, loves video games and, like, dresses like a guy and stuff." Through a class exercise in introductory programming, students learned about "personality types that are in computer science and how, like, a lot of people are introverted" on the Myers-Briggs scale. Per Kelsey, the instructor said "it's normal for, like, 25 percent of the population to be introverted or

something—I don't know if that's true, but, like 65 percent of the people in our class were introverted." Reinforcing this stereotype during the introductory computer science classes positions more social women as not belonging. Kelsey's personality type was extroverted, and she had found that "when I tell people that I'm, like, engineering… they're, like 'Oh. But…you're so outgoing.'" Kelsey had found that when she told people of her interest in computer science "they automatically think that you are really smart," which may be why as "a general thing people would be almost intimidated by it." For women who do not want to risk intimidating men by being smart, computer science would be an unlikely choice of major. Kelsey resisted being positioned out of computer science by noting how she was similar to computer science students and by persisting in the face of negative reactions of others. Kelsey thought that some of her interests, including "being interested in, like, math, problem solving, like, programming: that part fits" the stereotype of the computer science major. Kelsey had become accustomed to being around introverts, saying "I think I've gotten more used to it now. But I've gotten better with, like, dealing with people like that" as she continued to try and meet new people and began conversations. Kelsey believed that her high school girlfriends who studied science are as smart as she is, saying that studying computer science "doesn't mean that it's smarter than someone that's doing, like, you know, biology or, like, some other thing, which I think is really interesting."

Misconceptions about the computer science workplace—particularly the notion that you should have been and will be coding at a computer all the time—discourage women from pursuing a major in the field. Kelsey found that the concept that you need to have been coding for many years in order to obtain an internship led other applicants to discourage her at an interview. She reported that "people actually told me, like, 'why are you here?' because, like, because I didn't have much programming experience as them. And they literally said that to me." Kelsey shook her head at their response, wondering "'why would you say that?!' It's, like, it's, like, obviously I'm here because I wanted to be here." This contrasted with the interviewers, who told applicants "you're not competing against anyone else. We want to see if you are a good fit for our company," and, indeed, Kelsey successfully obtained the internship.

As noted above, Kelsey found one common stereotype about computer scientists to be that they do coding by themselves. She had heard that the computer science department is "trying really hard to dispel the stereotype that you're by yourself, coding in a basement or something" and computer science "has actually become more interesting for me, because I think there's a lot more you can do with it than I thought." Through her involvement with the URM engineering scholarship, Kelsey received emails from a group that does "a lot of programming for, like, kind of, like, applications for Third World countries, so, like, developing, like phones for them, or, like, someone developed an ultrasound machine that's portable that they can use for, like, midwives there." This knowledge had increased Kelsey's interest in computer science, since "I just think it's interesting that you can do a lot more than I originally thought," which appealed to her interest in community service.

Kelsey was able to reposition herself as belonging in computer science by being aware of racist and sexist storylines and actively resisting these patterns. Kelsey reported to me that she was interested in the topic of underrepresentation in engineering and computer science and was interested in diversifying the field. During the time of the study, Kelsey was involved in PEERs, an NSF program that offers a one-credit seminar to train leaders who educate others in diversity issues, which meant that "I realize more a lack of diversity more than, like, most people do." When Kelsey received the email about the Women in Computer Science and Engineering seminar, she decided to enroll in the class "I guess because there aren't that many, like, women in computer science I was really interested to, like, see what it was about, but also to, like, maybe to, like, meet other people that could be in my classes." Kelsey thought it was important to be aware of issues of underrepresentation in order to change the culture of engineering fields to be more welcoming to women and to minorities. Kelsey was aware that being positioned out of computer science as a woman and as an URM was inherent in the culture of the field and was something that she could work to change.

Kelsey's mother, "Teresa," believed that she had provided a role model for Kelsey that helped her see a way that was different from the norm. Teresa hesitated to take credit for Kelsey's success, saying "I don't feel like I've done that much and she has gone way beyond that, you know? In her young age, you

know? And has so much ahead of her." She did indicate that the role model she had provided may have helped Kelsey position herself as belonging in areas that have been traditionally male-dominated. Since Teresa was a single mother "that's all [Kelsey] saw was a woman that, you know, that provided for her and, you know, made the way of working and providing for her and just that's what you do."

Kelsey believed that underrepresented students often become accustomed to being in environments of people unlike themselves in some way, thereby positioning themselves as belonging in the environment. Kelsey talked about being the only Filipina in her class at high school, saying

> out of my class of 100, I think I was the only one. There was actually a friend who was Filipino who was in the class below me, though, but it's, like, especially living in [this state], like, I feel like that was just, like, really intense. And as far as, like, other minorities go, it was, like, worse. Like there was, like, where did everyone go?! So, but that's, I think because of that, because I just, like, I was used to, like, not growing up in very, like, diverse environments that I just, I don't think it bothers me. Like, I don't feel excluded.

In college, Kelsey considered joining the Filipino student group, but found that she also felt like a minority in that setting because "most people that are in it are, like, 100 percent, like, Filipino, and they almost treat you, like, differently;…it's really odd. Like, I almost don't feel like I belong there because I'm not 100 percent."

Kelsey believed that, similarly, women in computer science simply stop noticing that they are a minority in the setting.

> I just feel like the type of women that are in computer science don't think that it's weird that there aren't that many women. And just them talking about, they're, like, 'Oh, I don't think it's a big deal. I don't think that guys treat me differently.' And I was just, like, 'what?!' Like, 'I don't know where you have been, but definitely not the case for me,' so. And like I kind of just, I feel like just because of the personality type it's like people just don't notice that type of thing, maybe, but, like, I don't know. It was surprising that so many people thought that, at least in my group

> [at a Women in CSE seminar discussion], I think, like, a lot of people mentioned that or, like, kind of like, alluded to the fact where it's like 'oh, I don't think it's a big deal.'

Even when women do notice how few women are in the field, Kelsey thought that they simply think "I'm here; there's nothing I can really do about it. I'll just go on with whatever."

The storylines around who belongs in computer science foster a pattern of White and Asian male domination of the computer science classroom. As noted by Margolis et al. (2008), the common perception is that computing is for inherently smart people, and, once in the classroom, less prepared students feel excluded, intimidated, and isolated. Kelsey is well aware of the stereotypes and behaviors that would serve to prevent her from entering the field, and she consciously refuses to be discouraged. However, this only became the case at the university; in high school, storylines and interactions prevented Kelsey from enrolling in AP computer science.

Storyline: *The Filipino community does not embrace computer science (particularly for girls).*

According to Kelsey's observations and experience, girls in the Filipino community are not encouraged to pursue computer science, as it is not a traditional field and is not well known in the community. Not only Filipinas but also girls of any minority group can be positioned as not belonging in computer science due to the lack of similar others in the field and the resulting feeling of being singled out. Kelsey believed that her experiences have differed from other Filipinas since her mother was born in the U.S. rather than being an immigrant, and she hopes to be a role model for other Filipinas. Since high school Kelsey had become accustomed to a majority White environments and she appears to take her minority status in stride.

Speaking with her family from the Philippines Kelsey realized that "in ethnic cultures it's not traditional for women to go into, like, technical fields and stuff like that." She had found that "a lot of my family asks me, like, 'Oh, what are you doing?' And, you know, I tell them I am doing computer science, they are, like, 'Why?!'" Kelsey related that "Filipino parents really influence what, like, or just ethnic parents in general, like, really influence what you go into." This is true of both a field of study and work as well as procreation expectations "because of the social norms of, like, 'it's going to be a doctor,'

like…’you need to have a family by, like, this age,’… I think that's why a lot of people just don't go into it.” Due to the influence of parents on the lives of their children in Filipino families, “if your parents don't know about computer science, then they wouldn't add that to the list of stuff that you would, like, want your child to do,” preventing the children from considering a computer science major. Kelsey pointed out that her parents did not have the career and family expectations of traditional Filipino families. Kelsey hoped that her success in the field would provide a role model to her Filipino relatives, as she thinks “being a role model helps, I think, because, like, since I'm doing computer science and they see, like, ‘oh, wow, you're actually, like, doing well.’”

Kelsey herself “grew up here with this environment of, like, you know, American culture” since her mother grew up in the United States. “I think I grew up in a different environment, because I feel like… the demeanor of having parents from a different country is a lot different, because you grow up differently. Although she grew up in American culture, Kelsey notes that if “there's not as many people, like, in your race, like, in a field, then you wouldn't want to be singled out. Like, you wouldn't want to be, like, feel like you are different than everyone else.” When asked if she identifies more with her ethnicity or her gender, Kelsey said that she “would probably have to identify more with ethnicity” because she “notice[s], like, ethnicity, like, diversity before I notice, like, gender diversity, which actually is interesting” and she feels that her ethnic difference “is more of, like, a difference between me and other people than me being a female.”

Although cultural background and minority status position many women as not belonging in computer science, Kelsey persisted “because I just, like, I was used to, like, not growing up in very, like, diverse environments that I just, I don't think it bothers me. Like, I don't feel excluded.”

Kelsey’s experience suggests that further research is needed to better understand the intersection of ethnicity, class, and immigration status in barriers to computer science. Interactions and beliefs about who belongs in computer science varies between racial and ethnic groups (Varma et al., 2008), yet all Asian American and Pacific Islander (AAPI) groups are often lumped together. As indicated by Kelsey, ethnically Filipino families may have particular views about computer science, and these views may not

be shared by other AAPI cultures. In addition, Kelsey indicated that her ties to the Filipino community were weak due to her status as a second generation American. Research on cultural background and the persistence of cultural practices through generational status should be brought together with research on representation in computing.

Kelsey: "Identification" Position

The computer science storylines that position those who like computers and who are good at math as belonging include Kelsey, as she fell into both categories. Her Filipino family's storyline of the importance and value of education positioned Kelsey as belonging in a rigorous academic field such as computer science. Through an engineering scholarship for underrepresented minorities, Kelsey had financial, academic, and social support that positioned her as belonging in engineering fields such as computer science.

Storylines: ***Computer science is for those who are good at math and science; Computer science is for those who like computers.*** The fact that Kelsey liked math and had liked computers position her as belonging in computer science. Kelsey was attracted to computer science at a young age. "When I was really young, like grade school, I actually really, really wanted to do computer engineering." She also reported that "I've always liked math. So. And been good at it." When she considered what is stereotypically true of computer science majors, she found that she has common interests to others in the field. "I think as far as, like, interests go, like, being interested in, like, math, problem solving, like, programming: that part fits."

Similar to Mónica, Kelsey's enjoyment of and identification with math and science had opened the possibility of majoring in a STEM field such as computer science. Furthermore, her interest in computers from a young age encouraged her to explore and choose a STEM field in computing. In this particular case, the housing of computer science in the engineering department did not detour Kelsey as it might for other women (T. J. Misa, 2010b) as the receipt of an URM engineering scholarship encouraged Kelsey to explore engineering fields despite her stated lack of interest.

Storyline: ***Programs for underrepresented minorities (URM) help in success in computer science.*** Although skeptical about the interest it held for her, Kelsey accepted an URM engineering scholarship that not only paid for her first year of college but also provided informational field trips designed to educate students about the variety of engineering fields and study groups and tutoring in engineering subjects. Through this program Kelsey found that engineering was interesting to her and that she enjoyed computer programming. Such programs position underrepresented minorities as belonging in computer science by grouping the scholarship recipients together in classes and study groups, since Kelsey thought it was helpful to know that there "are other people out there, in case you do feel different, like, they are having a hard time, too, like, so it's more of a thing to get people to know that, like, you are not the only one." The scholarship provided a teaching assistant for STEM study groups, and Kelsey thought "it was helpful for me to do well." Kelsey also believed that such scholarships offset the financial differentials between many underrepresented minorities and majority students, stating that minority scholarships are "definitely helpful, because I think just, like, typically people that are, like, minorities just have a lower income level, just for whatever reason, like, I read some study about that."

As found by Margolis and Fisher (2002), building a supportive group can help underrepresented students continue in computer science. For the recipients of the URM scholarships at the university where this study was conducted, a built-in cohort of students appears to have provided a readymade support group for Kelsey. In addition, the financial support opened up the possibility of an engineering major to low income students.

Storyline: ***Education makes you the best person you can be and creates opportunities.*** The emphasis on education by Kelsey's family and friends position her as belonging in school and in demanding fields of study. Teresa reported that "education was always a priority" in her family because "my parents were actually teachers…and then also for us growing up was important for us and to really strive for the best for education." For Teresa, education was important "for self-worth. And then also for opportunities. But I just think to make yourself a whole person; the best person that you can be to be educated." Teresa had continued the emphasis on schooling since her parents "pretty much imbued that

in me: that it's really important." Teresa "tried to give [her daughters] the best education possible," including allowing her two girls to go "to different high schools because that's what they wanted to do, and in different parts of town, so there are challenges in doing that." Kelsey echoed the sentiment that education was important in her family, explaining that college "was pretty much expected of me since, like, I can remember." Even away from her family Kelsey chose friends who were studious. "My friends in high school, if you were to, like, stereotype us, we would be, like, we were all just, like, a group of girls—people that studied and didn't go out and party and stuff."

The possibility of majoring in computer science, particularly at the university where this study was conducted, requires a strong educational background and continued enrollment in math and science courses. As noted by Margolis et al. (2008), a strong college preparatory curriculum in high school is critical to success in academically rigorous majors such as computer science. Students such as Kelsey who come from families and a culture that values a challenging education have an opportunity to consider a computer science major that is unavailable to ill-prepared students.

Summary: Kelsey

For Kelsey, the positioning of women as not belonging in computer science could have prevented her from entering the field. When Kelsey was undecided in high school about what field she wished to pursue, she allowed herself to be positioned as not belonging in computer science and she did not take the advanced placement (AP) computer science class that was available to her. Once given the opportunity, however, to pursue a technical field, Kelsey had resisted being positioned as not belonging, even as she notices the barriers she faces. The change of heart about her interest in computer science came through her receipt of an engineering scholarship for underrepresented minorities that paid for her first year at the university and the accompanying informational field trips and schoolwork assistance.

In contrast to Mónica, Kelsey felt some tension around cultural background, as her ethnic and class background put her in a tension between clearly defined worlds. Being the second generation in her family born and raised in the U.S., Kelsey's ties to the Pacific Islander community and culture did not appear to be as strong as Mónica's ties to the Latino culture. Although half Caucasian, Kelsey was raised

by her Filipina mother, identified as a Filipina, and knew about Filipino culture and had family still in the Philippines. However, she did not feel accepted by the Filipino community because she was not one hundred percent Filipina. Kelsey is the second generation born in the U.S., and she believed that having an American-born mother made her home life more culturally American than if her mother had been born in the Philippines while her appearance and culture marked her as different from the White culture. Although noting differences between the two cultures, Kelsey did not indicate that she views Filipino and American culture as oppositional, and, in fact, she alluded to the importance of schooling in her exposure to both cultures. As found by Benet-Martinez, Leu, Lee, and Morris (2002), Kelsey's view of the two cultures as compatible may allow her to switch comfortably between the two and to embrace the parts of each culture of benefit to her. In order to consider a computer science major, Kelsey's weaker cultural ties benefitted her, as she did not need to fight against the Filipino attitude she perceived that computer science was not a desirable major, particularly for women.

Socioeconomic status can be measured in different ways, but the educational background and white collar work of her mother gave Kelsey class advantages that were not available to Mónica. Kelsey described her family as "low income," yet both her parents received college degrees. Kelsey did not talk about having any questions or difficulties in knowing how to choose apply to colleges. Teresa was able to give Kelsey input and advice about majors in a knowledgeable way and knew enough about computer science to believe that it was a "fabulous" major for Kelsey to consider. Although it was a sacrifice, Teresa was able to send Kelsey to a private high school, which could have served to give Kelsey an advantage towards a computer science major since her school was one of the few that offer advanced placement computer science classes. Unfortunately, the class was taught by and populated with almost exclusively men, which discouraged her from enrolling. Kelsey had carved out a place for herself by working hard to excel in school—even as the only non-White in many situations—and by giving of her time and herself in volunteer work to those she felt had been less fortunate than she has. In her STEM classes Kelsey worked to persist by focusing on her schoolwork and seeking the assistance she needs to be successful.

Being an underrepresented minority had had some perhaps surprising influences on Kelsey's college experiences. Kelsey's first choice of colleges was NYU, but receiving an engineering scholarship for the first year of the state university convinced Kelsey to choose the state university for financial reasons. Kelsey doubted that she wanted to pursue an engineering major when she came to college—Teresa reports that Kelsey had expressed interest in graphic design or photography majors at the end of high school—but immersion in engineering classes and exploration of different types of engineering in the field convinced Kelsey that a major related to engineering was at the top of her list. Without the money and the corresponding information, Kelsey may well have never considered majoring in an engineering field such as computer science.

Case 3: "Erin"

"Erin" grew up in a Caucasian, middle-class, two-parent home. Erin's variety of interests—embodied by her simultaneous participation in cheerleading and debate while in high school and illustrated by her love of both math and art—led her parents to label her "our Renaissance girl." This diversity of activities as well as her physical beauty has caused Erin to experience tension between how others see her and how she sees herself. She found, for example, that acquaintances in college expected her to join a sorority, whereas she identified more as nerdy or intellectual and the idea of living with all women in a sorority was anathema to her. Because of how others see her, Erin's interactions with others repeatedly positioned her as not belonging in computer science, but she had successfully resisted this positioning to prove that she belonged. At the time of this study, Erin was considering majoring in math, computer science, or a combination of the two.

Erin: "Disidentification" Position

A storyline in U.S. society suggested by Erin's story is that beautiful, White women are not expected to be smart and to do well in rigorous subjects such as math and fields related to math. Other societal storylines about who will enjoy and do well in computer science in our society position women such as Erin that do not particularly like computers nor see them as enjoyable for recreational use as not belonging in computer science.

Storyline: ***Beautiful White women are not smart enough to do well in math and related fields.***

Erin's mother, "Ann," was indignant about how Erin has been "judged for her appearance and not her intellect" during her school years. Ann thought "that sometimes [Erin] is judged harshly because of her looks. And it has happened to her through high school, that she was judged unfairly." In illustration, Ann told the apocalyptic story where in a high school math class "she had one particular teacher who didn't treat her very kindly. She's a beautiful young girl and came in wearing her varsity cheerleading uniform. And the teacher told her she was in the wrong [i.e. too advanced] class." In response to this, Ann had noticed that Erin "fights hard to prove herself and to show what she is made of." Ann believed that the combination of beauty and intelligence had made Erin "a little bit of an enigma." Erin was positioned as not belonging in computer science because, as Ann noted, "I think she's a very beautiful young lady, and she's not what people stereotypically think of as a computer person."

Erin had also noticed the contrast between how she was seen by others and how she saw herself. Because of this, her interactions positioned her as not belonging in computer science, which she resisted by doing well in math and introductory programming classes. Erin talked about her "academic two-sidedness" where "in high school I was part of the cheer squad and the debate team." This had led to her immersion in two worlds with "two very different groups of people. And I could get along with both just fine, but I think where I'm most comfortable is with the debate team, and, you know, I like Dr. Who and math jokes. Erin speculated that "people that don't know me probably would think that I'm more the cheerleader type, and I actually, I get that a lot from people: 'Oh, are you going to do sororities? You seem like it's perfect for you!'," but Erin emphasized that "I would never do a sorority, because…I'm much more comfortable, like, playing monopoly until the wee hours of the morning and stuff." Erin believed that "the whole Greek life system" was not for her. "I'm definitely more comfortable with just kind of academic people and geeky people." Notwithstanding her protestations about never joining a sorority, by the end of the quarter Erin had "joined a sorority that's very different from the traditional sorority; it's for engineering women. And, so we don't have a house or anything, but we get together, and we're just kind of an academic support system for each other." Erin had found that the engineering

sorority "has really encouraged me to stick with the STEM fields, because, you know, everybody's very supportive of each other, and all the girls have been through basically the same classes I have been through." Erin had found it "inspiring to see these beautiful, articulate, really nice young women that are, you know, 'I'm a biochemist; I'm a chemical engineer' you know?" and this had "given me a little extra push to stay [in computer science]." Despite the stereotypes, Erin had "found a lot of people in the CS major that I see eye to eye with, and they get excited about the same things I do."

Although Erin's parents called Erin their "little Renaissance girl" because "she has a strong desire to do well and is academically drawn to mathematics and things of that nature and has excelled in all of that, but…she's an artist…and she... loves drama—she's a quite talented actress," Erin had chosen to pursue her interest in math in college. Erin "tested into a higher math class for my level around, like, sixth grade" and had continued to excel in and enjoy math. Despite her abilities in areas more expected of her, such as humanities, Erin had consistently repositioned herself as belonging in math and math-related fields by persisting in and doing well in her math and related classes.

In the U.S. culture, beauty and brains are viewed as incompatible, as illustrated by the proliferation of so-called "blonde jokes" and even television shows such as "Beauty and the Geek." With computer science a field that is stereotyped to belong to innately smart people (J. Margolis et al., 2008), beautiful women are excluded based on the assumption that they cannot also be smart.

Storyline: *Computer science is for those who like computers (particularly gaming).* Perhaps surprisingly, considering her interest in a computer science major, Erin related that she and computers "did not have a very good relationship in the beginning. It was required at my high school to take a computer competency class…and I kind of hated that class…so I just kind of figured computers were probably not for me." Ann added that the family had a computer in the house since Erin was "a tiny little tot. But she never really was on it all the time other than doing schoolwork. She didn't really sit around and play on the computer;…they were tools. It was a tool and not a toy."

Erin's disinterest in computers positioned her as not belonging in computer science, and her love of programming therefore came as a surprise both to her mother and herself. The presentation of

programming on the first day of class hooked Erin immediately. Before the class, Erin "just kind of did it as 'oh, well, I guess I'll give it a shot,'" but

> the point when I decided I wanted to learn it and was excited to learn it, was, I think it was the first lecture, and [the female instructor] was talking about how, you know, like, this major was like solving puzzles. And I love storybook puzzles, crossword puzzles, actual puzzles. And so I thought, you know, 'this is really something I could enjoy, if that's the criteria.' And after our first homework problem and after we got the grade back for it, I was just kind of, like, 'I can do this. And I'm pretty decent at it, maybe!' And so that's when I kind of wanted to learn more about it.

During her first quarter of introductory programming, Erin "just fell in love with" computer science. When she heard about it, Ann "was a little bit surprised that she was as excited about the computer programming as she was," although Ann was not surprised "that she took to it well, because I think the child is extremely gifted and very intellectual. So not that it came easily to her."

In contrast to Mónica and Kelsey, the storyline that a love of computers and computer applications is a prerequisite to computer science positions Erin as not belonging in the field. As noted by Margolis and Fisher (2002), a passion for computers and computing, particularly gaming, is the yardstick by which interest in programming or computer science is measured. For women such as Erin who are not inclined to spend all their free time on the computer, consideration of a computer science major is not a natural step.

Storyline: ***Computer science is for boys (particularly introverted Whites and Asians who like to sit in front of a computer all day and to work on their own).*** Erin believed that the lack of women in computer science positions them as not belonging in the field. Although she did not notice the lack of women her first quarter in introductory programming, during the second quarter, due to her enrollment in the Women in Computer Science and Engineering seminar, she had "looked around and really noticed. Today in class everybody sitting in front of me was a guy, you know? And I was like, five, six rows back." Because of this, Erin thought that "the social experience is definitely different" for men and

women in computer science. In her “quiz section there are two girls in the entire section. So maybe it's just in my head, but I just kind of feel like there's a ‘why are you here?’ kind of thing.” Because of this, Erin “feel[s] like there's just a little bit of confusion when a girl walks into, you know, the CS section and, I don't know, it seems kind of like ‘the man's club.’” She thought that “just the sheer volume of [men] kind of makes them seem more like a powerhouse.” The icebreaker exercise at the beginning of the quarter highlighted this difference for Erin, who found it “kind of weird doing the ice breaker,” since “there's all these guys ‘I want to be a CS major,’” but when it is her turn to speak, Erin could only claim that “I would like to do CS—I think!” Later in the quarter, Erin noticed that, as a woman, her interactions with others are different than several of the men in the class. In our interview, she told me about a recent interaction, saying

> I just came from my quiz section, and it's a fascinating experience, because I'll get into my small group and there's one guy in particular who just, you know, takes off and he's already writing code, and I had to stop him and ask him today ‘are we going to talk about this, or are you just going to kind of off and do your own thing?’ And he looked a little, like, offended and taken aback, and I was—I thought that was a reasonable question. Like, we're in a small group; we're supposed to be doing group work.

The desire of men in her class to work on their own contrasts with Erin’s own interest in working with others. Erin hoped that, once in upper division classes, her desire to collaborate would be fulfilled. Her understanding was that “once you get into upper division there are smaller classes and more collaboration, whereas in [introductory programming] we are told explicitly not to collaborate. So I'm excited for getting to work with other people.”

Stereotypes of the type of person majoring in computer science serve to position women as not belonging in the field. When asked about the stereotype of the computer science major, Erin said that “in my mind, a lot of it's, like, big, thick glasses; sometimes Asian comes to mind…I think the stereotype is an introvert. Likes computers more than people, you know, ‘don't talk to me, I'm just coding’ kind of personality.” The stereotype bothers Erin, who thinks “that might be one of the reasons women are so

deterred from it.” She had an epiphany when talking to me, since “I didn't really think about it this way before, but…that would bother me if people decided not even to try it because there's this idea of ‘computer nerds’ rather than, like, actual human interaction. So, yeah. That's bothersome.” She differentiated between “the stereotype of being, like, tied to a computer all the time and not talking to people” and women, who “love to talk and they love interacting.” As far as stereotypes about women in the field, the reactions Erin received when telling men of her intended major have led her to think that “guys definitely look at girls who go into that kind of thing as kind of ‘alpha females.’” Women in the field are seen as less feminine “because to be a woman in the STEM fields you kind of have to be a strong-willed person and that kind of determination and confidence are seen as manly attributes.” Erin had not let these stereotypes deter her from pursuing her love of the subject. Erin said that she identified more strongly with her gender than her ethnicity, and she positioned herself as belonging in STEM fields such as computer science by identifying with women such as those in her engineering sorority. Erin found commonality with all computer science students through noting that they were academic and geeky like she was, and she appeared to take into stride comments such as one received from a customer at her workplace who, when told of her intended major, responded “oh, wow! I just gained a whole lot of respect for you!”

Erin positioned herself as belonging in the computer science classroom through telling herself that “the learning experience is the same” for men and women in the classroom and by doing well in the class. Erin’s instructor both quarters of introductory programming was a woman who Erin finds “completely approachable and just very personable,” so Erin had a role model of female success in and excitement about programming and computer science.

Due to the mismatch between the goals and dreams of women and the perception of computer science careers, women are positioned as not belonging. Erin’s dad was worried that a computer science career may involve sitting at a desk coding all day. Erin reported that she had recently presented the idea of majoring in computer science to her parents, and her dad seemed “really hesitant about that.” Erin speculated that “it's just because they are from a generation where it wasn't really like a field with a lot of

opportunity…and he thinks I'll be stuck behind a desk all the time. Which isn't me, necessarily.” Erin hoped “that once I move further in CS and can specialize and try to figure out which part of computer science I'd like to focus on, then he'll probably get behind it more.” If Erin’s dad were correct, Erin would not be interested in a computer science major, as she “would dislike—like my dad's worried about—if I were stuck behind a desk all the time and, you know, didn't get to work with other people. That wouldn't interest me nearly as much.” However, Erin had the opportunity to learn about the wide range of possibilities for computer science majors, as she

> actually was invited last quarter to have tea with [the female introductory programming instructor] and about fifteen other girls in [introductory programming] and she had a graduate student come in, and she talked to us about some research she has been doing with medical labs here to write a program to predict the growth or decay of brain tumors. And I thought that was just the coolest thing. And she's obviously working with people; she has to look at the slides of the X-rays and the CAT scans, and she has to work with biologists and medical professionals and understand how that kind of thing works. And she has to do all of that besides, you know, sitting down and writing code. And I thought that was very cool. And [the instructor] talked about the capstone classes and kind of gave us an idea of the variety of it. That's how I learned about the disabilities technology capstone. And she passed around a little device they have been using in a third world country to measure water use. And so just, she kind of talked a lot about the width of the field and all these different capstones you can take and all these different ways you can focus your computer science energy.

Not only did Erin have a misconception about jobs in the field, but she also did not fully understand characteristics of programming. Erin had come to see that programming requires “creativity. Which I didn't really see at first, writing Java—it seemed so rigid. But there's definitely an element of creativity.” She also found that programming required problem solving skills and the willingness “to sit down and be stumped for about an hour. Or more! So, I mean, you have to be persistent, definitely.” Since creativity

and problem solving are interesting to Erin, she saw herself as belonging in the field, particularly when she learned of computer science career possibilities where she could help the disadvantaged.

Erin had become immune to being in the minority, repositioning herself as belonging in a male-dominated field such as computer science. Although she had "always been interested in kind of gender studies," in her first quarter of introductory programming Erin "hardly noticed that there was that much of a gender discrepancy." She believed that, in the computer science classroom, "the learning environment is the same. I think girls and guys have an equal opportunity to excel. Or to fail!" Erin believed that, since "there's not many personal things to put into CS homework," the computer science field—"I don't want to say it's impersonal—but it's kind of an equalizer." Erin saw an advantage to being one of few women, since "I honestly think that because I'm a girl I have a better chance [at being accepted into the computer science major] than some guys that have better grades." Ann concurred, since "many companies are trying to diversify their workforce." Ann believed that Erin "could potentially get a job based on her gender, but I think she has the ability to prove to people and to become a valuable asset to anybody that would hire her and could advance in that way."

Erin's experiences and interactions, similar to those of Mónica and Kelsey, indicated that computer science is a field for boys. In comparison to the other two, Erin's realization that introductory programming is dominated by men comes late; only after she enrolled in the Women in Computer Science seminar did she notice how few women were in her introductory programming class. After discovering that she enjoyed programming and the intriguing variety of career possibilities, Erin strongly rejected being excluded from the male-dominated settings, helped by supportive relationships (J. Margolis & Fisher, 2002) in the classroom—by enrolling in the class with her boyfriend—and outside of the classroom by joining an engineering sorority.

Erin: "Identification" Position

The U.S. storyline about computer science being for those who are good at math positions Erin as belonging in the field, and, in fact, she had continued to pursue math and computer science. The

emphasis on education among her family and friends is also a storyline that position Erin as belonging in computer science.

Storyline: ***Computer science is for those who are good at math and science.*** Having a strong background in math had positioned Erin as belonging in computer science. Erin had "always liked math. It's really beautiful if you understand it or appreciate it," and she has been in accelerated math classes since the sixth grade. Erin chose the state university because "I wanted to do math or something along those lines, and I know that this school is really known for, you know, the math departments, and the engineering, and the more scientific disciplines." Once at the university, Erin intended to major in math, but was considering "math or computer science. Or a mix of both" at the time of this study. Erin saw computer science "a way to apply my math."

Like Mónica and Kelsey, Erin's strong background and interest in math and science facilitated her interest in majoring in computer science. Having persisted in classes where she was not expected to excel, Erin had experiences to draw from when faced with classrooms full of men who could have made her doubt her ability to succeed in the field.

Storyline: ***Education extends beyond the four walls of the classroom.*** The emphasis on the importance of education by family and friends positioned Erin as belonging in academic fields such as computer science. Ann championed education for her family and herself and had even made it her vocation. "I'm an elementary school teacher. I love school. I have enjoyed it immensely…I just value education a great deal." Similarly, Erin "always loved school. And I always did pretty well in school. Which is, I guess, why I'm in college now. I always liked it. I was always kind of a nerd." Ann remembered that Erin was self-motivated in school, and so where she and Erin's father could enhance her education was in informal, cultural settings. To encourage Erin, Ann and her husband "would take her to museums or concerts or we would do more family experiences related to learning but not with a bent toward learning. It was just creating life experiences." Ann "felt like if we opened up [our daughters'] eyes to the world's possibilities they could see more than the four walls of the classroom." At home, Ann and her husband would foster traditional learning by "helping with homework, and…math was my thing

so I helped with math homework and dad …did social studies" and by "validating what the kids were doing." In addition to traditional learning, Erin's parents "also encouraged [our daughters] to think and to converse with adults and peers about world events and what they were seeing out in the world." Erin also recalled that her parents pushed education and were "very academic focused, I guess. So it was always a big deal to get good grades in our house…It's just always been a big deal to our family...so they've always pushed. And education is a huge, important thing."

In high school and continuing on in college, Erin chose friends that are "academic" and "geeky." Ann noted that Erin "had several friends that wanted to go into engineering programs or into computer avenues" when she transitioned from high school to college, and it was these friends that inspired Erin to enroll in introductory programming.

Erin's parents stressed the importance of a college degree upon their children. Ann reported that "we've told our kids from the time they could talk that a college degree was a must," and Ann reasoned that "a degree doesn't guarantee you a job, but it opens doors that are not open to you without that degree. And it buys you often different working conditions." A family story told to me by Ann and Erin told of Erin's father going back to college to get a degree after his children were born. Erin related that her dad "didn't go to college until after my sister and I were born;…he would show us his tax statements for the past couple years and you would able to tell with, like, the jump in salary, like, when he graduated."

The emphasis on the importance of education in Erin's family encouraged her to excel in academic classes that gave her the background to be able to consider a computer science major once in college in a manner similar to the families of Mónica and Kelsey. In contrast to the other two, however, Erin's family extended "education" outside of the classroom, encouraging her to seek out learning experiences in out-of-school settings. More research is needed on the role of informal experiences to the choice of a college major.

Summary: Erin

Erin comes from what appears to be a typical northern European American middle-class background where her family has been in the U.S. for generations and her family is educated. This

background offers privileges such as a plethora of opportunities and a roadmap for getting a higher education. However, even with such privileges, Erin has had barriers to her path to considering a computer science major.

Erin had clear role modeling at home that focused on the joy and advantage of education and the ability of women to do math, positioning her as belonging in a field such as computer science. Both of Erin's parents had college degrees, and an oft-repeated family story noted that her father got his degree after Erin and her sister were born and the advantage to him of obtaining the degree. Erin's mother was a school teacher who loved education and continued not only to teach others but also to further her own learning. Ann had always loved and excelled in math, and it was she who would help Erin with math homework when assistance was needed. Erin's parents emphasized learning not only in formal school settings but also in informal settings by taking family outings to concerts and museums.

Some of Erin's school experiences positioned her as not belonging in rigorous fields such as math when her intelligence was doubted based upon her looks or her activities. Being a beautiful White woman meant that Erin was expected to rely on the power of beauty and privilege to ease her way through life. Choosing instead to pursue difficult intellectual pursuits even in the face of low expectations marks her as someone out of the mainstream. Erin's view that women in computer science are seen as "alpha females" is supported by Ong (2005), who found that with the culture of STEM fields at odds with femininity, when women act as scientists through self-promotion, assertiveness, or domination of interactions, they are judged harshly, yet when they act in a feminine manner they are not seen as real scientists. Erin responded to being positioned as not belonging by working harder in school and positioning herself as belonging by doing well in math and by ignoring her underrepresented status in such classes.

Erin's entry into computer science was serendipitous; due to her indifference to—even dislike of—computers and to the stereotypes about computer scientists, Erin had concluded that programming and computer science were not for her. However, some of her friends from high school—specifically her boyfriend—enrolled in the introductory programming class, and Erin decided to join them because it fit

into her schedule and a student she knew who had taken the class the previous year "told us that it was a really cool class." Since "everybody else seems really interested" she thought "I'll just try it." Ann believed that Erin's strategy was to make the huge university campus feel smaller and more intimate her freshman year by having classes with friends. Erin's first day in class predisposed her to think that she would enjoy the class, as the instructor presented programming as similar to solving puzzles, which aligned with a pastime that Erin enjoyed. The pleasure she took in completing the assignments and the high grades she received resulted in Erin falling "in love" with the subject and repositioning herself as belonging in the field.

On the surface, it would seem that Erin would have been the most likely of all three women in this study to major in computer science, since her ethnicity does not make her a minority in the field and she has advantages of class and educational background. However, Erin's introduction to computer science was the most arbitrary of all three of the women—she took the class simply to be with friends—even though she has a strong background in math. In addition, Erin is less aware of discrimination than the other two women—illustrated by her lack of awareness of the low proportion of women during her entire first quarter of introductory programming—so may be less likely to attribute difficulties to the situation or the context.

Conclusions

Storylines found using a positioning theory framework highlight the ways in which women are positioned as not belonging in computer science. The storyline that computer science is for particular types of boys (White and Asian introverted gamers who like to sit in front of a computer all day) excludes most women from the field. Minority cultural storylines further position women as not belonging, as Latinas are thought to belong in the home and are expected to put their family obligations first and Filipinas are guided towards medicine or other fields of study and work. Storylines that members of the working class are not good students and that they should be knowledgeable about choosing colleges and majors put students of lower socioeconomic status at a disadvantage. The women in this study had to strongly reposition themselves as belonging in the field in contrast to these storylines, speaking of the

necessity of "proving" that they could succeed and that they belonged. Other storylines uncovered here—an emphasis on education and computer science for those who are good at math and science—positioned these particular women as belonging in computer science, but might position women in other circumstances as not belonging. Storylines related to the ethnicity of the two underrepresented students—supportive Latino communities and programs for URMs—supported the position of these two women belonging in computer science, while the storyline that beautiful, White women do not belong in math and related fields positioned the White participant as not belonging in the field. Of note is the response that the three women had to being in settings dominated by those unlike themselves: the White woman claimed that there was "equality" of opportunity in the computer science setting and to not have noticed initially the lack of women, while the URM women were well aware of their minority status and had been vigorously working to succeed in spite of it.

Despite their differences, various commonalities were found in the cases of the three women in this study. All three of the women came to the university with a strong background in school. Education was a top priority for the families of each woman as a way to ensure one's financial well-being and to help one become the best person she can be. The women remained focused on working hard and getting good grades, and each of the women chose friends that were similarly academically minded, even if that meant that her friends were not of the same race or ethnicity. All three women enjoyed and did well in math during their K-12 schooling years, and none of the women had done any computer programming previous to college.

Upon entry to the university, none of the women were considering a computer science major. All of the women thought that computer science involved sitting in front of a computer in a dark room all day working by oneself, which held no interest for any of them, and none of them reported finding out how broad the computer science field can be in their introductory programming classes but, instead, outside of class. Enrollment in the introductory programming class was either because, for Erin, her friends were enrolling, or, for Mónica and Kelsey, because it was a required class for majors they were considering. Once in the class, all of the women found that they enjoyed programming, which came as a surprise to

each of them. All three women reported that it was mastery experiences of successfully completing class assignments and received good grades that gave them self-confidence in computer science and the desire to continue, in contrast to the findings of Zeldin and Pajares (2000), who reported the expressed confidence of others—in particular, teachers—more important than mastery experiences for women in STEM fields. All the women enjoyed the computer science lectures and the instructors and found that the rumors they had heard about the class being "cool" or fun were well-founded. During the time they took introductory programming, all three women heard information about capstones and careers that were surprisingly broad at department events such as a women's tea and the Women in Computer Science and Engineering seminar. All three women had a strong interest in helping others, community service, and social justice, and they had come to find that they could pursue such interests through pursuing computer science.

All three women had experiences in the computer science classroom detrimental to their interest in pursuing a computer science major. Not only did they feel insecure because of the overwhelming number of boys in the classroom, but also because of the perceived differential between their own lack of experience and the highly experienced boys in the class. These findings are supported by Bartol and Aspray (2008), who found that women have higher computer anxiety than men that leads them to believe they do not belong in computer science by comparing how they feel to how they see men operating.

All three women found some discomfort in computer science classroom experiences and the way boys talked—or did not talk— in the classroom. This finding is supported by Colyar, (2008), who found that within IT classes there are discourses of power through technical talk laced with competition and discourses of disengagement as an expression of power. Women are talked "through" as questions they raise are dismissed as unnecessary and women are kept on the margins of technical talk. The lack of open-ended questions and discussions in the classroom leaves only a question and answer volley where answers are evidence of mastery rather than an opening of discussion. In the IT classroom women do not express or negotiate power as often or in the same way as males.

All three women anticipate that being a minority in the field will help them in the future as the university department and hiring companies will—in their opinion—give preference to women in order to reach diversity goals. This perceived advantage may change to a disadvantage once in the field. Female computer science major panelists who spoke at the Women in Computer Science and Engineering seminar reported that male peers frequently said some version of "you only got in because you are a girl," illustrating the belief that they are only in the field because of affirmative action goals to include more women and questioning their ability to succeed based on their own merits, as found by Crosby, Iyer, and Sincharoen (2006). In addition, this advantage is based on a misunderstanding of how Affirmative Action operations and on a false belief; it is currently illegal at the university to give gender- or race-based admittance preferences to minorities.

Each of the women in this study had groups that supported their interest in computer science. Kelsey was part of an engineering scholarship cohort in her first year and had joined PEERs; Mónica was part of the Latino community, including a Latina sorority; Erin joined a sorority for STEM women. This not only supports Wentling and Comancho's (2008) findings that peer support while studying with classmates and friends or participating in discipline-specific campus organizations aid women in feeling that they belong in engineering disciplines such as computer science, but also extend these findings to suggest that even non-discipline-specific ethnic communities can help support the persistence of minority students in school and in rigorous majors. All three of the women were aware of and interested in gender issues and, to a greater or lesser degree, each was interested in changing the culture of fields such as computer science to be more welcoming to women. As reported by Clewell and Giniorio (1996), awareness of discrimination helped these women view a cold climate as a problem in the field, not a problem in themselves. Mónica talked about changing the culture in terms of being a role model for others by proving through her own success that women can do the same work as men. Kelsey had become more aware of diversity issues through her PEERs work and hoped to educate others through hands-on volunteer work. Erin was interested in gender issues and had become more aware of the lack of diversity through her participation in the Women in Computer Science and Engineering seminar. All of

the women had accustomed themselves—either purposefully or through repeated experiences—to being in the minority in school settings.

Although there were many similarities in the experiences of all three women, the constellations of race, class, and culture also created different experiences for the three women based on these differences. Intersectionality provides an overarching lens for investigating gender and ethnicity in conjunction in education, as it highlights the interconnectedness of identities for individuals and how aspects of identity can be emphasized or ignored (Banks, 2012). How characteristic intertwine, the contexts under which categories become important and how moments of both oppression and privilege exist in lived experience are all important when studying gender and ethnicity together. Gutierrez and Rogoff (2003) argue that cultural patterns can inform assumptions or guesses about practices of participation for individuals but that any assumptions made must be checked out on an individual basis to avoid the trap of seeing culture as an inborn trait.

Implications

We can gather from comments by the women in this study that they believe computer science offers an "equal opportunity" to all students in the classroom. However, "equal opportunity" for women and minorities has not resulted in proportional representation in the field, as the field has been set up to accommodate the desires and goals of men. If we wish to change representation, perhaps we need to move to a model of equality of outcome, where the computer science field provides what each student needs rather than the same treatment for all (Ginorio, 1995).

The institutional experiences of the women in this study provide particular examples of policies and practices that either help or hinder women's entry into computer science. Barriers include practices that are continuations of the way things have commonly been done. For example, the computer science and engineering department of this university bases admission to the computer science major solely on grades in lower division college classes, which findings by Margolis and Fisher (2002) would indicate are more detrimental to women than to men. Carnegie Mellon's change in computer science admission policies from favoring students with experience to emphasizing demonstrated independence, energy,

creativity, and community involvement as well as diversity was followed by a dramatic increase in women's representations, although it is difficult to disaggregate this from other interventions. The university also focuses its introductory programming classes entirely on programming skills, in contrast to findings that restructuring introductory courses to focus on conceptual issues rather than programming skills and to create course assignments that show how computing can made a difference in the world can be beneficial to women (Misa, 2010). The university requires completely individual work during introductory programming; the women in this study appear fearful of any discussion of class work with friends. Studies have found, in contrast, that peer support through pair programming encourages women to persist in the field (Misa, 2010).

Other experiences of these students at this institution give examples of practices that may encourage women and minorities in computer science. Information about the breadth of computer science research and career options given through the women's tea invitational and the Women in Computer Science and Engineering seminar opened the women's eyes to possibilities of interest to them. Study participants agree that the engagement and enthusiasm of computer science and engineering instructors create a fun and interesting classroom experience, which has spread the word-of-mouth reputation of the classes as "cool," encouraging women to enroll in the class. Smaller class experiences through breakout quiz sections led by undergraduate teaching assistants—who have their introductory programming experiences fresh in mind—have helped the participants to feel comfortable speaking up. Computer labs designed for extra practice attract less-experienced students, giving them a place to work together and to ask basic questions. Each of these practices could be imitated by other universities in their attempts to make the environment more welcome to women and minority students.

For underrepresented minority women one implication of this study is the importance of ethnic communities where students can receive support from others on campus from the same cultural group. Sharing experiences with others who are in the same situation encourages women to not only persist in college but to consider majors that are not traditionally pursued by women of their ethnicity.

A sobering implication of this study is the lack of knowledge about computer science by women who are well prepared to major in the field. Women come to the university ignorant of what programming involves and of the variety of possibilities for research and work in the field. None of the three students written about here had any intention of taking a computer programming class in college when they left high school, much less majoring in computer science. It is of paramount importance that we introduce women to programming much earlier in their schooling and that we advertise the possibilities that computer science offers.

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Appendix A
Student Interview Protocol

	First I will ask you a set of questions about where you are in the process of choosing a major and how you came to this point. Then I will ask you more general questions about your thoughts and beliefs about computer science. There are no right or wrong answers; I am simply trying to get a sense of what your path was like to this point and how you see the field.
1.	Where are you in the process of being in a major? -what major(s) are you considering? (interested in CSE) -what interests you *the most* in each of these majors? -what interests you *the least* in each of these majors? -how have you/will you decide on a major? -what things do you think are important to take into account when deciding on a major? -what did your parents (or others) advise you about choosing a major? -what qualities do you think are important for computer science majors to have?
2.	<u>For students in/applying to CSE</u>: -when do you expect to apply to CSE? -how confident do you feel about being accepted into the major? -do you think that coming to consider majoring in CSE was the "path of least resistance" for you? --Did you have to overcome hurdles to make it to this point? --Or did the way seem easy and natural? --In what way(s) was it easiest? What was the easiest part? --In what way(s) wit it difficult? What was the hardest part?
3.	<u>For students in other majors</u>: -why are you taking the introduction to programming class? -did you consider a CSE major? Why or why not? If so, what kept you from pursuing a CSE major?
4.	How much do you know about programming? How did you learn what you know so far? What inspired you to learn how to program? Who was influential in your learning about programming? Finish these sentences: -I like programming because… -I don't like programming because….
5.	How did you feel about school growing up? What are you academic strengths? What are your academic likes? What advice did your parents or family give you about school growing up? Did your parents or family help you with your homework? If so, what subject(s)? Did your parents or family give you additional schoolwork outside of school? If so, what subject(s)?
6.	Why did you decide to go to college? Who influenced you in the decision to go to college? How did you pick THIS UNIVERSITY? What other schools did you consider?
7.	Can you tell me the story about you and computers? (Prompt: when and how did you get interested?) Listen for and ask about: -when they became interested -what interested them

	-who interested them -where they became interested -schooling experiences -out-of-school experiences -affective experience (love, one interest among many, mixed, slow to warm)
	Now I would like to ask you a few more general questions about your experiences and beliefs
8.	Think about yourself in different settings both in the past and now. With what individuals or in what groups of people do you feel the most comfortable? When do you take a breath and say "Ahh…these are my people!"? Would a CSE major make you more similar to [each person/group of people] or less similar? How so? How is CSE seen by [each person/group of people]? [CSE majors] How will majoring in CSE affect how you fit in with [each person/group of people]?
9.	Do you believe that gender makes a difference for CSE students? [if so…] -how do you think that your experiences in CSE will be/would be affected by being a woman? -how do you think that experiences in CSE for male students differ from yours?
10.	Why do you think that few women pursue computer science majors?
11.	What are some of your life goals? Do you think that, in general, life goals for women differ from life goals for men? [if so…] -what are the differences? -how are your life goals similar to or different from the life goals of most women? -how does a CSE major/your major fit with your life goals? Not fit?
12.	Do you believe that cultural background or ethnic identification make a difference for CSE students? [if so…] -how do you think that your experiences in CSE will be/would be affected by your background as a [ethnic identification] student? -how do you think that experiences in CSE for students of other ethnic or cultural backgrounds differ from yours based on their ethnicity?
	I have a few questions now about how you see computer science
13.	Imagine you are a CSE major. What would you be doing in your upper division coursework? -what would you like about what you are doing? -what would you dislike about what you are doing?
14.	Imagine you are working in the CSE field. What would you be doing in your job? -what would you like about what you are doing? -what would you dislike about what you are doing? If you graduate with a CSE degree, what do you think is your likelihood of getting a job in the field?
15.	What do you value in a job or career? [CSE majors] How would a CSE career be compatible with these values? How would it be incompatible?
16.	[CSE majors] How do you think other aspects of your life will be affected (positively OR negatively) by getting a computer science degree?
17.	What is the stereotype of the "typical" computer science major? -what do you think is true about the stereotype? -what do you think is false about the stereotype? -does the stereotype bother you? Why/why not?

	-how do you fit the stereotype? -how are you different from the stereotype? -does the stereotype at THIS UNIVERSITY differ from the stereotype held more generally in the U.S.? If so, how?
	Now it is your turn to lead the conversation!
18.	Is there anything else I haven't asked you about that you think might be of interest to me?
19.	Do you have any questions you would like to ask me or comments you would like to make?

Appendix B
Student Interview Protocol Example
Second Interview

How you are thinking about a major now

1. At the beginning of the quarter, you said you were interested in majoring in Informatics or CSE. What is your current thinking on what you are interested in majoring in? What did you learn about the two fields during this quarter? Are you still interested in cybersecurity? Have you learned any more about how each of the two majors would help with this?

How you felt in classes

What friendships you have formed

1. What did you think about each of your classes this quarter? How do you think you did in each of them?
2. When we talked on the field trip, you called the Informatics instructors "extravagant" and in our first interview you said that you imagined that the CSE instructors teaching the introductory classes were more extravagant than the instructors of the upper division classes. Can you describe what you mean by "extravagant" and what it is you like about it?
3. In one of the Informatics classes I sat in on the instructor called on you to explain black hats, white hats, grey hats. How did you feel when answering his question?
4. Did you go to lab sections in Informatics? Did you talk much or were you called on during lab? How did that feel?
5. Which professors do you feel most connected to? Do you feel more connected to your TA(s)?
6. You said in our first interview that Informatics requires less math than CSE. How do you feel about math? Is less math an advantage or disadvantage for you?
7. Are there others you study with? [Did you meet them this quarter, or did you already know them?]
8. Did you do any programming outside of homework this quarter? Did you do much programming in your job?

How you are thinking about women in CSE now; why you took the women in CSE class

1. Did you learn anything surprising to you about women in CSE through the Women in CSE seminar?
2. Did you make any friends in the seminar?

Other

1. Would you say you identify more with your gender (as a woman) or with your ethnicity (as White/Caucasian)? How do you think that your identification influences whether you feel a part of things or feel left out?
2. Do you think that boys see girls differently that major in areas like CSE than those that major in more traditionally female fields? If so, how? Do you think that women CSE majors have a harder or easier time getting dates?!
3. Do you think that women in CSE are less feminine than women in traditionally female-dominated majors?

Appendix C
Mother Interview Protocol Example

First, I have some questions about majors and how Your daughter came to this point

1. Can you tell me the story of Your daughter and computers?
2. Can you tell me the story of Your daughter and programming?
3. What advice have you given Your daughter about choosing a major?
4. What do you think about Your daughter's interest in majoring in computer science? In math? Are there other majors you think that she should consider?
5. When did you first know that majoring in computer science might be interesting for Your daughter?
6. How do you think that majoring in computer science would be an advantage for Your daughter? A disadvantage? What about advantages/disadvantages of majoring in math?
7. What qualities does Your daughter have that would make a computer science major good for her? What qualities does Your daughter have that would make math a good major for her?
8. What difficulties do you think Your daughter may run into majoring in computer science? In math?

Now I have some questions about what you think about jobs or careers

9. How have you advised Your daughter about jobs? What did you tell her about working when she was growing up? What do you tell her about working now? What have you learned from working?
10. What types of work do you think that Your daughter should consider?
11. In what ways do you think that a career in computer science would be satisfying to Your daughter? What difficulties do you think that Your daughter might have in a computer science career? What about math?

Now I have some questions about what you think about education

12. How did you feel about school when you were growing up?
13. How do you think that getting a higher education will affect Your daughter's life? How did you encourage her in school when she was younger? How do you encourage her in school now?
14. What do you tell Your daughter to do when she struggles with her schoolwork?

Now I have some questions about traditional roles for women

15. Do you think that you have followed a path of what was traditionally expected of you as a woman? Tell me any stories of how your path has differed from the traditional path.
16. Do you think that Your daughter is living a life that is different from that of the life of a traditional woman? [If so, how?]
17. What would you like Your daughter to learn from your life as a woman?

Chapter 3

Maternal Influences on Daughters Pondering a Computer Science Major: Does Class Trump Race?

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Maternal Influences on Daughters Pondering a Computer Science Major: Does Class Trump Race?

Despite successes in some science, technology, engineering, and math (STEM) fields in equalizing representation for women, the field of computer science has remained doggedly inequitable. When we look at bachelor degree recipients, we find that not only do women lag behind men, but that there has actually been a *decline* in the proportion of women bachelor degree recipients in the past two decades (National Science Foundation, 2008). Much research has been done on the barriers to women in computer science (c.f. Cohoon & Aspray, 2006, for a review), but researchers have for the most part neglected to explore how the intersection of race, class, and culture may influence women's choices to major in computer science. The numbers suggest that this perspective may be important, as the ratio of females to males is *higher* for each non-White ethnic group than for Whites in bachelor degree recipients (National Science Foundation, 2008).

For some time, researchers in many fields have noted that the investigation of social categories such as gender or race alone may misrepresent the lives of particular individuals. Works based on theories from the "double bind" (Malcolm, Hall, & Brown, 1976) to "intersectionality" (Crenshaw, 1991) have attempted to combat this oversight by looking at various categories together to better explain the experiences and outcomes of those who sit at different axes of several social categories. Positioning theory, proposed by Rom Harré from cultural psychology (Harré & Moghaddam, 2003), suggests that actions available to individuals are constrained both by interactions with others that limit the rights they have to act and by storylines in society that compel individuals to follow expected patterns. For women poised to major in computer science, the expectations for and attitudes about their choice of major of both themselves and others differ based on categories of race, class, and culture. These differences must influence women in their selection of a major by broadening or constraining apparent choices. Positioning theory offers an appropriate lens for investigating how women are influenced in their choice of major and how these influences differ based on social categories by proposing that interactions point to larger patterns that—often covertly—limit our actions. Using positioning theory as an analytical lens allows us to focus on concrete interactions and associated cultural and societal storylines to investigate

how race, class, and culture work together to give women more or less freedom to choose a computer science major.

Parents can play an important role in the pursuit of STEM fields for young people (Barron, 2006; Harackiewicz, Rozek, Hulleman, & Hyde, 2012). In particular, mothers are often cast in the role of primary caregivers of children, and therefore in many cases are the parent that transmits a home culture to the children. Through this, mothers can offer alternative storylines to prevailing societal storylines for their offspring. As the same-sex role model for girls in the family, mothers may influence their daughters in behavior as well as instruction and may provide both supports and barriers to their daughters along pathways to considering a computer science major. Mothers can support daughters in general or specific ways to receive the foundational rigorous academic background necessary to attend college and to major in computer science, for example. Mothers can also instill personal and cultural values and interests in their daughters that can influence how and why students choose particular majors. In addition, mothers can provide positive or negative role models—both in terms of roles for women and in terms of education—on pathways to a major in computer science. Investigating the attitudes and beliefs of mothers offers a window into the interactions and cultural storylines that exist for girls at home that can influence their choice of major once they reach college.

If we agree that mothers are significant influences in the lives of their daughters, how are the reported interactions between mothers and daughters constraining or affording opportunities for the daughters to choose a computer science major? What storyline patterns do these interactions indicate, and how do these storylines differ based on race, class, and culture? This chapter describes a study in which I make explicit some of the storylines three mothers of widely varying race, class, and culture are following that have influenced their daughters' preparation for and interest in a computer science major. In order to uncover interactions and storylines related to choosing a major, I explored with each mother her remembrance of past events in the lives of her daughter that led up to the daughter's interest in computer science, her attitudes and opinions about schooling and computer science, and her values around schooling and career.

Mothers and Daughters

As part of an ethnographic study centered on women enrolled in a seminar entitled "Women in Computer Science and Engineering" at a large, public university in the Pacific Northwest, three pre-major women agreed not only to be interviewed but also to have their mothers interviewed about their interest in and pathways to considering a computer science major. I was interested in discovering how the mothers viewed their daughters' pathways to enrolling in introductory programming, and the values and beliefs of the mothers about education, majors, careers, and the field of computer science. This chapter investigates three cases: "Guadalupe," a re-married migrant farm worker who immigrated to the United States from Mexico with two small daughters, "Teresa," a middle class Filipina American single mother, and "Ann," a married middle class White elementary school teacher. The three daughters of these women—"Mónica," "Kelsey," and "Erin," respectively, were enrolled in the first or second academic quarter of introductory programming during the time of the study and were considering a computer science major either on its own or as one of a double major. Two of the qualitative interviews with mothers (Guadalupe and Ann) were conducted and videotaped over Skype with the daughter and I on campus and the mother at home, while the third interview (Teresa) was conducted and videotaped in person on campus without the daughter present.

Guadalupe and Mónica

In talking with Guadalupe, four themes emerged that indicated storylines both from the Mexican and American culture. These themes related to education—*education is the way to a better life* and *the way to success is through hard work*—and to cultural background—*machismo* and *take the best and leave the rest.* Mónica had responded these storylines in ways that had brought her to a point of being able to choose to major in computer science.

Education is the way to a better life. When asked about education, Guadalupe emphasized the storyline that *education is the way to a better life.* Guadalupe had experienced the difficulties in being a migrant farm worker, and she had instilled in Mónica the belief that the way out of that kind of life is through education. Guadalupe said "I told [Mónica] 'You need to work with me. You need to go

sometimes with me and check what I am doing. If you don't like this kind of life, you need to study. You need to learn more.'" Mónica concurred that her mother stressed the importance of school, reporting "I have to say that my mom was very strict on school. She never had education like we did, and so she stressed it on us…I thought that helped me a lot." Mónica knew why her mother emphasized doing well in school, as Guadalupe told her "you're going to go to school; you're going to get a better job than what we had. You have seen what we went through, and I don't want you to go through that." For Guadalupe, "education is the, how to say, 'principio,'" or foundation for a better life. When asked about the value of a college education for her daughter, Guadalupe responds that "she gonna be, you know, like, she gonna have better life, she gonna have a better job and she gonna get what she wants. You know? Like more easy than I am. And she gonna be better."

In contrast to the cultural expectations of girls placed upon her while she was growing up, Guadalupe expressed the importance of school to her daughters by requiring them to do their homework before helping her with the housework. She told me that "I told [Mónica] every single day after I came home, I told her 'you need to do your homework.' 'You need to get your thirty minutes'…'You need to do all of it.'" When Guadalupe was young, her "mom, she don't care if I have a homework, she wants to see that the stuff clean, the dishes and clothes and I don't like that for my daughters." Mónica reports that her mother would tell her "I don't want you to come help me clean. I don't want you wash the dishes. I want you to go into your room, lock yourself, start doing your homework."

Guadalupe notes that Mónica echoed her valuing of school growing up; in fact, Mónica "don't want to be late. She don't want to miss one class…She wants to be better each day." Now that she was in college, Mónica had realized that her schooling was not only important to her, but also to her family and her community. Mónica reported that recently when her grandmother "comes up to me, she never used to this, but when I go to college now, she, 'me persigna;' how do you say that? She does like a prayer on me, right before I leave." This impressed Mónica, who thinks "wow! This is this big thing, not just for me, for my family—my entire family. And so I guess that's what keeps me going."

The way to success is through hard work. Through her words and actions Guadalupe espouses the storyline that *the way to success is through hard work.* "My idea is I need to tell her how is the real life; how to work for to get money. Because nothing is easy. I teach her work for, if she want something, she need to work for it." Mónica had taken this storyline seriously as she pursued her interest in computer science. In spite of the fact that she didn't know even the basics of computer programming—such as the fact they there are various computer languages ("this guy behind us raised his hand and he asked 'Oh, so what language is the programming going to be in?' And I turned to my friend and I was, like, 'well, in English, duh!')—Mónica puts all her effort into succeeding in class. At the start of the academic quarter, Mónica imagined that "this is going to be easy. Simple, right? I can pick up on it. It's computers. OK. It's our generation," but she quickly discovered that "it was a lot more difficult than I thought it was going to be." Her response to the difficulty was to work hard and to seek out help. After performing poorly on a midterm taken immediately after an illness and hospital admittance, Mónica redoubled her efforts and received "100% on the rest of my assignments" during the quarter. Guadalupe can be proud of her daughter's work ethic, as she hoped that what Mónica will learn from her life is that "she needs to work for the things that she wants. You know? Like nothing is free in this life." Guadalupe required reciprocity from Mónica at home; she told Mónica "I don't want to give you everything free and you don't gonna do nothing for me."

Machismo. According to Mónica, her mother had been a big role model in resisting the *machismo* storyline of their Mexican culture. Mónica's stepfather "didn't like the idea of [Guadalupe] going back to school to get her GED," but "[Guadalupe] kept telling him, like, I'm going to keep going to school, and she would always fight with him." Mónica had found this inspiring, as "seeing my mom succeed in that, seeing my mom break away from all of the obstacles, like, has helped me." She noted that the role model provided by her mother had strengthened her determination to prove that she can succeed in computer science. Guadalupe had also resisted the *machismo* storyline by pursuing what would be considered "men's work." She noted that "I work…like the guys. I'm learned how to drive trucks, and a lot of people said 'No, that job is for mens! Not for girls!' And I said 'it's a lazy job, I can

do it!'" Guadalupe's persistent resistance to the storyline had even brought around her own mother, who Mónica reports used to tell Guadalupe "You're supposed to be serving your man." Recently, however, Guadalupe's mother had a change of heart, telling her daughter that she was "really proud of you! You have overcome so many things, and you have done so much…You never asked for help from me or from anyone else in the family. You did everything on your own," according to Mónica.

Take the best and leave the rest. Although she rejected aspects of the Mexican culture—specifically the *machismo*—Guadalupe valued other aspects and worried that Mónica would discard her entire cultural background in favor of American culture. In this, Guadalupe hoped that Mónica would follow a storyline of *take the best and leave the rest* in terms of the Mexican and American cultures. Guadalupe reported that, in the way of adolescents, Mónica would come to her mother in high school and say "'Oh, mom, I want this' or 'I want to go somewhere because this girl, her parents, they let go' and this and that," to which Guadalupe would respond "this girl is White. This girl has different culture than we are. You know? Like, they have different culture than us. And that's why they think different." In our interview, Guadalupe reported that she had told Mónica to take the "conveniencia," which Mónica translates for me as "what's good for you. Like, you only take certain things." Guadalupe confirmed this translation, saying that she has told Mónica "you need to choose the better way; how to make your life happy."

The culture clash that Guadalupe referenced has put Mónica into some uncomfortable positions while trying to navigate a *take the best and leave the rest* storyline. Specifically, Mónica told me that "like my mom was saying, when I was in middle school I wanted everything that, like, my friends had, and most of my friends were, like, they were mostly the smart people." This caused tension for Mónica, as befriending the studious kids meant that she was immersing herself in a culture unlike her home culture, as her friends "came from, like, a rich family. And compared to me, like, I was smart, but I was—I didn't come from a rich family." Mónica was successfully able to navigate this tension, as her continued achievements in high school led to receipt of a full-ride scholarship to college where she socialized with and felt at home with other Latina students. She had absorbed some of the values and

beliefs of her mother's; Guadalupe, for example, reports that "when she was little I taught her to help when somebody needs help," and now Mónica "want[s] to do something relating to the field [of computer science], but also to help a community. Like, somewhere in destruction. Someone who is suffering."

Summary: Guadalupe and Mónica. What came out most strongly in my interview with Guadalupe was her unshakable belief that education and hard work are tickets to better jobs and a better life and her desire for her daughter Mónica to have these things. One way that Guadalupe instilled this message in her children was to insist not only that they complete their homework, but also to require extra reading above and beyond what was necessary for school. Another technique was to have her children work alongside her in the fields picking crops so that they would experience the difficulty of the job in the hopes that it would inspire them to continue their education.

The educational assistance that Guadalupe was able to offer her children was of a general nature, which helped Mónica to have the educational background she needed for college but was not otherwise of great assistance on her path to possibly majoring in computer science. This supports findings by Yang (2009), which found that Latino/a parents use encouragement and discipline to support their children's education, but may only have vague higher education and career goals that may not be in line with their child's wishes and interests which make educational assistance less effective. For example, Guadalupe did not require extra math in addition to school requirements that may have helped better prepare Mónica for a computer science major. Now that Mónica is in college, Guadalupe is unable to advise her on choosing a major or a career since she is unfamiliar with the details. For example, when Guadalupe mentioned that Mónica was interested in computer science and I asked if she thought that this would be good for her, Guadalupe answered in the affirmative, reasoning that Mónica was good at creating Power Point presentations.

Guadalupe was uneasy about how her daughter would navigate absorbing the beliefs and values of two cultures: the Mexican culture of her parents and the American culture she currently lives in. On the one hand, Mónica must reject the Mexican machismo culture in order to become an educated woman possibly working in a male-dominated field. On the other hand, Guadalupe did not want Mónica to

follow the American values of letting boyfriends in the house, parties, and sleepovers and she was troubled by letting Mónica leave the house at eighteen to attend college; according to Mónica, Guadalupe would have been more comfortable with her living at home and attending the local community college. As it turns out, Guadalupe helped her daughter on the path to considering a computer science major by serving as a role model of an independent woman who has insisted on educating herself and on working in "men's" jobs.

Teresa and Kelsey

Four storylines emerged from themes in Teresa's interview, one relating to gender and the others relating to choosing a major: the storyline that Teresa has been *role modeling* education and career goals for women, the desire for Kelsey to *keep your options open,* the belief that *outcome is a result of possibility plus ability,* and the value to *give back.* Teresa was able to not only encourage Kelsey in her schooling, but also to give her knowledgeable advice about choosing a major.

Role modeling. When talking about her daughter, Teresa spoke of her relationship with Kelsey in a *role modeling* storyline, seeing herself in some cases as a model to imitate and in other cases as a model to oppose. Teresa speculated that she had been a role model for her daughter in Kelsey's interest in a career, saying "that's all she saw was a woman that, you know, that did, you know, provided for her and, you know, made the way of working and, again, providing for her and just that's what you do," as well as her interest in working with computers. Teresa remembered that Kelsey "could see me from wherever she was in the room when I was working, and I think that kind of set the tone…that just part of regular, you know, everyday life is being on a computer."

The importance and value of an education had been part of the *role modeling* storyline since at least the generation of Teresa's parents. Growing up, Teresa found that "education was always a priority. My parents were educators and I'm first generation born Filipino here." Her parents taught Teresa to "really strive for the best for education," and she noted that her parents "pretty much imbued that in me." Teresa learned from her parents that education was important "for self-worth. And then also for opportunities. But I just think to make yourself a whole person; the best person that you can be to be

educated." Now as a the adult setting the tone for Kelsey and her sister, Teresa had "tried to give them the best education possible," including letting the two girls choose "different high schools because that's what they wanted to do, and in different parts of town" even though "there are challenges in doing that." Teresa had been a role model for women in higher education, as she was "on the cusp of, you know, definitely women's, you know, graduating from college."

Teresa hoped that Kelsey would forge a new path rather than imitating her mother if she decides to complete a graduate degree. "Sometimes you do graduate, and then you get a job offer and then you are off doing something else, which is what happened to me, so I never went to graduate school, but that may not happen to her." Because of this experience, Teresa had told Kelsey that "it's better to do it [graduate school] now rather than later. It's a lot harder to come back around and do it."

Although Teresa had "definitely" followed the path of what was traditionally expected of her as a woman, she was "really proud" that Kelsey is living a nontraditional life. Teresa found Kelsey's pursuit of an engineering degree and her interest in graduate school both as not following the expected path for women. According to Teresa, Kelsey also felt proud of doing well in male-dominated fields. Teresa noted that Kelsey had received a "pretty good taste" of being underrepresented at work "because last summer she worked at Boeing, and I think she was, like, there was only two other women besides her in this huge department. And so she was kind of proud of that, with its challenges."

Keep your options open. In reference to her ideas about choosing a college major, Teresa was a strong proponent of the storyline *keep your options open.* At the end of Kelsey's high school tenure, Teresa reported that "right off the bat she wanted, you know, to do [major in] graphic design." Teresa, however, was "trying to steer her in the direction of…'let's see what's out there on the horizon,' and she was fighting a little bit, and I was just trying to, you know, kind of trying to open it up for her." Teresa claimed "that's kind of how I actually got her interested in pursuing different possibilities."

Teresa believed that a major should be chosen through exploration of many options. When Kelsey enrolled in a programming class, Teresa told her "this will give you an avenue to…explore that and see whether that is something you want to integrate into what you could possible want to do or what

you may need to do;...you may need to have that skill." When asked what majors Kelsey should consider, Teresa suggested the possibility of double majoring if she were considering "the arts. But I think she's seeing that she can also do that and still, you know, do engineering or have another degree." Teresa did not see computer science necessarily as an end goal, but instead as a way to broaden Kelsey's options. Teresa thought "it opens up the doors to many other things, because, you know, because I know she will do a lot of different things, you know, going forward. So I think it's a great base for her to have."

Teresa believed that Kelsey's status as an underrepresented candidate would help her to have more options than she would otherwise. Since there are "not that many females in engineering," Teresa thought that there was "a demand for that so...that opens up the door for her and her degree…opens up the door for possibilities of what she can do. If there's more people pursuing her, it would seem that she would have more offers." Teresa tempered her views by noting that "getting in the working world then going up against a lot of male competition" could be a disadvantage for Kelsey of working in a male-dominated field.

Outcome = possibility + ability. Teresa believed that the best outcomes are reached not only through keeping your options open but also through natural abilities, or a storyline of *outcomes are based on possibilities plus abilities*. Teresa learned to program many years ago as she "had to have it for my degree," and she believed that Kelsey "has a natural talent for that, or skill" for programming. Although she was surprised when she found that Kelsey was learning to program ("she's doing this and, you know, I didn't really know that she's doing it"), when asked about the qualities Kelsey had that would make computer science a good major choice, Teresa responded that Kelsey is "very detail oriented and very orderly. So she's very good at putting things in sequence, I think. And, you know, and persistent. Which you really definitely have to have to get the, you know, to get it right." Kelsey also "has a really good math background." When Kelsey was younger, Teresa encouraged her in school by telling her to "do her best...and to realize that there are certain subject you're going to do well in and certain subjects that you are not." Teresa believed that Kelsey's natural abilities plus the opportunity to explore programming are

what led to her interest in computer science; "I think she just had it in her and had the opportunities early on that kind of gave her encouragement that, you know, 'this is something that I can do.'"

Give back. When asked what should be considered when choosing a major, Teresa responded with her personal value that you should be able to *give back.* "I think no matter what it is, that [Kelsey] get something that it's giving back, I think, to the community or to society…that it's not just kind of self-serving...as far as being employed goes." Teresa believed that a computer science major and a computing job "can definitely play in there. Be a big part of it, actually." Kelsey's interests appeared to follow this storyline, as she said she "really like[s] to do, like, community service" and in her investigation of majors, computer science "has actually become more interesting for me, because I think there's a lot more you can do with it than I thought;" in fact, a group on campus emails her information about "lot of programming for, like, kind of, like, applications for Third World countries."

Summary: Teresa and Kelsey. Teresa believed that being a single mom working from home gave Kelsey implicit messages that have influenced her pathway to a major and career. Seeing her mother support the family with her work using computers meant that Kelsey did not question that she would one day have a career and that computers could be a large part of that career. Where Teresa found she had to be more explicit with Kelsey was in choosing a major. In our interview it came across strongly that Teresa not only wanted Kelsey to broaden her options, but that she was instrumental in making sure that she did so. This appeared to be important to Teresa because she believed that Kelsey's future depended both on her innate abilities and also the possibilities open to her. Teresa expected Kelsey to take advantage of opportunities in order to give back to society, continuing a pattern of women's interest in socially oriented fields (Barker & Aspray, 2008).

Teresa had been able to help Kelsey along her pathway to considering a computer science major in several ways. Teresa valued education and instilled this in her daughter so that Kelsey had the educational background necessary to continue to college. Having received higher education herself, Teresa was familiar with majors and was able to talk with Kelsey about keeping her options open, exploring majors, and the goals and value of different major choices. With her knowledge of the working

world, Teresa was able to help Kelsey match her skills and abilities to possible careers. As found by Yang (2009), Teresa's status as a U.S.-born parent gives her the knowledge and ability to help Kelsey through higher education that is not available to immigrant parents.

Ann and Erin

In my interview with Ann, six storylines emerged from themes regarding education and choosing a major. Erin was raised with the model that *education is not just in the classroom* and Ann and her husband were *role modeling* the importance of education and the fact that *higher education leads to an improved quality of life.* Ann believed that *you can do anything you put your mind to.* Although Ann explicitly stated that, when choosing a major and career, one should *do what you love*, it is also apparent that she believed that *financial security is important, too.*

Education is not just in the classroom. Ann and her husband found that Erin "was a very motivated child to do well in school." Because of this, Ann implies that she and her husband had followed a storyline of *education is not just in the classroom.* Ann did not need to push Erin to excel; instead, "to encourage her, her dad and I would take her to museums or concerts or we would do more family experiences related to learning…and just felt like if we opened up [our daughters'] eyes to the world's possibilities they could see more than the four walls of the classroom." This has continued, and Erin "and her dad have developed a great bonding connection where the two of them will just go and spend the day at an art museum or something." At home traditional roles were reversed, where Ann would help Erin with math homework and Erin's father would help with social studies work. Ann reported that they not only "fostered learning through those traditional means and helping with homework and validating what the kids were doing," but that they also encouraged them "to think and to converse with adults and peers about world events and what they were seeing out in the world. And, like I said, those were nontraditional type of learning experiences of going places or doing things."

Role modeling. When Ann spoke of the importance of education to her and her husband, it became apparent that they had been *role modeling* for Erin. Ann, an elementary school teacher, "love[d] school. I have enjoyed it immensely… I'm actually a full-time student right now getting my

administrative certification. So I just value education a great deal." Ann reported that math was her "favorite subject in school," and Erin seemed to be following in her footsteps as Ann said Erin has "loved math forever." Ann noted that she and her husband "told our kids from the time they could talk that a college degree was a must," and that her husband served as an example as he "was not a college graduate when we met, nor when we married, and not when the children were born, and has since gone back and gotten a degree after the fact. So he speaks from experience."

You can do anything you put your mind to. At least in Erin's case, Ann believed a storyline of *you can do anything you put your mind to.* Ann and her husband had dubbed Erin "our little Renaissance girl" due to her eclectic interests. Not only was Erin drawn to "mathematics and things of that nature—and has excelled in all of that—but she also loves art and she paints and…loves the idea of learning languages and reading and...she loves drama; she's a quite talented actress." Ann believed that Erin could succeed in any field, as she "is extremely gifted and very intellectual…most academic endeavors come pretty easily."

In spite of Erin's multifaceted talents, Ann told me that the nature of stereotypes had forced Erin to have to fight to pursue some of her interests. Ann found "that sometimes she is judged harshly because of her looks. And it has happened to her through high school, that she was judged unfairly. And she fights hard to prove herself and to show what she is made of." Ann told me a shocking story that illustrates her point, relating that in high school "in math classes she had one particular teacher who didn't treat her very kindly. She's a beautiful young girl and came in wearing her varsity cheerleading uniform, and the teacher told her she was in the wrong class." In fact, according to Ann, "there have been several times in her few years in high school that she was judged for her appearance and not her intellect." Ann hoped that she had taught Erin to "stand up for yourself if somebody isn't kind to you. You don't have to put up with it."

Now that Erin was interested in pursuing computer science, Ann anticipated that she would have "a lot of doors to open" since she "is a little bit of an enigma. I think she's a very beautiful young lady, and she's not what people stereotypically think of as a computer person." Ann was aware of the

stereotype of computer science majors as “somebody who sits in a room with a wall of computers and never sees the light of day and doesn't have strong social skills, and it's not necessarily a physical appearance, just kind of a behavioral stereotype.” Despite Erin’s difference from the stereotype, Ann was confident that Erin would be able to “back up her knowledge and her skills” and would “work hard to make sure she makes a name for herself.”

Do what you love. When choosing a major and a career, Ann believed that Erin should follow a storyline of *do what you love.* Ann wanted Erin to “pick something you love,” and since Erin had “had a love of things mathematical,” Ann and her husband “keep telling her ‘stick with the math and the computer stuff!’” as a major.

Erin’s love of programming was a recent discovery for her and a surprise to Ann. Ann reported that Erin “took her first computer programming class in fall quarter of this year and loved it. Absolutely loved it! Was excited about the creative part, and she's loved math forever.” Because of this, “that's been kind of the direction [Erin] headed, but she would tell me that she felt like with the computer programming she got to take her love of math and apply her creative interest as well.” Ann found that when Erin came home during a school break “she got really excited about showing me programs she had written and things she could make the computer do that I thought were weird!” Ann found that “I guess I was a little bit surprised that she was as excited about the computer programming as she was.”

Erin’s exposure to computer science was serendipitous, according to Ann. Growing up, Erin “didn't really sit around and play on the computer…It was a tool and not a toy.” Ann felt “like she signed up for computer programming [as] a way to make that big place [the university] feel smaller and more intimate by having classes with friends.” Although Erin “never had expressed an interest in it before,” once in introductory programming “she just really took to it.” Ann had noticed that “we have a very close family friend who is a senior at a different university graduating…with a degree in computer science and they've never talked about it. Yeah, it was a surprise that she has a sudden interest.”

When Erin was growing up, Ann told her that “she needed to have a job and a career that she enjoyed.” Ann believed that “there are too many people who go to work with jobs they hate, and you

spend a lot of your life at work, and if you are doing something you love it makes what you do all the better."

…but financial security is important, too. When talking about careers, Ann spoke not only of *doing what you love* but also indicated that *financial security is important*. When asked how a career in computer science might be satisfying for Erin, Ann responded "hopefully financially. But, like I said, I just want her to have a job that she enjoys." In my interview with Erin, she told me that the family story about her father getting a degree after she was born had been important because "he would show us, like, his tax statements for the past couple years and you would able to tell with, like, the jump in salary, like, when he graduated." Ann believed that majoring in computer science would be an advantage to Erin because "computer fields seem to have strong potential for careers and a career path." Ann loved computer science as "an option for her, and I think there's the potential for a well-paying career path. And I would love to see her be an independent person of some means doing something she loves." Similarly, when asked what is important to consider when deciding on a major, Erin mentioned jobs first and enjoyment second; "I mean, the job market is important, but I don't think that should be the absolute deciding factor. If you enjoy doing it, I think, it's the most important."

Ann believed that Erin may have an advantage finding a job in a computer science field, as "many companies are trying to diversify their workforce" by hiring women, and if they hire someone like Erin "who can be a diversity hire, she can prove to anyone that she may be a diversity hire but she can do the job. And so I think that she will have advantages in that regard as well." Ann emphasized that Erin "could potentially get a job based on her gender, but I think she has the ability to prove to people and to become a valuable asset to anybody that would hire her. And could advance in that way."

Higher education leads to an improved quality of life. Ann and her husband had emphasized the importance of higher education to Erin because *higher education leads to an improved quality of life.* Ann believes that "the quality of life changes" because "a degree opens doors that are not open to you without that degree, and it buys you often different working conditions. So someone with a college degree is less likely to have to work nights or weekends."

Summary: Ann and Erin. Since Erin was raised in a two-parent household, Ann's interview referred not only to her beliefs and background, but also to those of Erin's father as seen through Ann's eyes. As an elementary school teacher, Ann valued education immensely, but, interestingly, saw education not only as schooling but also as cultural enrichment and as experiences and interactions with others in the world outside of the classroom. Both Ann and her husband had been role models in gaining a higher education, which they thought improves quality of life. Ann believed that Erin should choose a major and career based on what she loves to do, but she also acknowledged that financial security is important. Ann had great confidence that Erin had a rosy future while acknowledging the struggles Erin had encountered to prove herself.

Ann and her husband had helped Erin along her pathway to considering a computer science major in both implicit and explicit ways. Erin had followed in Ann's footsteps in her love of mathematics, and it was Ann who helped Erin with her math homework when necessary, and Ann had been a same-sex role model for Erin in mathematics excellence, which may have encouraged Erin to continue as parental interest can have an effect on persistence (Margolis & Fisher, 2002). When Erin expressed interest in a math major or, more recently, in a computer science major, Ann and her husband repeatedly told her to pursue those interests. Erin had been encouraged to continue her education through the family story about her father's obtaining a college degree after his children were born.

Race, Class, and Culture

Using a positioning theory lens to focus on interactions and storylines, we can see that these three cases indicate storylines that in some cases overlap and in other cases differ depending on the race, class, and culture of the mother/daughter pairs. In each of these cases, adherence to supportive storylines and rejection of negative storylines had resulted in the daughters being educationally and socially prepared to consider choosing a computer science major, although there had been struggles along the way. The enthusiasm of the three mothers for education and their conviction that education is the way to a more financially secure and happier life had supported their daughters in navigating the academically rigorous background necessary to have the pre-college preparation for a computer science major. All three

mothers had served as role models of independently minded, working women who pursue a life outside of the home, which has encouraged their daughters to consider majors such as computer science that have strong career outcomes. All three mothers expressed confidence in their daughters' ability to succeed in higher education and beyond.

When we look at the storylines and details of the mothers' points of view, we can see some variations related to race, class, and culture as well as immigration status. For Guadalupe, education is the way to a better life through a less physically demanding and a better paying job. Coming from an immigrant, working class background, Guadalupe was focused on Mónica's ability to improve her class status and she emphasizes to Mónica the value of hard work. In contrast, Teresa and Ann—both middle class, U.S. natives—expressed more concern with the content of the major and career their daughters choose. Teresa wanted Kelsey to keep her options open, to widen the possibilities open to her, and to strive to give back to society. Ann hoped that Erin would do what she loves and would find a career that offers desirable working hours and a better quality of life. In addition, Ann had a broader view of education as cultural exposure and involvement with people of all ages.

Guadalupe felt a cultural and racial tension that neither Teresa nor Ann express. Guadalupe valued her Mexican culture and heritage, and was concerned that Mónica would lose some of the morals of her family and culture, such as girls remaining closer to home and family. However, Guadalupe had spent much of her life fighting against the machismo storyline of her Mexican culture, and she had pushed Mónica to focus on schoolwork and getting a better job instead of the traditional focus for girls on helping in the home. This had enabled Mónica to do well in school and to be academically prepared to consider a computer science major. Guadalupe hoped that Mónica would take the best of her Mexican heritage to combine with what is valuable in her American home culture in the future in order to integrate the two cultures rather than feeling the tension that Guadalupe had experienced.

Although Teresa and Ann are different races—Filipina and White, respectively—they have similar views of education, majors, and appropriate paths for their daughters. Both mothers applaud the educational success of their daughters in a male-dominated field. Teresa and Ann have a broader view of

education than does Guadalupe, seeing the value in a cultural education outside of schooling (Ann) and the value to society of an education by being about to give back (Teresa) rather than being primarily focused on education as a path to financial success. The expressed commonalities between the views of Ann and Teresa and the resulting assistance they can give their daughters in choosing a nontraditional major indicate that their status as middle-class, U.S. born, college-educated women allow them and their daughters to follow storylines that are more amenable to choosing a computer science major.

Implications

In order to equalize representation in computer science, we should consider twofold efforts: first, to inform parents of the details and advantages of a computer science major, and, second, to provide support, information, and assistance to students that their parents may not be able to provide. Similar to Yang's (2009) findings, this study indicates that middle class, educated parents of many races are able to help their daughters navigate through the K-16 educational system in a more focused manner than immigrant parents. Daughters of working-class, immigrant parents need more information and targeted assistance to better prepare them to choose a major. Unlike these participants, girls who do not have parents that emphasize the importance of education and who follow restrictive cultural storylines will not be prepared to consider a computer science major. Informing parents of the details and advantages of a computer science major and career can help them help their daughters make more informed choices, and offering support to students that their parents are unequipped to give can help balance the resources available to students. College counselors can help provide information and assistance to high school students, but perhaps schools also need to reach out to working class and immigrant communities, assisting in founding parental groups that can provide information and support to parents who wish for their children to succeed in higher education. Groups available in the community during evening or non-working hours could be self-sustaining once schools provide the initial information and core groundwork.

None of the three mothers in this study suggested computer science to their daughters, thereby forcing the daughters to find the field by happenstance at the college level. Guadalupe emphasized the importance of education as the way to a better job and a better life, but did not know enough about

computer science and the financial benefits of many computer science careers to suggest the field to her daughter. Teresa and Ann encouraged their daughters to pursue a major in a field that they enjoyed, but did not envision their daughters enjoying programming and computer science. If girls could be introduced to the subject in an enticing manner at school before graduating from high school, it would be more likely that they would discover and continue in a field that they enjoy while gaining the financial benefits of careers in the field. Finding ways to introduce girls of all classes and cultures to the joys of programming at school could enhance efforts made to inform parents of the rewards and benefits of choosing and pursuing a computer science major in order to diversify the field.

Finally, this study indicates that class trumps race in the influence of mothers on their daughters pursuing a computer science major if we consider educational level as an indicator of class status. Teresa and Ann, both from educated, middle class backgrounds, were able to help their daughters navigate choosing a major in a focused, knowledgeable manner, even though they were of different races. Her working class, immigrant background limited the assistance Guadalupe gave to her daughter to emphasizing school and homework. Once her daughter reached college, Guadalupe was unable to provide any guidance or assistance in choosing a major. Because of this, it is important for institutes of higher education to continue to provide information and support to socioeconomically disadvantaged students of all races and cultures as they investigate possible majors.

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Conclusion to the Dissertation

The home and school experiences of the undergraduate, pre-major women in this study prior to their arrival at the university generally did not encourage them to consider a computer science major. Even women with a background in math and science with strong family support for education did not visualize themselves enjoying and succeeding in a computer science major and only come to enroll in introductory programming classes by happenstance. Differences in experiences in the home appeared to be attributable more to immigration status and socioeconomic status than to ethnic differences, as the daughters of U.S.-born, middle class mothers seamlessly followed the path to academic success across ethnicities, while immigrant, working class mothers had to create certain breaks from their ethnic background to role model success in male-dominated fields and to enable educational excellence for the three case study women in this dissertation. School experiences offered a gradation of who belongs based upon stereotypes of ethnicity and socioeconomic status. The working-class Latina was stereotyped to not belong in academically-focused classes in school. The beautiful, White woman was not expected to excel in math. Women of all ethnicities did not expect to have an aptitude or interest for advanced placement computer science.

Once at the university and enrolled in introductory programming classes, some women discover a burgeoning interest in computer science they would never have anticipated during their K-12 schooling years. Interesting classes billed as “puzzle solving” with young, dynamic instructors—including a female instructor—encouraged women to enroll and persist in programming classes. Women who enjoyed the introductory programming classes and had early—if hard-fought—successes become interested in pursuing their newfound passion, particularly after they discovered that career outcomes are broader than they anticipated and can include working for humanitarian causes. Women from underrepresented minority groups noticed early that there were few others of their gender and ethnicity, perhaps encouraging them to blame setbacks on racism or sexism rather than personal failures thereby supporting their continuation in the field. The determination of some women to continue to pursue their interests and even to prove themselves in spite of stereotypes and discouraging situations was notable, as computer

science classrooms may seem to be filled with know-it-all males who have been programming for fun for years.

In both schooling and the workplace, the portrayed culture of the computer science field served to discourage women from entrance. The vision of a computer scientist in the United States is of someone, usually a White or Asian male, who is naturally geeky and devoted to computers. Certain personality characteristics, such as introverted, narrowly intelligent, and a tinkerer are considered prerequisites to an interest in the field. In addition, careers are stereotyped to require a fondness for working on a computer in isolation. Women of many ethnicities, even those that saw themselves as "nerds," rarely identified with this image and only began to be interested in computer science once they discovered excitement about programming and began to explore the wide variety of computer science career possibilities. Islands of personal support can buffer women against the exclusionary culture of computer science. For some women, social groups for those of their ethnicity provided a respite from moving in an alien world. For others, academically-categorized groups, either for underrepresented minorities or for women of all ethnicities, offered a place to open up and share emotional and academic support with others in similar circumstances.

The findings from this study have implications in several areas for diversifying computer science. In school, designing introductory programming classes to be enjoyable and intellectually stimulating encourages interest in computing that can lead both to a critical thinking stance about computers in society and to an interest in a computer science major. Offering, or even requiring, such classes as early as possible in all schools could kindle an interest in computer science among diverse students at an early age. A first step should be to prioritize the goal of enjoyment in the curriculum of existing university introductory programming classes.

Correcting stereotypical views of who is successful in computer science and of what careers in computer science entail would assist a diverse set of students to more realistically assess their interest in the field. Time should be spent in introductory computer science classes exposing students to successful

computer scientists who do not fit the stereotypical mold and to interesting careers that students might not imagine or be exposed to in popular culture.

Subtle interactions that create a hostile climate to women and underrepresented minorities in the classroom should be exposed and corrected in order to encourage a diverse set of students to pursue and persist in computer science. Being explicit about underrepresentation and the reasons for it, as well as explaining and disallowing male posturing in the classroom would make the classroom climate more welcoming to women and underrepresented minorities. In addition, education in both overt and subtle sexism and racism could encourage women and minorities to blame setbacks on these dynamics rather than a lack of personal ability.

At the university, computer science departments should carefully review the types of student groups that they retain and endorse. Acceptance of participation in non-computer science groups and even non-academically focused groups can give non-majority students a comfortable base that helps them persist as a minority in the computer science culture.

Home cultures affect performance in and enjoyment of school; attention needs to be paid to giving students and families from diverse ethnicities, immigration statuses, and socioeconomic backgrounds the tools they need to understand and succeed in computer science. Parents and students of immigrant, working-class families may need more information and financial help that those from dominant families if girls from those families are to learn about computer science. Community groups might be formed and/or used to increase understanding of the benefits to girls of pursuing a study of computer science.

Increased diversity in computer science would not only increase access of marginalized groups to interesting, well-paying careers, but would also bring new insights and creativity to the field. Continued research in this area is important in a world that is becoming more and more infused with technology not only to attain diversification goals but also to create a better-educated populace.

Appendix A
Seminar Email Invitation

Date: XXXX
Subject: Invitation to XXX YYY, Women in Computer Science
To:

Hello!

I'm emailing to tell you about a 1-credit seminar that I think may interest you.

XXX YYY, Women In Computer Science, is a non-graded class that brings together a small group of pre-major women to explore the field of computer science. I lead the seminar, along with a TA who is a current Computer Science major. The class is not technical, and requires no programming. We see research demos, go on a field trip to a local company, talk about majors and careers, and meet current women computer scientists. The seminar requires in-class participation and some short written assignments. I try to base the course content in helpful info that students really want/need to know.

I'm sending you this info because you're registered for [Intro Programming] for next quarter. To request an add code, fill out the survey at the top of this page:
http://www.url

Why do we offer XXX YYY? You may notice that there are more men than women in computer science classes, and in the workforce. It's a complicated issue (we'll talk more about it in the seminar), but we want to help more women explore computer science. Ideally, we want to recruit you to CSE. :) If you don't join the major, that's OK -- you'll still get some helpful info on majors, careers, and technology.

If you can't join YYY but would like to talk about CSE, let me know and we can find a time to meet.

[Course Instructor]

Appendix B
Seminar Syllabus

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
First day!	Discussion: Why "Women in CSE?"	Presentations: Tech Leaders	Discussion: Exploring Majors	Panel: Current CSE majors	Field trip: Google!	Panel: Internships!	CSE Research Demo	Discussion: issues in CSE	CSE Research Demo
	Due: Critical Response to assigned article	Due: Profile of tech leader	Due: Profile of assigned major	Bring a question!		Bring a question!		Due: Critical Response to assigned article	

Basic info:
Tuesdays 2:30-3:20 in
Room 691 of building XXX.
This course is intended for pre-major women currently enrolled in Intro Programming.

Instructor:
YYY YYY, CSE Academic Advisor.
Questions? Talk to me in class, send an email, or come in for an appointment!
Office: XXX, room 101

TA: ZZZ ZZZ, current CSE major!
ZZZ is your best resource for questions about what it's like to be a CSE major, work in an internship, help a professor with research, or any other question about the CSE student experience.

Course Goals:
1. Explore computer science, including research, careers, and the contributions of important women.
2. Encourage a broad, accurate view of computer science and related fields.
3. Establish an environment for discussion, debate, and community for women interested in CSE
4. Inspire interest, enthusiasm, and curiosity about computer science.

Participation: This seminar is based in discussion, demonstrations, and in-class activities, so participating is very important. You can earn participation points by asking questions and participating in discussions in class, and/or by posting questions and articles in the "General Discussion" section of our GoPost board.

Assignments: This course will include four assignments. For each, you'll research a specific topic, read an assigned text or watch a lecture online, then share information from the assignments in class.

Download and turn-in assignments in the "Assignments" section of our GoPost board.
You need to post all assignments online to receive credit.
1. Why Women in CSE? This assignment introduces the purpose of this seminar
2. Leadership - Important Women in CS: Research a leader in the tech industry, and share her profile with the class
3. Majors - Your options as a student: Collect and share info about a computing-related major
4. Experiences - Talking with Women in the field: Read and discuss first-person narratives from women computer scientists

+ Panel Questions: We'll have two panels, one with current majors and one with alumni. Please think of questions in advance! Asking questions will count toward your participation points.

Make-up assignments: Make-up assignments are possible if you must miss more than one class, but it is highly preferable that you actually attend every week!

Appendix C
Student Interview Protocol

	First I will ask you a set of questions about where you are in the process of choosing a major and how you came to this point. Then I will ask you more general questions about your thoughts and beliefs about computer science. There are no right or wrong answers; I am simply trying to get a sense of what your path was like to this point and how you see the field.
20.	Where are you in the process of being in a major? -what major(s) are you considering? (interested in CSE) -what interests you *the most* in each of these majors? -what interests you *the least* in each of these majors? -how have you/will you decide on a major? -what things do you think are important to take into account when deciding on a major? -what did your parents (or others) advise you about choosing a major? -what qualities do you think are important for computer science majors to have?
21.	<u>For students in/applying to CSE</u>: -when do you expect to apply to CSE? -how confident do you feel about being accepted into the major? -do you think that coming to consider majoring in CSE was the "path of least resistance" for you? --Did you have to overcome hurdles to make it to this point? --Or did the way seem easy and natural? --In what way(s) was it easiest? What was the easiest part? --In what way(s) wit it difficult? What was the hardest part?
22.	<u>For students in other majors</u>: -why are you taking the introduction to programming class? -did you consider a CSE major? Why or why not? If so, what kept you from pursuing a CSE major?
23.	How much do you know about programming? How did you learn what you know so far? What inspired you to learn how to program? Who was influential in your learning about programming? Finish these sentences: -I like programming because… -I don't like programming because….
24.	How did you feel about school growing up? What are you academic strengths? What are your academic likes? What advice did your parents or family give you about school growing up? Did your parents or family help you with your homework? If so, what subject(s)? Did your parents or family give you additional schoolwork outside of school? If so, what subject(s)?
25.	Why did you decide to go to college? Who influenced you in the decision to go to college? How did you pick THIS UNIVERSITY? What other schools did you consider?
26.	Can you tell me the story about you and computers? (Prompt: when and how did you get interested?) Listen for and ask about: -when they became interested -what interested them

	-who interested them -where they became interested -schooling experiences -out-of-school experiences -affective experience (love, one interest among many, mixed, slow to warm)
	Now I would like to ask you a few more general questions about your experiences and beliefs
27.	Think about yourself in different settings both in the past and now. With what individuals or in what groups of people do you feel the most comfortable? When do you take a breath and say "Ahh…these are my people!"? Would a CSE major make you more similar to [each person/group of people] or less similar? How so? How is CSE seen by [each person/group of people]? [CSE majors] How will majoring in CSE affect how you fit in with [each person/group of people]?
28.	Do you believe that gender makes a difference for CSE students? [if so…] -how do you think that your experiences in CSE will be/would be affected by being a woman? -how do you think that experiences in CSE for male students differ from yours?
29.	Why do you think that few women pursue computer science majors?
30.	What are some of your life goals? Do you think that, in general, life goals for women differ from life goals for men? [if so…] -what are the differences? -how are your life goals similar to or different from the life goals of most women? -how does a CSE major/your major fit with your life goals? Not fit?
31.	Do you believe that cultural background or ethnic identification make a difference for CSE students? [if so…] -how do you think that your experiences in CSE will be/would be affected by your background as a [ethnic identification] student? -how do you think that experiences in CSE for students of other ethnic or cultural backgrounds differ from yours based on their ethnicity?
	I have a few questions now about how you see computer science
32.	Imagine you are a CSE major. What would you be doing in your upper division coursework? -what would you like about what you are doing? -what would you dislike about what you are doing?
33.	Imagine you are working in the CSE field. What would you be doing in your job? -what would you like about what you are doing? -what would you dislike about what you are doing? If you graduate with a CSE degree, what do you think is your likelihood of getting a job in the field?
34.	What do you value in a job or career? [CSE majors] How would a CSE career be compatible with these values? How would it be incompatible?
35.	[CSE majors] How do you think other aspects of your life will be affected (positively OR negatively) by getting a computer science degree?
36.	What is the stereotype of the "typical" computer science major? -what do you think is true about the stereotype? -what do you think is false about the stereotype? -does the stereotype bother you? Why/why not?

	-how do you fit the stereotype? -how are you different from the stereotype? -does the stereotype at THIS UNIVERSITY differ from the stereotype held more generally in the U.S.? If so, how?
	Now it is your turn to lead the conversation!
37.	Is there anything else I haven't asked you about that you think might be of interest to me?
38.	Do you have any questions you would like to ask me or comments you would like to make?

Appendix D
Student Interview Protocol Example
Second Interview

How you are thinking about a major now

2. At the beginning of the quarter, you said you were interested in majoring in Informatics or CSE. What is your current thinking on what you are interested in majoring in? What did you learn about the two fields during this quarter? Are you still interested in cybersecurity? Have you learned any more about how each of the two majors would help with this?

How you felt in classes

What friendships you have formed

9. What did you think about each of your classes this quarter? How do you think you did in each of them?
10. When we talked on the field trip, you called the Informatics instructors "extravagant" and in our first interview you said that you imagined that the CSE instructors teaching the introductory classes were more extravagant than the instructors of the upper division classes. Can you describe what you mean by "extravagant" and what it is you like about it?
11. In one of the Informatics classes I sat in on the instructor called on you to explain black hats, white hats, grey hats. How did you feel when answering his question?
12. Did you go to lab sections in Informatics? Did you talk much or were you called on during lab? How did that feel?
13. Which professors do you feel most connected to? Do you feel more connected to your TA(s)?
14. You said in our first interview that Informatics requires less math than CSE. How do you feel about math? Is less math an advantage or disadvantage for you?
15. Are there others you study with? [Did you meet them this quarter, or did you already know them?]
16. Did you do any programming outside of homework this quarter? Did you do much programming in your job?

How you are thinking about women in CSE now; why you took the women in CSE class

3. Did you learn anything surprising to you about women in CSE through the Women in CSE seminar?
4. Did you make any friends in the seminar?

Other

4. Would you say you identify more with your gender (as a woman) or with your ethnicity (as White/Caucasian)? How do you think that your identification influences whether you feel a part of things or feel left out?
5. Do you think that boys see girls differently that major in areas like CSE than those that major in more traditionally female fields? If so, how? Do you think that women CSE majors have a harder or easier time getting dates?!
6. Do you think that women in CSE are less feminine than women in traditionally female-dominated majors?

Appendix E
Mother Interview Protocol Example

First, I have some questions about majors and how Your daughter came to this point

18. Can you tell me the story of Your daughter and computers?
19. Can you tell me the story of Your daughter and programming?
20. What advice have you given Your daughter about choosing a major?
21. What do you think about Your daughter's interest in majoring in computer science? In math? Are there other majors you think that she should consider?
22. When did you first know that majoring in computer science might be interesting for Your daughter?
23. How do you think that majoring in computer science would be an advantage for Your daughter? A disadvantage? What about advantages/disadvantages of majoring in math?
24. What qualities does Your daughter have that would make a computer science major good for her? What qualities does Your daughter have that would make math a good major for her?
25. What difficulties do you think Your daughter may run into majoring in computer science? In math?

Now I have some questions about what you think about jobs or careers

26. How have you advised Your daughter about jobs? What did you tell her about working when she was growing up? What do you tell her about working now? What have you learned from working?
27. What types of work do you think that Your daughter should consider?
28. In what ways do you think that a career in computer science would be satisfying to Your daughter? What difficulties do you think that Your daughter might have in a computer science career? What about math?

Now I have some questions about what you think about education

29. How did you feel about school when you were growing up?
30. How do you think that getting a higher education will affect Your daughter's life? How did you encourage her in school when she was younger? How do you encourage her in school now?
31. What do you tell Your daughter to do when she struggles with her schoolwork?

Now I have some questions about traditional roles for women

32. Do you think that you have followed a path of what was traditionally expected of you as a woman? Tell me any stories of how your path has differed from the traditional path.
33. Do you think that Your daughter is living a life that is different from that of the life of a traditional woman? [If so, how?]
34. What would you like Your daughter to learn from your life as a woman?

Appendix F
Seminar Instructor Interview Protocol

1. How did you come to be teaching the Women in CSE seminar?
2. What are your goals for this class?
3. What are most students' goals for this class?
4. What is the most common feedback you hear in course evaluations?
5. What are the common changes you see in students from the beginning to the end of the quarter, as far as how they see CSE?
6. How do you recruit students for this class?
7. What is the enrollment in the class this quarter? How does that compare to past quarters? Why are there so many more students?
8. What do you commonly hear from students in the class about why they think there are few women in CSE?
9. What stories from students stand out in your mind about how they have felt that they belong in CSE?
10. What stories from students stand out in your mind about how they have felt that they do NOT belong in CSE?
11. Have you noticed any differences in the general conversations or in GoPost postings this quarter in class from previous quarters? Have you noticed any other differences in the students this quarter from previous quarters?
12. How is the seminar the same as or different from seminars in past quarters?
13. How are students accepted into the CSE major; what is the decision based on?
14. How do you think that CSE at THIS UNIVERSITY is being effective at recruiting and retaining women? How do you think that CSE at THIS UNIVERSITY is being effective at recruiting and retaining underrepresented minorities?
15. How do you see your role as advisor in recruiting and retaining a more diverse student body in the major?
16. If you could wave a magic wand to change one thing in the world to make CSE more attractive to women and/or underrepresented minorities, what would that change be?

Appendix G
Seminar TA Interview Protocol

1. How did you come to major in CSE?
2. Who or what supported you in coming to major in CSE?
3. Who or what created barriers to your coming to major in CSE?
4. How did you come to be the TA for the Women in CSE seminar?
5. How do you see your role as TA of this class?
6. What are your goals for this class?
7. What are most students' goals for this class?
8. What are the common changes you see in students from the beginning to the end of the quarter, as far as how they see CSE?
9. What do you commonly hear from students in the class about why they think there are few women in CSE?
10. What stories from students stand out in your mind about how they have felt that they belong in CSE?
11. What stories from students stand out in your mind about how they have felt that they do NOT belong in CSE?
12. How is the seminar the same as or different from seminars in past quarters?
13. How do you think that CSE at THIS UNIVERSITY is being effective at recruiting and retaining women? How do you think that CSE at THIS UNIVERSITY is being effective at recruiting and retaining underrepresented minorities?
14. You said in an email that you thought that the instructor had done a lot to support women in CSE. In what ways has she done this?
15. If you could wave a magic wand to change one thing in the world to make CSE more attractive to women and/or underrepresented minorities, what would that change be?

Appendix H
CSE Instructor Interview Protocol

Your background

1. How did you come to be teaching CSE intro programming here at THIS UNIVERSITY?
2. What led you to choose teaching over other careers you might have had? What had been best about your choice? What has been difficult?
3. What were your goals for teaching at the high school level?
4. How did you encourage more students to take your computer science classes when you worked at the local high school?
5. Did you do anything special to attract women or underrepresented minorities to your computer science classes at the local high school?
6. What are you proudest of in thinking back on your teaching in high school?
7. Do you see yourself as a role model? For what students? What do you try and model for them?

CSE at THIS UNIVERSITY

8. What do you see as your role as CSE faculty here at THIS UNIVERSITY? (listen for: coach, gatekeeper)
9. What do you think are the main goals of CSE intro programming? (weed out?)
10. How do you make your classroom welcoming for all types of students?
11. How do you promote majoring in CSE? Do you assume that everyone in your class wants to major in CSE? How do you think about promoting the major to a diversity of students?
12. What kind of contact is expected by the department between you and your students? What kind of contact do YOU expect between yourself and your students?
13. How do you see the role of TAs? What process do you go through to choose TAs for your class?
14. How are students mentored in CSE? Tell me about any mentoring that is designed to overcome underrepresentation. How have you mentored students? Do you notice any differences in the type of mentoring needed by male and female students?
15. Describe a time when a student expressed their desire to leave the field and your response to this.
16. What differences do you notice between students in your classes? [What differences do you notice differences between male and female students?] [Do you notice any differences based on cultural background or ethinicity?]
17. My understanding is that CSE intro programming classes are graded on a curve; is that correct? [if so] What do you think are the advantages and disadvantages of grading on a curve?
18. What do you see the role of competition in your class? What do you do to either encourage or discourage competitiveness?
19. Do you know of any attempts by CSE at this university to attract a more diverse set of students into the program? If so, what success did these attempts have?
20. Tell me about how you view the application process for students to become CSE majors. What advice do you give to students about successfully applying to the CSE major? Do you have a role in admitting students to the CSE major?

CSE in general

21. What would you like for your students to know about the computer science field? How do you express this to students?
22. What do you think is the biggest misconception about computer science by your students? How do you think that this misconception affects students? Does it have a different affect on different groups of students? Are there other big misconceptions?
23. What qualities are important for computer science students to have? Are there qualities that students have that make them unsuitable for computer science?
24. What do you look for in students when deciding which students to promote/recommend/encourage?
25. From what you have seen, read, and experienced, what do you think are the factors in women's underrepresentation in computer science?
26. From what you have seen, read, and experienced, what do you think are the factors in the underrepresentation by some ethnicities in computer science?
27. If you could wave a magic wand and change one thing that would result in representation in computer science in proportion to representation in the population, what one thing would you change?

Finally…

Is there anything I haven't asked you about that you think is important in the recruitment and retention of women and underrepresented minorities to computer science?

Appendix I
Data Collected

CSE Women in Computer Science and Engineering

- Demographic questionnaire from all students
- Videotaped every session each Tuesday of the quarter (topics: "Why Women in CSE?", female tech leaders, exploring majors, current CSE majors panel, Google field trip, internship panel, CSE research demos, issues for women in CSE)
- Copied "GoPost" postings submitted by students
- Interviewed class instructor
- Interviewed class TA

CSE Second quarter Introductory programming

- Observed lecture classes on 1/13, 1/20, 1/27, 2/10, 2/17
- Observed lab section on 2/23
- Interviewed instructor

Non-CSE classes observed

Class	Dates
ASTRO 101	1/30, 2/6, 2/17
MATH 124	2/6, 2/8, 2/10
MATH 125	2/13, 2/15, 2/17
INFO 200	2/1, 2/8, 2/10
INFO 200 lab	2/9

Student participants

Pseudonym	Ethnicity	Class Obs	Interview	Int 2	Parent	Major(s)	Year
Monica	Hispanic	INFO 200	Jan 4	Feb 27	Feb 27	INFO CSE	Fresh
Erin	White	CSE 143, MATH 125	Jan 9	Feb 28	Mar 1	MATH CSE	Fresh
Lucy	White	INFO 200	Jan 9	Mar 12		INFO CSE	Fresh
Marley	Nat Am, PR	MATH 124	Jan 13	Feb 28		CSE CE	Trans
Kelsey	Filipina		Jan 13	Mar 7	Mar 14	HCDE CSE	Soph
Emma	White		Jan 7			Business CSE	Soph
Lily	Asian Am		Jan 5			CSE INFO Business	Fresh
Paula	White		Jan 4			EE CSE	Fresh
Alice	Asian		Jan 4			CSE	Fresh

						PSYCH	
Katya	White		Jan 6			REECAS	Grad
Amalie	White		Jan 8			INFO CSE	Fresh
Kyleah	Asian Am		Jan 11			CSE PSYCH	Soph
Natalya	Russian		Jan 31			HCDE PSYCH	Trans
Crystal	White		Jan 5			CSE Vis arts	Soph
Sally	White		Jan 12			Biochem CSE	Jr
Sandra	Asian Am		Jan 5			CSE EE	Fresh
Leona	White		Jan 11			HCDE	Trans
Victoria	White		Jan 13			PSYCH	Sr
Jasmine	Japanese Pakistani American		Jan 14			Mech Eng CSE	Fresh
Chanel	Int'l		Jan 10			CSE Stats ACMS	Fresh
Nancy	Int'l		Jan 12			Physics Arch	Fresh
Sissi	Int'l		Jan 11			Stats CSE Math	Fresh

Appendix J
IRB Form

Experiences of CSE Women Pre-Majors
STUDENT PARTICIPANT ASSENT/CONSENT FORM
And PARENT PERMISSION (for students less than 18 years of age)

Researchers: Louise Ann Lyon, doctoral student, Learning Sciences

Dr. Philip Bell, advisor, Associate Professor of the Learning Sciences

**Please note that we cannot ensure the confidentiality of information sent via e-mail*.

Researchers' statement

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

PURPOSE OF THE STUDY

The purpose of this study is to gain a better understanding of how women come to be interested in majoring in computer science and how they experience their pre-major schooling across settings. This study may shed light on factors that encourage women to persist in the computer science field.

STUDY PROCEDURES

There are several different procedures; you can choose how many and to what degree you want to participate at the end of this study.

Getting to know the class

Demographic Questionnaire: All students in this "Women in Computer Science and Engineering Seminar" are being asked to fill out the attached demographic questionnaire asking for such information as your name, year in school, and other classes taken this quarter. You may choose to not answer any question or item in this questionnaire.

Videotaping and Observations: During the quarter the "Women in Computer Science and Engineering Seminar" will be video and audio taped and photographs taken. In addition, the researcher will take typed and written notes. The study will last for the duration of the quarter.

Class Assignments: The researcher will copy written assignments you turn in for this class on GoPost and as part of your request to take the class. You may refuse to give permission to the researcher to copy any of your assignments.

Getting to know you as an individual

Interviews: I would like to interview you about your experiences and why you are interested in majoring in computer science. The initial interview will take about 1 hour and I will ask questions like "Tell me how you came to be interested in majoring in computer science" and "Do you have any fears about majoring in computer science?" Follow-up interview(s) will focus on your experiences in school during the quarter and would last from 30 minutes to 1 hour. With your permission, I would like to videotape and/or audiotape these interviews so that I can have an accurate record of our conversation.

Observations in other Classes and Informal Settings: I would like to observe your participation in different settings. I will observe you in classes, both CSE and other classes, and in lab sections. I will obtain permission from these instructors to observe in their classes and labs, but I will not identify you to them as a student of interest. I would also like to observe you in other settings associated with CSE, such as study groups or social groups or working in the lab at mutually agreeable days/times.

Interviews with Parents/Guardians: I might like to interview your parents or guardians about your interest in computer science. The interview will take about 1 hour and I will ask questions like "Do you have a background in computer science or related fields?" and "What do you think about your daughter's interest in majoring in computer science?"

Putting the word out

I may want to use samples from videotapes or audiotapes for presentations to educational audiences, such as at professional conferences. I would like your permission to keep the tapes indefinitely and to use them for these educational purposes.

RISKS, STRESS, OR DISCOMFORT

Some people feel that providing information for research is an invasion of privacy. I have addressed concerns for your privacy in the section below. Some people feel self-conscious when notes are taken or when they are recorded. In addition, although this research will be strictly confidential, some people may experience sensitivity when discussing gender.

BENEFITS OF THE STUDY

You and society will not benefit directly from this study. Future benefits to society may include a more diverse representation in the computer science field.

OTHER INFORMATION

You may refuse to participate and you are free to withdraw from this study at any time without penalty or loss of benefits to which you are otherwise entitled. All the information you provide will be confidential. As part of this study, I will create a pseudonym for you, I will use only the pseudonym when referring to you, and I will keep the link between your name and your pseudonym in a separate location from other data. I will keep the link between your name and the pseudonym in a secured location until June 2017. Then I will destroy the information linking your identification to the pseudonym. When the results of this study are published or presented, I will not use your name.

Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

_____

Printed name of study staff obtaining consent Signature Date

Subject's statement

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later about the research, I can ask one of the researchers listed above. If I have questions about my rights as a research subject, I can call the Human Subjects Division. I will receive a copy of this consent form.

Please INTIAL next to either yes or no for each of the items below:

Getting to know the class

Yes: _____ No: _____ I will fill out the attached demographic questionnaire

Yes: _____ No: _____ I allow typed and handwritten notes of observations of me in this "Women in Computer Science" class by the researcher which will be used as part of her study.

Yes: _____ No: _____ I allow the video and audiotapes of me made during this class to be used by the researcher as part of her study.

Yes: _____ No: _____ I allow my postings for the "Women in Computer Science and Engineering Seminar" to be copied by the researcher and used as part of her study.

Getting to know you as an individual

Yes: _____ No: _____ I will take part in an interview(s) and I will allow my interview to be video and/or audio recorded for accurate transcription and analysis.

Yes: _____ No: _____ I allow observations of me and typed and handwritten notes in other classes I attend. I understand that I will not be identified by the researcher to the instructors of those classes.

Yes: _____ No: _____ If the researcher asks me, and if we find mutually agreeable days/times, I will allow the researcher to observe me and to take typed and handwritten notes in informal school settings.

Yes: _____ No: _____ If the researcher asks me, and if we find mutually agreeable days/times, I will give the researcher contact information for my parents or guardians and allow the researcher to interview my parents or guardians. I understand that I can choose whether or not I wish to be present during this interview.

Yes: _____ No: _____ I give my permission for the researcher to re-contact me to inquire about my final decision on a major.

Putting the word out

Yes: _____ No: _____ I give my permission for the researcher to keep the video- and audiotape and photos even after the conclusion of this study.

Yes: _____ No: _____ I give my permission for the researcher to use the video and audio recordings and photographs from the class and from any interviews at academic public presentations (e.g. conferences) and for professional publications (e.g. educational journals). I know that my name will not be used and that I will not be identified to the audience. I know I can always ask you not to use any image or tape.

_____

Printed name of subject Signature of subject

Parent's statement: for parents of subjects under **18** years of age:

This study has been explained to me. I voluntarily provide permission for my child to take part in this research. I have had a chance to ask questions. If I have questions later about the research, I can ask one of the researchers listed above. If I have questions about my child's rights as a research subject, I can call the Human Subjects Division at (206) 543-0098I will receive a copy of this consent form.

_____

Printed name of parent Signature of parent

Copies to: Researcher
Subject
Parent (for subjects less than 18 years of age)