SAVORING THE FIRST BYTE:
GIRLS AND BOYS IN INTRODUCTORY-LEVEL HIGH SCHOOL
COMPUTER SCIENCE CLASSES

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ABSTRACT OF THE DISSERTATION

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By

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Purpose

This case study sought to investigate the structure, pedagogy and culture of an introductory-level, high school computer science class and to examine the experiences of the girls and boys in the class to understand why so few girls enroll in the advanced computer science classes.

Research Questions

What factors can help explain why so few girls enroll in the advanced computer science classes in high school?

a) How do the existing structure, pedagogy and culture of the entry-level computer science class encourage or discourage girls' and boys' interest, enrollment and persistence in the advanced computer science classes?

b) How do girls and boys perceive their experiences in the entry-level computer science class?

c) What kinds of opportunities occur in the entry-level computer science class to foster the construction of the identity of a computer scientist for girls and boys?

d) How do perceptions of Computer Science as a discipline influence high school girls' interest and enrollment in advanced computer science classes?

Methodology

This qualitative study utilized surveys, classroom observations, individual and focus group interviews and document collection. Four students, two girls and two boys,

two teachers and two guidance counselors were chosen to participate. Interview transcripts and documents were coded to discover patterns, grouped into general categories and later combined into narrower themes and perspectives. Validity procedures included member checking, use of participants' words, triangulation and researcher reflexivity.

Findings

Female students often enter the introductory computer science classes with weaker computer skills and less involvement with computers than their male peers. Opportunities to manage their learning environment by working at their own pace, collaborating and focusing on project topics and features that were meaningful to them proved to be a successful combination for the students in the introductory computer science class. Additionally, this research study yielded the discovery of institutional factors that influence the gender imbalance in computer science classes: course scheduling practices and prerequisites, teacher beliefs and attitudes, students' prior experience and knowledge of computers, transition from middle school to high school computer science classes and computer-related opportunities outside the classroom.

Significance of Study

Understanding the ways that girls and boys experience high school computer science classes can help schools provide a positive classroom experience for all students and redistribute the power of important social, cultural and academic resources. Providing an opportunity for high school students to share their perceptions, successes, failures and recommendations can serve as a catalyst for school improvement and promote the futures of girls and boys in technology.

ACKNOWLEDGMENTS

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Introduction

While shopping for greeting cards, I noticed a striking difference between the cards for newborn girls and newborn boys. In addition to the expected pink and blue color schemes, the cards presented the baby girls passively sleeping in a cuddly cradle with teddy bears and the boys actively playing with toys or sports equipment. The card shopping experience triggered a number of challenging questions regarding the scores of similarities and the small number of differences between newborn girls and newborn boys, how and when children develop their gender identity and why most children willingly socialize themselves to be masculine and feminine.

There are different theories of how children become gendered, some stressing how the environment shapes children's learning and behavior and others emphasizing biological or cognitive development factors within the child (Zucker, 2001; Martin & Ruble, 2004). However, by the age of 3, children in a gender-differentiated environment, where gender-type activities, values and beliefs are reinforced, learn gender-type behavior (Crawford, 2006). Society is intricately involved in the process of developing gender identity as it shapes and is shaped by what is taught and learned (West & Zimmerman, 1987). Children learn what it means to be a boy or a girl from cues and messages offered by peers, adults and the world around them. This means that gender is socially constructed, that we are not born a boy or a girl so much as we learn *how* to be a boy or a girl (West & Zimmerman, 1987). Furthermore, society constructs its educational system to promote and reproduce its idea of what a gendered member of society should be.

How children *do* gender is influenced by their multiple discourses and social relationships with adults and peers. These social interactions influence the children's lives, including their career goals and expectations (West & Zimmerman, 1987; Margolis & Fisher, 2002). Children are accomplished observers. As they look around the world, they imagine possibilities for themselves and speculate on what others expect of them. They develop ideas about who will be successful and who will *not* be successful in certain fields of study. Influenced by social-cultural norms and everyday social interactions, children tend to place computing on the male side of the gender divide (Margolis & Fisher, 2002).

Women in Computer Science

In the early 1980s, computer science was a new field of study in many universities across the country. The absence of the male-dominated legacy of other math and science fields promised an opportunity for gender equity. In its early years, the field of computer science attracted women and boasted the highest percentage of female undergraduates in comparison to other areas of science (Yasuhara, 2005). However, recent comparisons reveal a greater gender imbalance in computer science than in other fields in science and engineering (Yasuhara, 2005). At the undergraduate level in the United States, computer science is the only science, technology, engineering and mathematics (STEM) field whose gender gap has widened during the last two decades (Yasuhara, 2005; Yasuhara, 2003; West, 2002). According to the National Center for Education Statistics (NCES), the percentage of Computer Science bachelor's degrees granted to women steadily dropped from its peak in 1984 of 37% to 28% throughout the 1990s to an all-time low of 11.8% in 2008 (NCES, 2009). Although more than 50% of college students are women, they are vastly underrepresented in the field of computer science (Camp, 2001). While the percentage of women awarded undergraduate degrees in all disciplines, including STEM fields, have increased, the percentage of undergraduate degrees awarded to women in Computer Science has decreased (AAUW, 2010; Camp, 2001).

The low level of participation of females in the computer field is a concern for educators and for industry. Under-representation in computer science threatens to make females bystanders in the technological world of the 21st century. Because so few young women are learning "how to invent, create, and design" computer technology, women are missing the educational and economic opportunities that are readily accessible to computer-savvy young men (Margolis & Fisher, 2002, p. 3). Additionally, a knowledge and expertise in technology is an asset in many contexts outside the field of computer science. For these reasons, it is critical for women to be part of the teams who are influencing the world for that world to reflect and support women as well as men (Margolis & Fisher, 2002).

Most research studies exploring gender and computer science have investigated the issues of access, participation and persistence of women at the bachelor's and graduate level. The emphasis of research has focused on gender bias and stereotyping, societal factors, attitudes toward computer science, gender grouping and previous computer experience and motivation (West, 2002). The most common reasons for women to discontinue with their study of computer science include: (a) overall pressure by male peers not to study Computer Science; (b) lack of self-confidence, (c) feeling of being unwanted, alone and uncomfortable; (d) having one's opinions under-valued;

(e) considering Computer Science to be male-dominated; and (f) fear of combination of work and family life in the IT-sector being problematic (Yasuhara, 2005; Margolis & Fisher, 2002; West, 2002; Camp, 2001). Studies of undergraduates in computer science show that many women who leave the computer science field for other STEM fields are academically successful. This suggests a need for further investigation of pre-college experiences (Margolis & Fisher; 2002; Camp, 2001).

Why should it matter if girls enroll in computer science classes in high school? While few research studies have focused on girls in high school computer science classes, the limited findings suggest that experiences in high school programming courses influence girls' decisions to major in computer science in college (Margolis & Fisher, 2002). Although enrollment in entry-level high school computer classes is approximately even (half girls and half boys), boys predominantly take advanced classes (Bravo, Gilbert, & Kearney, 2003). The 2008 Advanced Placement (AP) participation statistics support this finding with a small percentage of women taking the Computer Science A exams (18.6%) and the Computer Science AB exams (12.8%) nationwide.

These same trends hold true at Garden State High School, a public high school in New Jersey. The school was the site of my investigation of factors that influence high school girls' enrollment in advanced computer science classes. Although female students comprise the majority in many advanced placement and honors math and science classes at Garden State High School, data clearly show that female students are underrepresented in computer science classes (see Appendixes B, C and D). Female students enroll in entry-level Web Design classes, but they rarely schedule advanced computer science classes, spend time in the computer labs after school or participate in maintaining the school website. Garden State High School girls are using computers for completion of class projects and assignments, but it is predominately the boys who are programming the computers and designing the school website (see Appendix B). The “boy’s clubhouse” perception of the Garden State High School computer lab reinforces the cultural perceptions surrounding technology and influences enrollment in the computer science classes (Margolis & Fisher, 2002, p. 4).

As a former Supervisor of Math and Science and a current Assistant Superintendent for Curricula and Instruction, I have facilitated many discussions with students, teachers, guidance counselors and school administrators regarding the considerable discrepancy between the enrollment of girls in advanced math and science classes and the enrollment of girls in computer science classes, the social and academic implications of a gender gap in the computer science classes and the remedies that might help to reverse the trend in high school computer science classes. During the past seven years, recruitment attempts to remedy the gender gap in the advanced computer science classes at Garden State High School have focused on individual meetings with girls currently enrolled in entry-level computer science classes and “all-girl” group activities intended to bring girls together for discussion. Personalized outreach efforts have included: math and science teachers identifying and encouraging girls in their classes to enroll in computer science classes, guidance counselors encouraging girls to enroll in computer science classes during conferencing or scheduling sessions with students and parents, and female computer science students facilitating events such as “A Celebration of Women in Technology” to showcase their computer science projects and to share their experiences with other girls. Despite these efforts, the gender gap in computer science classes persists at Garden State High School.

Study Design

The purpose of this case study was to investigate the structure, pedagogy and culture of the entry-level computer science class at Garden State High School to understand why so few girls enroll in the advanced computer science classes. Through the students' accounts of their experiences and classroom observations in the entry-level computer science class, I examined the girls' and boys' daily experiences to understand their perceptions and perspectives and to capture both gender similarities and differences. This case study was conducted within a socio-cultural framework with a gender perspective. This perspective claims that knowledge and gender are constructed and developed through interaction with the environment (Crawford, 2006). By examining the structure, pedagogy and culture of the entry-level computer science classes and the experiences of girls and boys in the entry-level computer science classes at Garden State High School, my study sought to answer the following questions:

What factors can help explain why so few girls enroll in the advanced computer science classes at Garden State High School?

a. How do the existing structure, pedagogy and culture of the entry-level computer science class at Garden State High School encourage or discourage girls' and boys' interest, enrollment and persistence in the advanced computer science classes?

b. How do girls and boys perceive their experiences in the entry-level computer science class at Garden State High School?

c. What kinds of opportunities occur in the entry-level computer science class at Garden State High School to foster the construction of the identity of a computer scientist for girls and boys?

d. How do perceptions of Computer Science as a discipline influence high school girls' interest and enrollment in advanced computer science classes?

These questions were generated to guide the examination of some of the perceptions and experiences that might affect high school students' ability to succeed in computer science classes.

Significance of the Study

The gender gap in Computer Science is an educational and social phenomenon that warrants further research into its causes and potential remedies. Computer Science is a field that has the potential to become increasingly important as our society becomes more reliant on information technology. This study contributes to the research on the gender gap in computer science by focusing attention on high school girls' and boys' experiences in the entry-level computer science class and providing a detailed account of the daily classroom occurrences, including the teacher's pedagogical and curricular decisions. Providing an opportunity for high school students to share their perceptions, successes, failures and recommendations can serve as a catalyst for school improvement and promote the futures of girls and boys in technology. Additionally, this research study benefits school administrators who are looking for a plan to increase girls' participation in the advanced computer science classes at Garden State High School and to ensure equal opportunities to learn, excel and achieve educationally for all students.

Terms and Definitions

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

Computer Science: An academic discipline that may encompass the study of computer hardware and software, web design and programming.

Culture: Culture is expressed by behavior, rules, and customs in a specific context. Ever changing, culture shapes and is shaped by the learning and teaching that happen during the practical conduct of daily life (Erickson, 2001).

Gender: As used in this study, gender is a classification system that influences access to power and resources and shapes the relations among women and men. It is not the same as sex, which depends on biological characteristics of women and men. Instead, gender is determined by how a person manages her or his behavior according to the normative conceptions of appropriate attitudes and activities attributed to women and men in society and in public and private life (West & Zimmerman, 1987; Crawford, 2006).

Social Construction: Social construction is a shared understanding and collectively-held belief of what a particular characteristic, like gender or race, means in a social context. As used in this study, social construction refers to the way we create meaning and value for things and ideas though social interactions with others. Language, symbols, colors and gestures are all examples of social constructions. In socially constructing people, we create categories and ideas about what people in those categories are like (Wortham, 2006; Crawford, 2006).

Assumptions of the Researcher

A primary assumption of this researcher is that gender is socially constructed. Social construction of gender means that gender is not an inevitable result of biology, but highly contingent on social and historical processes and influences social power and status (Crawford, 2006). Gender is created, performed and perpetuated in social interactions (West & Zimmerman, 1987). Children learn what it means to be a boy or a girl from cues and messages offered by peers, adults and the world around them. Additionally, the meanings of disciplines, like computer science, can be seen as socially constructed because there is a shared notion of what it means to be a computer scientist. Furthermore, society constructs its educational system to promote and reproduce its idea of what a gendered member of society should be.

An additional key assumption is that there are more differences within the genders than between the genders. Most research on women in computer science refers to two models: the deficit model and the difference model. The deficit model proposes that women lack "some key factor" they need in order to succeed in computer science and intervention approaches involve "fixing the women" (Wyer & Adam, 1999, p. 4). The difference model proposes that "life experiences" hinder the outlooks and goals of women as related to computer science and interventions involve adopting different approaches to the field, such as "fixing the curricula" (Wyer & Adam, 1999, p. 4). Eliminating deficits in women and differences between the genders for the disparity in attitudes and achievement between girls and boys focuses attention on gender construction and the influence of privilege.

Researcher's Background

I began my career as a mathematics teacher in 1972. During the past 39 years, I have been active in all facets of school life, serving as a teacher, grade team leader, mentor to new teachers, district Mentoring Coordinator, Supervisor of Math and Science, and currently as an Assistant Superintendent of Curricula and Instruction. I completed a master's degree in Curricula and Instruction in 1999. In Spring 2004, I entered the Rutgers University doctoral program, focusing on Sociological and Philosophical Foundations in Education. My course work has focused on the philosophies of education, issues of race, class and gender, curricula development, statistics and research methods.

I became aware of the gender gap in high school computer science classes during the five years that I served as a math department supervisor. Year after year, girls were underrepresented in the computer science classes and recruitment attempts to remedy the gender gap were unsuccessful. My research was undertaken to understand the factors that influence gender imbalance in high school computer science classes and to ensure equal opportunities to achieve educationally for all students.

Limitations of the Study

I have chosen to focus this study on high school students in computer science because girls are significantly underrepresented in this area of study in Garden State High School (see Appendix B). Due to the declining enrollment of girls in entry-level computer classes, this study was limited to one entry-level computer science class, comprised of two girls and fourteen boys, in one suburban high school. The small number of participants and the unique nature of the school may limit the ability to generalize results. Additionally, I am acquainted with the students and faculty members in the computer science department in the school. Therefore, my relationship with the participants may affect the results of the interviews and classroom observations. To address the potential of the corruption of data, the student and teacher participants were assured that their participation was voluntary and that they were able to review the data throughout the process.

Organization of the Document

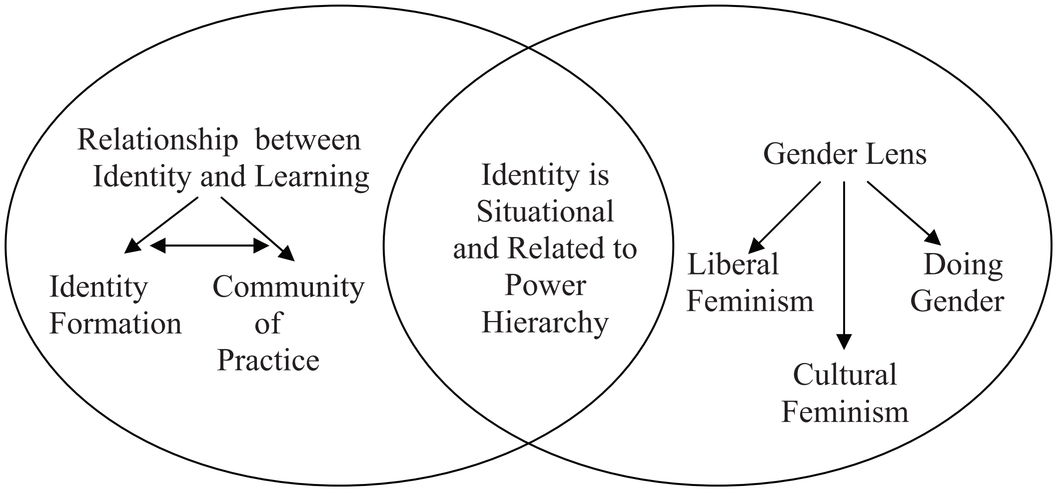
In Chapter Two, I review the literature on women in computer science, specifically the cultural perceptions surrounding computer science and gender as a significant dimension in the classroom. The chapter begins with a historical perspective of feminist theory and an examination of how learning involves both cognitive and identity development. The chapter continues with the key concepts of communities of practice learning theory. Community of Practice Theory focuses on learning as social participation, where the individual is an active participant in the practices of the communities and in the construction of his/her identity through these communities (Lave & Wenger, 1991). I conclude the chapter with the findings of research studies of gender and technology in schools to highlight the difficulties that girls face in computer science classes. The findings underscore the differences in prior knowledge and experience in computer science between girls and boys and the role that the classroom teachers' expectations and curricula and pedagogical decisions play in student achievement and self-perception.

In Chapter Three, I reintroduce the research questions and define assumptions that underlie this study. I include the characteristics of a case study and outline the methods used for data collection and data analysis. In Chapter Four, I include a description of the classroom setting and the Web Design 1 curriculum. Profiles of the Web Design I class, focal students and teacher introduce interesting characteristics of the participants and their history, and provide context for the quotations used later in the document.

In Chapter Five, I present the findings of the study and discuss themes that emerged from the data. In Chapter Six, I compare the findings of this study to the literature and discuss implications for practice and future research.

CHAPTER II: A REVIEW OF THE LITERATURE

Theoretical Framework



Feminist Theory and the Gender Lens

The distinction between sex and gender was first made in the late 1970s (Crawford, 2006). Sex was defined as biological differences in genetic composition and reproductive anatomy and function. In contrast, gender was "defined as those characteristics and traits socio-culturally considered appropriate to males and females" (Unger, 1979, p. 1085). According to these definitions, sex specifies what is biological and natural, while gender designates what is learned or cultural. The sex/gender distinction was an important step in recognizing that many of the apparent differences between men and women might be imposed by society rather than be natural or inevitable (Crawford, 2006).

However, a broader concept of gender was needed. The nature/nurture dichotomy limited the view of gender to a role or display and ignored the ways that people interact across different situations (West & Zimmerman, 1987). Additionally, this view of gender failed to recognize gender as a culturally shared system through which societies organize relationships between males and females.

In *Doing Gender* (1987), Candace West and Don Zimmerman suggest that gender is not something a person *has*, but something a person *does*. They view gender as a social activity where both men and women act out *a self* in response to the expectations and responses of others (West & Zimmerman, 1987). For West and Zimmerman, gender is a "situated accomplishment" within the normative conceptions of appropriate attitudes and activities for particular sex categories (p. 126).

> When we view gender as an accomplishment, an achieved property of situated conduct, our attention shifts from matters internal to the individual and focuses on interactional and, ultimately, institutional arenas. Rather than as a property of individuals, we conceive of gender as an emergent feature of social situations: both as an outcome of and a rationale for various social arrangements and as a means of legitimating one of the most fundamental divisions of society (West & Zimmerman, 1987, p. 126).

According to West and Zimmerman (1987), "doing gender means creating differences between girls and boys and women and men, differences that are not natural, essential, or biological" (p. 137). A person engaged in virtually any activity may be held accountable for performance of that activity as a woman or man, and "their incumbency in one or the other sex category can be used to legitimate or discredit their other activities" (West & Zimmerman, 1987, p. 136). For example, in the school setting, masculine behavior displayed by girls is often devalued by peers because it is not performed in and through a socially perceived male body (Messerschmidt, 2009). The balance between the perceived sex category and gender behavior is essential for validating masculinity and femininity (Messerschmidt, 2009). Masculine girls and feminine boys "are often bullied in school for their 'failure' to conform to sex/gender congruence" (Messerschmidt, 2009). As a result, *doing gender* becomes part of the social structure of situated practiced behaviors.

Gender equity in computer science is a well-explored area of feminist research. In the United States, the most influential feminist theoretical perspectives include liberal and cultural feminism. Liberal feminism, popular in the 1950s and 1960s, was influenced by the civil rights movements. Focusing on the similarities between men and women, liberal feminists believe that few differences would exist if boys and girls were given similar opportunities. Liberal feminists blame society for supporting patriarchy and oppressing women. They believe that men and women are entitled to legal and social equality. They support changes in laws, customs, and values to achieve the goal of equality.

In contrast, cultural feminism emphasizes the differences between women and men. Cultural feminists believe that there are fundamental, biological differences between men and women that should be acknowledged and celebrated. Because of these differences, cultural feminists explain that women *see, know,* and *function* in different ways than men. This feminist perspective stresses that the qualities and characteristics of women have been devalued and should be honored and respected in society (Crawford, 2006). Although feminist theory has many variants, two important themes emerge. Feminists value women as important and worthwhile people and feminists recognize the need for social change to end sexism and sexist oppression.

Feminist have examined and theorized about sex and gender, as well as the intersections of gender with other systems of power, particularly race, class and sexuality. *Doing Gender* was a conceptual breakthrough that considerably influenced feminist theory (Messerschmidt, 2009). All feminist perspectives recognize the link connecting gender to power and status. Gender influences social power and can be the basis for prejudice, discrimination and oppression. Most societies are patriarchal and allocate more power and status to men. The gender system can be conceptualized as operating on three levels, the socio-cultural level, the interpersonal level and the individual level (Crawford, 2006). At the socio-cultural level, men have more institutional and public power. The gender category "male" is socially linked with greater prestige, prominence and value than the gender category "female" (Crawford, 2006). The interaction of the gender system with other systems of race, ethnicity and social class explain why all men are not equally privileged and why all women are not equally disadvantaged. At the interpersonal level, gender is created, performed and perpetuated through social interaction. *Doing gender* is not just a matter of creating and displaying differences. When men and women *do* gender, they also *do* status (Crawford, 2006). The gender system operates on the individual level when people internalize their social status and hierarchical social practices.

Doing gender is sometimes about challenging it. In *Gender Play*, Barrie Thorne (1993) examines how gender roles are reproduced, negotiated and transformed on the playground and in the classroom. Thorne describes how children at play group themselves along gender lines as separate, opposite and sometimes antagonistic. Likewise, by organizing girls and boys into separate teams for classroom competitions, teachers reinforce gender antagonism.

How children do gender is "relevant in different ways, from one social context to another" (Thorne, 1993, p. 29). According to Barrie Thorne (1993), children's gendered interactions and relationships are governed by socially recognized gender roles and their individual status within their social group (Thorne, 1993). Thorne observed that girls and boys mix or separate while at play depending on the circumstances. Sometimes children find a source of solidarity; for example, defending another student against mistreatment from a teacher or authority figure, which causes gender divisions to recede in importance.

Thorne's research challenges the traditional view that children are socialized by adults into gendered roles and suggests that children themselves "come together to help create, and sometimes challenge gender structures and meanings" (Thorne, 1993, p. 84). In this way, children play a role in shaping their own gender development and identity formation (Thorne, 1993).

Identity Formation

Identity is constructed over a period of time and is influenced by many different factors, including social structures, cultural symbols, myths and stereotypes. The construction of identity defines individuals to themselves and to others. Cultural identity is the feeling of belonging to a group and being influenced by belonging to a group. Recognition by others as a member of a group is often a contributing factor to identity formation. Surrounded and saturated by popular media and influential imagery, high school students have many resources available to them to decide how they wish to present their "selves."

According to Stanton Wortham (2004), social identification and academic learning are interdependent and interconnected. The act of learning not only changes "what the learner knows" but "who the learner is" (Wortham, 2004, p. 715). When students become involved in a new practice, e.g., learning to read or solving algebra problems, they participate in new activities and change their positions with respect to other people (Lave & Wenger, 1991). In this way, learning involves both cognitive and identity development (Lave & Wenger, 1991).

Social identification is the process through which individuals and groups become identified as part of socially recognized categories of people (Wortham, 2004). These categories can be established over different periods of time: local patterns develop over days, months or years and social-historical patterns develop over decades and centuries (Wortham, 2004). To become socially identified, a person must exhibit the characteristics or behaviors associated with that category. For example, if a student displays a passion for computer games, he or she could be recognized as a particular social type, i.e., being a "nerd" (Wortham, 2004) However, this behavior could also be associated with a different category depending on local patterns.

Within a classroom, students and teachers often establish local categories of identification that modify social-historical categories. The students' social identities are based on categories that exist in their school, e.g., being an athlete, being a "good" student or being a trouble-maker. For high school students, the power relations, interpersonal struggles and "other non-academic processes that occur at school cannot easily be separated from the academic activities that occur in the classroom" (Wortham, 2006, p. 1).

Teachers often think of students in an entry-level class as blank slates. However, students bring some aspect of their social identity into the classroom. According to Wortham (2004), learning always includes at least three components: the learner, the activity and the situation or social-historical context (Wortham, 2004). For example, learning computer programming involves the ability to learn programming languages, help or cues from others, and social-historical processes that identify different kinds of people as computer programmers. How teachers create classroom events that link students' own experiences to the curricula can "facilitate overlap between identity and academic learning and have various effects on students' identities: empowerment as well as disempowerment, inclusion as well as exclusion, respect as well as disrespect" (Wortham, 2006, p. 277). Learning can change identity and the self (Wortham, 2006).

Students learn through classroom interactions with other students and the teacher. As the students engage in the collective process of learning, they form a "community" through which they develop and share the capacity to create and to use knowledge (Wegner, 1999). Through different levels of individual participation and different levels of interaction among the members, the community establishes an identity for itself and its members according to the social-historical categories in the school, including gendered characterizations (Wortham, 2006).

Community of Practice

Like other disciplines, computer science is easier to learn if you form a learning community with friends and mentors. According to Lave and Wenger (1991), social interaction and collaboration are essential components of learning. Their model of situated learning proposes that learning involves a process of engagement in a "community of practice" (Lave & Wenger, 1991).

In *Situated Learning: Legitimate peripheral participation*, Lave and Wenger (1991) describe communities of practice as groups of people who engage in a shared concern or passion and who learn by working together. According to Lave and Wenger (1991), learning is a process of social participation where the nature of the situation impacts significantly on the process. As part of their research, Lave and Wenger (1991) observed different apprenticeships; including midwives, tailors, U.S. Navy quartermasters, meat-cutters and members of Alcoholics Anonymous. Members of the communities worked on common activities that resulted in collective learning. Through the pursuit of this knowledge, members sensed a "joint enterprise and identity" (Lave & Wenger, 1991, p. 98; Wenger, 1999).

Initially, members may have different responsibilities and status in the community. As they learn the practices of the community, they become active participants and "move from legitimate peripheral participation into full participation" (Lave & Wenger 1991, p. 37). Lave and Wenger (1991) differentiate this process of "learning *to* talk" from "learning *from* talk" (p. 108-9). Learners eventually participate in the community of practice as full practitioners and construct identities in relationship to the community (Lave & Wenger, 1991). In contrast to thinking of learning as an individual activity, learning is seen as "increasing participation" in the community of practice (Lave & Wenger, 1991, p. 49).

Community involves relationships among people based on common endeavors "with some stability of involvement and attention to the ways that members relate to each other" (Rogoff, 2001, p. 10). A community of learners develops "cultural practices" and traditions that transcend the particular teachers and students involved and focus on members providing each other with support (Rogoff, 2001, p. 10). When students engage in a community of practice, they gradually acquire knowledge and skills and develop the identity of the community in the context of everyday classroom experiences. According to Barbara Rogoff (2001), educators should foster communities of practice because learning is in the relationships between people. She recommends that schools be places where learning activities are planned by students as well as teachers, instruction is build on students' interests and collaboration is a key component in planning learning activities (Rogoff, 2001).

Recent research and theory in the area of gender and technology suggests that providing girls with opportunities to be creators and leaders of technology can break down the barriers that cause issues of access and participation (AAUW, 2010; Dee, 2006). For girls to gain access to the wider society of the school and future career opportunities, they must master the language and culture of computer science. More opportunities for girls to practice computer skills, both in and outside school, are needed to help them move from novice to expert and to see themselves as an integral part of the "community" of computer programmers.

Cultural Perceptions Surrounding Technology

Schools can be agents of social change, not just reproduction. "People learn different sets and subsets of culture, and they can unlearn culture–shedding it as well as adopting it" (Erickson, 2001, p. 32). Making students comfortable in the culture of technology necessitates highlighting the human, social, and cultural dimensions of computer science and emphasizing individual relationships with technology regardless of eventual occupational goals. To encourage all students in the field of technology, computer science classes must present opportunities for students to work in a welcoming environment and offer new possibilities, broad expectations and flexible gender roles.

At the most basic level, culture is expressed by behavior, rules and customs in a specific context. Culture shapes and is shaped by the learning and teaching that happen during the practical conduct of daily life (Erickson, 2001). The experiences that learners bring to the classroom, the ways they interpret their learning experiences and the knowledge, skills, and attitudes with which they leave the classroom greatly vary.

How are perceptions and misperceptions formed and how do they influence students' decisions? The current cultural perceptions surrounding technology subtly reinforce the stereotypes that males are naturally more computer-oriented and what constitutes acceptable "male" and "female" activities (Margolis & Fisher, 2002; De Bare, 1996-a). The media image of a programmer as a super-smart, white male hacker is especially discouraging and repelling to female students (Margolis & Fisher, 2002). When a school's social-historical patterns of identity sanction an imbalanced enrollment in computer classes, girls perceive the message that computers are not for them (De Bare, 1996-a). Within the school, local patterns of identity establish the social identities and behaviors available for girls and discourage participation in computer science classes (De Bare, 1996-a).

The roots of the high-tech gender gap are deep and reflect the cultural conceptions of gender. In seeking ways to shift the prevailing culture surrounding computer classes, the reproductive aspect of culture becomes visible. In addition to gender differences in attitudes to computing, everyone, including students, have different expectations regarding computer-related abilities (De Bare, 1996-a). Although counter to the general academic performance of adolescents, boys are expected to do better than girls in computer science courses (De Bare, 1996-a).

The study of computer science education can be seen as a "microcosm of how a realm of power can be claimed by one group of people, relegating others to outsiders" (Margolis & Fisher, 2002, p. 6). From their early experiences with computers, boys create human and cultural capital at a young age (Bourdieu & Passeron, 1977). Girls tend to develop social skills sooner and do not turn to the computer as a silent friend like boys (De Bare, 1996-a). Computer games are considered a gateway to computer literacy (De Bare, 1996-b). With violent characters, sports themes, and sexual content, computer software is not gender-neutral.

Gender as a Significant Dimension in the Classroom

In *Changing the Educational Landscape: Philosophy, Women, and Curricula*, Martin (1994) identified "gender as a significant dimension in classrooms" (p. 106). Martin supported a "gender-sensitive ideal, one which takes sex or gender into account when it makes a difference or ignores it when it does not" (Martin, 1994, p. 83).
A gender-sensitive ideal allows educators to create curricula, instructional methods and learning environments that support all students, boys as well as girls (Martin, 1994). Her early insight into the absence of discussion by and about women in education has influenced many scholars.

The historical, sociological, and legal perspectives of gender equity encompass the early exclusion of women from all-male schools and the future "vision of gender equality based purely on equal treatment and equal access and assimilation" (Salomone, 2003, p. 2). The unequal schooling that existed resulted in unequal power, income and prestige among adult men and women.

Although gender equity has historically been viewed in terms of remedies for improving girls' achievement and opportunities, more recently, some scholars have focused on girls and boys (Datnow & Hubbard, 2002). In *We've Come a Long Way-Maybe: New Challenges for Gender Equity in Education*, Spencer, Porche, and Tolman (2003) describe a research study that examines the relationship between school-wide gender equity efforts and seventh grade girls' and boys' educational outcomes and psychological functioning. Despite school-wide efforts to use gender-fair curricular materials, to address issues of power and social justice and to offer professional development activities for staff in gender equity practices, the researchers' findings indicate a contradiction between their qualitative (classroom observations and interviews) and quantitative (survey) analysis. Although the students perceive teacher fairness along the lines of gender, the researchers note different classroom treatment for boys and girls. As the students interact with their teachers and peers, these differences are reproduced and seem inevitable, natural, and freely chosen. The students perceive the different behaviors and treatment in the classroom as equitable because of their beliefs about the nature of girls and boys, i.e., their gender ideologies. "Unchallenged gender ideologies can undermine efforts aimed at diminishing differential treatment, behavior, and opportunities based on gender by rendering what is unfair to seem necessary, natural and normal" (Spencer, Porche, & Tolman, 2003, p. 1801).

As the study demonstrates, boys and girls experience different worlds in the classroom. Often a small number of boys dominate classroom time, while girls sit patiently and passively becoming less visible each day (Sadker & Sadker, 1994). While boys get the most attention from their teachers, girls become less active, assertive, and visible in class as they approach adolescence (Sadker & Sadker, 1994). Girls' lower confidence levels about their abilities are a consistent finding in many studies (De Bare, 2004; Sadker & Sadker, 1994). By the time they reach adolescence, girls' self-assessment of their math abilities are independent of their actual performance. For adolescent girls, self-esteem is linked more to confidence in their physical appearance than it is to their academic ability (DeBare, 2004; Orenstein, 1994).

Since the American Association of University Women's (AAUW) landmark study in 1991, *How Schools Shortchange Girls*, girls have made great strides and surpassed the achievement of their male counterparts. The AAUW drew attention to the gender gap in science and mathematics and continues to encourage the implementation of policies and programs to support girls in these fields (AAUW, 2010; AAUW, 2008; AAUW, 2000; AAUW, 1998; AAUW, 1991).

Educational Equity and Social Justice

How can schools ensure that all children acquire the qualities and skills that will enable them to contribute meaningfully to society? Are schools shortchanging girls or boys? Educational systems serve as a window into a society's organization and change as society's collective values change. The current direction in U.S. educational practice and policy focuses overwhelmingly on academic achievement, specifically as measured by standardized achievement tests. The latest federal legislation, No Child Left Behind (NCLB), is focused on accountability for results. Educators, facing enormous pressure to show improved test scores each year, look to such important variables as the curricula, pedagogy or the classroom teacher to meet the needs and to create equitable opportunities for all students (Campbell & Sander, 2002, p. 33).

Teachers make many choices each day about how the learning environment will be structured and what curricula will be emphasized. Culturally responsive teachers recognize that the curricular and instructional decisions they make impact students' attitudes and constructions of self. More than just a physical setting with desks, bulletin boards and posters, the classroom environment also communicates subtle messages about what is valued in learning. When teachers acknowledge issues of gender in their lessons, they reframe traditional curricula and demonstrate that there is no single version of truth. Additionally, teachers' expectations play an important role in a student's achievement and self-perception.

Students within the same school often have different educational experiences. Because of the variation in backgrounds that students bring into the classroom, schools often reproduce inequities in society (Arum & Beattie, 2000; Stanton-Salazar, 1997). Equity issues related to the organization of schools and pedagogy continue to impact on the education system and to contribute to the existing gender imbalance in computer science classrooms. Efforts to close the gap require a critical look at all the conditions of learning. Those efforts must center on the fundamental elements that can act as catalysts for classrooms where all students are successful. Schools must acknowledge the different starting points and learning preferences of their students, and reorganize themselves to support a more student-centered approach (Darling-Hammond, 1997). Teachers need to develop teaching strategies and practices that address the needs of all students. Although the achievement gaps between boys and girls are closing in some STEM areas, girls' achievement still lags behind boys' in computer science (AAUW, 2000). There is also concern that gender equity solutions have reached girls of different ethnic groups unequally (Datnow & Hubbard, 2002).

Public schools are thought to be the central institution in our society for distributing opportunities (Strike, 1981, p. 219). Many gender inequalities exist and persist despite federally mandated legislation because of the stronghold of gender ideologies—the organizing framework for what is considered normative behaviors and practices in society. Gender bias is now seen as affecting both girls and boys, because neither group is immune to societal pressures and expectations. Reform efforts are thus more complex than simply eliminating sexist language or curricula, but rather require educators to strive to implement alternative pedagogies that challenge the unequal power relations inherent in traditional education and society (Murphy & Gibbs, 1996, in Datnow & Hubbard, 2002).

Researcher Barrie Thorne (1993) suggests that we "start with a sense of the whole rather than with an assumption of gender as separation and difference" and examine gender in context (p. 143). Although our educational system encourages and supports girls' achievement, girls receive contradictory messages from society, parents and teachers. Despite emphasis on equality for women, negative attitudes towards successful women exist. Men's success is more likely to be seen as the result of high ability and women's success as the result of luck or hard work (Orenstein, 1994).

It is not simply an issue of boys being misunderstood or girls being ignored in coeducational classrooms. Without a strong sense of self, boys and girls will "enter adulthood at a deficit: they will be less able to fulfill their potential, less willing to take on challenges, [and] less willing to defy tradition in their career choices…" (Orenstein, 1994, p. xxviii). The aim of education is to enable every child "to discover that corner of the field of knowledge they can call their own" (Sax, p. 113). Our present educational system is not doing very well in this regard. If the ultimate goal of education is to develop each student's full potential by accommodating individual needs, then school structure and pedagogy can alleviate the negative effects of the gender gap and improve educational opportunities and outcomes for all students.

Case Studies of Gender and Technology in Schools

Gender research in computer science claims that software and computers are not created and used on neutral ground, but rather under the influence of social assumptions (Schelhowe, 2006). Increasingly, technology is being constructed as a predominately male domain. For the American Association of University Women study (2000), *Tech Savvy: Educating Girls in the New Computer Age*, researchers gathered data from 900 teachers and 700 middle and high school girls. Their findings confirm that girls view a computer person as "male and antisocial" (AAUW, 2000, p. 2). They report that girls wish to change the computer culture, rather than change for it. The general acceptance of these views exists even at the middle school level (AAUW, 2000). The stereotype that computing is a solitary and antisocial activity discourages girls from participating in computer science classes (Camp, 1997).

Research studies in computer science consistently identify three factors that influence girls' persistence in computer science: gendered-biased classroom practices, self-esteem and prior experience with computers. According to the research findings of Garvin-Doxas and Barker (2004), *Communication in Computer Science Classrooms: Understanding Defensive Climates as a Means of Creating Supportive Behaviors,* computer science and technology are cultural structures that treat women and girls unfairly. Their research attributes the differences in achievement between genders to gender-biased classroom practices (Garvin-Doxas & Barker, 2004). Their findings echo the work of Sadker and Sadker (1994) in *Failing at fairness: How our schools cheat girls*. According to Sadker and Sadker (1994), while boys demand attention from their teachers, girls become less active, assertive and visible in class as they approach adolescence.

Similarly, a study conducted by Margaret West and Susan Ross (2002), *Retaining females in computer science: A new look at a persistent problem*, investigated classroom practices in undergraduate computer science classes. The researchers explored the significance of certain classroom events and interactions to the college female students in the university computer science program. The findings indicated that there was evidence that "gender bias still exists in the male-dominated computer science classrooms" (West & Ross, 2002, p. 3).

> The male environment in computer science is still perceived as cold and unresponsive to female students. Female students hesitate to ask questions in the male-dominated classes, and especially of male computer science teachers. Both learning and self-esteem are affected by these constraints, and these contribute to the attrition of females (West & Ross, 2002, p. 5).

Girls' lower confidence levels about their abilities in mathematics are a consistent finding in many studies (Sadker & Sadker, 1994). By the time they reach adolescence, girls' self-assessment of their math abilities are independent of their actual performance. For adolescent girls, self-esteem is linked more to confidence in their physical appearance than it is to their academic ability (Crawford, 2006). Computer science skills are often associated with mathematical skills because both depend on logical and sequential thinking abilities. However, in the West and Ross (2002) study, the connection between computer science and mathematics did not emerge. Excluding the concept of a variable, the female students did not relate programming concepts to mathematical concepts. Understanding or difficulty in understanding the programming concept was "directly related to the respondent's being able to connect it to something already familiar in her everyday experience" (West & Ross, 2002, p. 5). The researchers suggest that "since the females in this study did not relate the majority of computer science topics to any mathematical concepts, perhaps formal mathematical methods are not appropriate in teaching female student in beginning computer programming courses" (West & Ross, 2002, p. 5).

However, Ken Yasuhara (2005) suggests in his study, *Choosing Computer Science: Women at the Start of the Undergraduate Pipeline*, that the tendency of students to miss the significance of mathematics in Computer Science might represent an untapped opportunity to recruit more women. His findings suggest that computer science might become more accessible to a wider audience if introductory courses purposefully emphasize and support the transfer of logical and sequential thinking skills between mathematics and computer science.

In Garden State High School, mathematics and science have consistently achieved gender parity in all classes, except AP and Honors Physics (see Appendixes B, C and D). Similarly, female students in Israeli high schools comprise the majority of students in mathematics, biology and chemistry classes (Vilner & Zur, 2006). However, in computer science classes the situation is quite different (Vilner & Zur, 2006). As part of their research, Tamar Vilner and Ela Zur (2006) conducted a meta-analysis of existing studies to identify reasons why women avoid studying computer science. The studies suggest certain problems that women encounter: (a) Computer science courses have the reputation for being boring and not giving students creative freedom, (b) before entering college, women have significantly less hands-on experience with computing than most men, (c) computer science students suffer from the "nerd" image, and (d) women do not receive the same level of support as men for entering and persisting in the computer science field. The research suggests the need to include more hands-on experiences in the introductory computer science classes to close the initial technical gap that exists between girls and boys.

In *Unlocking the Clubhouse*, Jane Margolis and Allan Fisher (2002) examine the many influences contributing to the gender gap in computer science. Based on classroom observations and interviews with more than 100 computer science students from Carnegie Mellon University, the research demonstrates that "high school computer science can be critical for introducing girls to computer science" (Margolis & Fisher, 2002, p. 47). For one-third of the girls in the study, the high school programming course became the deciding factor in their decisions to major in computer science. For boys, the interest in computer science occurred much earlier, usually at home and with friends (Margolis & Fisher, 2002).

The research of Margolis and Fisher (2002) indicate that the gender gap in the confidence levels of male and females in computer science results from differences in prior experiences with computers. Girls feel inadequate compared to boys, which effects their self-esteem and confidence. Unlike boys who "play" with computers from a young age and see the computer as the "ultimate toy," girls develop an interest in computers over a period of time in a purposeful context (Fisher, et al., n.d.).

Similarly, Alice A. Christie's research highlights the computer experience gap between girls and boys. Christie (2005) visited middle school classrooms to investigate the meanings that adolescents assign to computers as they interacted with them. Her year-long study of seventh and eighth grade girls and boys, *How Adolescent Boys and Girls View Today's Computer Culture*, found that girls and boys viewed and used computers differently. "The gender differences surrounding technology are not differences in competence, confidence, or frequency of use" (Christie, 2005, p. 11). Christie (2005) found that girls used computers to communicate with others, to complete homework and to organize ideas and information, where boys used computers to compete with others, for entertainment and game, and to gather information. Each gender seemed to accept this as a natural part of its culture, and, in general, was accepting of each other's visions and uses" (p. 7).

It is well documented that women are attracted to computer courses that emphasize social issues and computer applications (West & Ross, 2002). Christie (2005) believes that "it is imperative that girls are welcomed into the *computer clubhouse* starting when they are infants in the home, then in preschool, then in elementary school, and so on. If we wait until girls are in high school, we are too late" (p. 12). The implications for classroom practice include honoring each gender's ways of viewing and existing within the computer culture and raising the teachers' consciousness about issues surrounding girls and computers (Christie, 2005).

Additional implications for classroom practice were suggested from the research of Linda Werner, Brian Hanks and Charlie McDowell. In *Pair-Programming Helps Female Computer Science Student*s, the researchers found that students who pair in their introductory computer programming courses are more confident, have greater course completion and pass rates, and are more likely to persist in computer-related majors (Werner, Hanks, & McDowell, 2005).

Pair-programming is a process involving two collaborators using a single computer. One of the programmers, the “driver,” controls the keyboard and mouse and is responsible for entering program code. The second programmer, the “navigator,” sits next to the driver and watches for errors, discusses alternative design approaches and offers suggestions. The programmers regularly trade roles to ensure that the pair collectively *own* the code. Traditional classroom practices in introductory classes generally require that students work individually on their programming assignments. Collaborative methods are often used in higher-level computer science classes where group projects are encouraged. Research findings indicated that more female students who pair-programmed performed better on the individual final exam and enrolled in subsequent programming class than solo female programmers (Werner, Hanks, & McDowell, 2005). As a second measure of the success of pair-programming, paired female students were more likely to declare a Computer Science-related major one year after completing the introductory computer class.

Pairing is particularly beneficial to female students because it addresses several significant factors that limit women’s participation in computer science: (a) the widely held perception that a career in computing is not well-rounded or conducive to family life, (b) the belief that work in the technology field is conducted in a competitive rather than collaborative environment, and (c) the perception of a computer scientist as a solitary occupation that is not well integrated into social discourse or social institutions (Werner, Hanks, & McDowell, 2005). Promising results from three studies regarding the use of pair-programming suggests that pairing could address the reasons why fewer women major in computer science.

Research findings suggest that pair-programming is beneficial to all students. Students who paired where more likely to declare a computer science-related major than those who worked individually: 59.5% versus 22.2% for females and 74% versus 47.2% for males (Werner, Hanks, & McDowell, 2005). Additionally, students who paired reported significantly higher confidence in their program solution than students who worked independently: 86.8% versus 63.0% for females and 90.3% versus 74.6% for males (Werner, Hanks, & McDowell, 2005). Gender of the student's partner was unrelated to the confidence level of that student. It seems that pairing has a greater effect on confidence levels of females and therefore may have a positive effect on the gender gap.

Similarly, researchers found that interventions aimed at changing behavior in technology classrooms must be consistent with principles of student-centered learning and collaborative group learning. A student-centered learning environment allows the learners to be active, to raise questions, to generate hypotheses, to test their own ideas and to construct their own meaning while the teacher takes a less active role. In *Interventions for Promoting Gender Equitable Technology Use in Classrooms*, Melinda Bravo, Lucia Albino Gilbert and Lisa K. Kearney (2003) describe interventions for breaking stereotypes surrounding the use of technology and fostering gender-fair collaboration between girls and boys in the classroom. Peer group interactions are particularly influential in perpetuating gender stereotypes, such as the belief that a person who likes computers is male and antisocial. The interventions, including carefully structured skits and collaborative learning exercises, were designed to engage the students in interactive activities that challenged conventional views about technology and allowed "girls to experience themselves as creators of technology and leaders in technology areas" (Bravo, Gilbert & Kearney, 2003, p. 97). The skits provided opportunities for the students to take on the roles, assume the characteristics and develop the perspectives of both sexes. After the interventions, the classroom teacher noted a change in the ways that girls participated in the classroom and a shift in gender awareness in her own teaching methods (Bravo, Gilbert & Kearney, 2003).

Marian Sackrowitz and Ann Parelius (1996) focused their study, *An Unlevel Playing Field: Women in the Introductory Computer Science Courses*, on introductory computer classes at Rutgers and Princeton Universities. Their research findings reveal that female students entered the introductory courses with weaker computer skills and less involvement with computers than their male peers. Since final grades in the courses were strongly dependent on incoming programming skill levels, high achievement in the course was very difficult without prior programming knowledge. Although introductory courses do not have prerequisites, the courses move quickly through the fundamental principles of programming. The fast pace is difficult for students encountering the concepts for the first time and causes some students to receive mediocre grades and to become discouraged with their ability in computer science. The research results imply that adjustments in pace and structure of high school and college level introductory computer science classes are needed "to ensure that a student with an aptitude for computer science but little computer science background can have a reasonable chance for success" (Sackrowitz & Parelius, 1996).

When researchers Ginger Rowell, Diane Perhac, et al. (2003) surveyed college students regarding interest and enjoyment of both using a computer and computer programming, their research findings underscored the important role that teachers play in recruiting students to computer programming (Rowell, Perhac, et al., 2003). Although students indicated their interest in *using a computer* was primarily influenced by family and friends, they identified their teachers as the primary influence on their interest in computer programming. "The challenge for teachers is to transfer students' interest and enjoyment of using computers for entertainment and intellectual purposes into an interest that would make capable students more likely to major in computer science" (Rowell, Perhac, et al., 2003, p. 57).

According to researchers Aura Paloheimo and Jenni Stenman, students fare better in their computer studies if their comfort level is high. One of the factors in defining comfort level is how comfortable students are in presenting questions to other students and their teachers. In *Gender, Communication and Comfort Level in Higher Level Computer Science Education,* Paloheimo and Stenman (2006) suggest that both male and female students would benefit if more women studied computer science. Their study focuses on the beginning of studies, which is essential, since it has been noted in previous studies that the critical period when women drop out of the natural science and engineering pipeline is before choosing a university major (Paloheimo & Stenman, 2006). Their findings reveal that the typical gender distribution (majority male) in computer science classes lowers the comfort level of all students in comparison to the case with an even gender distribution. In even gender distribution classes, both female and male students were comfortable with asking for help from each other or from the teacher. In the typical unbalanced class of one or two female students, the male students refrained from asking questions from the teacher and conversing with peers (Paloheimo & Stenman, 2006). Additionally, Paloheimo and Stenman (2006) suggest that support for girls in computer science should be focused during the age period before girls make a decision that will affect their possibilities to choose Computer Science as a course of study.

Case Studies of Gender and Technology in Schools Summary

Although the research studies vary in multiple respects, there are patterns of agreement among the findings that influence girls' persistence in computer science. The well-known study of Margolis and Fisher (2002), *Unlocking the Clubhouse: Women in Computing*, identifies issues of self-confidence, teaching and social influence as significant factors that impact persistence. Self-confidence is a critical factor in persistence in computer science. In many of the research studies, achievement in entry-level courses was found to correlate with prior experience and self-confidence (Paloheimo & Stenmen, 2006; Margolis & Fisher, 2002; Vilner & Zur, 2006; Sachrowitz & Parelius, 1996). Sachrowitz and Parelius (1996) and Vilner and Zur (2006) found that female students entered introductory courses with weaker computer skills and less involvement with computers than their male peers. Additionally, West and Ross

(2002) found that girls did not relate programming concepts to mathematical concepts. However, Ken Yasuhara (2003) suggests that a more established and standardized high school mathematics curricula results in more uniform preparation for undergraduate study in computer science.

Teachers play important roles in influencing persistence in computer science for female students. According to Garvin-Doxas and Barker (2004), gender-biased teaching practices influence girls' self-confidence. Vilner and Zur (2006) suggest that more hands-on experiences in introductory computer science classes could close the initial technical gap that exists between girls and boys. Bravo, Gilbert and Kearney (2003) recommend that changes in instructional methods in technology classrooms include principles of student-centered learning and collaborative group learning. Werner, Hanks and McDowell found that classroom practices that include pair-programming support all students' confidence, completion and pass rates, and persistence in computer-related majors. Additionally, they identified the widely-held perception of computer programming as a solitary activity as a factor in limiting girls' participation.

The case study findings offer various explanations for women's under-representation in the field of computer science. The explanations include gender-biased classroom practices, differences in girls and boys prior experiences with computers, issues of self-esteem and self-confidence in mathematics, and differences in how girls and boys view and use computers (Garvin-Doxas & Barker, 2004; Vilner & Zur, 2006; West & Ross, 2002; Christie, 2005; Margolis & Fisher, 2002).

The literature suggests employing *liberal feminist approaches* to remedy the gender gap in computer science. These approaches ensure that girls and boys have equal access to learning opportunities, encourage the development of autonomy among girls and support the girls' and boys' capacity to choose roles and lifestyles rather than being forced to accept traditionally-defined ones. Suggested classroom remedies include incorporating gender-fair classroom practices, integrating collaborative group learning experiences, encouraging hands-on experiences, adjusting the pace and structure of introductory computer science classes so that students with little background can have a reasonable chance for success and supporting a connection between computer science and mathematical thinking and concepts (Garvin-Doxie & Barker, 2004; Bravo, Gilbert, & Kearney, 2003; Werner, Hanks, & McDowell, 2005; Yasuhara, 2005; Sackrowitz & Parelius, 1996).

Although the literature suggests ways to remedy the gender gap and identifies relevant factors for examination, it reveals little research attention to the gender imbalance in high school computer science classes. To truly comprehend and resolve the gender gap in high school computer science classes, it is necessary to employ *situated approaches*. These approaches include investigating the context and culture of the entry-level computer science class by visiting the classroom, meeting the students and the teacher, and observing the classroom dynamics. Additionally, the examination of how gendered opportunities are structured through the curriculum and pedagogy and the existing classroom accommodations for students entering with different levels of knowledge and experience is essential for understanding and identifying the barriers, explicit or implicit, to girls' participation in advanced computer science classes. While visiting the Web Design 1 class, I observed various instructional approaches, including hands-on activities, opportunities for creative freedom and collaboration, and adjustments in the pace of the learning to meet individual student's needs. Contrary to research findings, the student and teacher participants in this study identified a significant connection between ability in mathematics and success in computer science.

CHAPTER III: METHODOLOGY

As discussed in Chapter One, the purpose of this research study was to examine the factors that influence girls' persistence in high school computer science classes and to investigate what opportunities exist for boys and girls to construct the identity of a computer scientist in entry-level computer science classes. The following questions were the focus of this inquiry:

What factors can help explain why so few girls enroll in the advanced computer science classes at Garden State High School?

a. How do the existing structure, pedagogy and culture of the entry-level computer science class at Garden State High School encourage or discourage girls' and boys' interest, enrollment and persistence in the advanced computer science classes?

b. How do girls and boys perceive their experiences in the entry-level computer science class at Garden State High School?

c. What kinds of opportunities occur in the entry-level computer science class at Garden State High School to foster the construction of the identity of a computer scientist for girls and boys?

d. How do perceptions of Computer Science as a discipline influence high school girls' interest and enrollment in advanced computer science classes?

The study was grounded in the realities of my educational practice and experiences. My decision to use qualitative research methodology was prompted by the desire to research a situation in its natural setting and to understand the situation in terms of the meaning and experiences of the students and the teacher involved. The structure of a case study - the problem, the context, the issues and the lessons learned – seemed to be the most appropriate qualitative model for my study (Marshall & Rossman, 2006). By focusing on the present gender gap in the high school entry-level computer science classes, my goal was to formulate and implement action strategies to promote the futures of girls and boys in technology.

A case study is "an exploration of a 'bounded system' or a case over time through detailed, in-depth data collection involving multiple sources of information rich in context" (Cresswell, 1998, p. 61). In Spring 2010, one Web Design 1 class was offered at Garden State High School. The semester-long, computer science class formed a "bounded system" (Cresswell, 1998, p. 61). In keeping with a case study design, the data included documents, classroom observations and formal and informal interviews (see Appendix A). I devoted extensive time to collecting data through multiple sources of information: conducting seventeen classroom observations during the semester, reviewing student work and interviewing teachers, focal students and guidance counselors. At the completion of the semester, I conducted two structured focus groups; one with the girls and one with the boys.

The Setting

Case studies describe the setting with detail that is not typically present in more analytic reporting formats (Marshall & Rossman, 2006). This study was conducted at Garden State High School, a grade 9-12 school, in a quaint town in New Jersey. The "bedroom community" has a population of approximately 23,000 and encompasses five square miles. Many Victorian homes are set along the river that winds through the town. Three beautiful parks provide areas for recreation and relaxation. There is a small commercial district in the center of town and a large business park located at the southeast corner of the township. The school district is designated in an "I" District Factor Group reflecting the upper middle class socio-economic level of the residents.

The District Factor Groups represent an approximate measure of a community's relative socioeconomic status (SES). School districts in New Jersey are categorized into District Factor Groups, which describe the socioeconomic characteristics of the local district. From lowest socioeconomic status to highest, the categories are A, B, CD, DE, FG, GH, I and J. The classification system provides a useful tool for examining student achievement and comparing similarly-situated school districts (New Jersey Department of Education, 2010).

Built in 1939, the Garden State High School is an impressive four story building located on 12 acres. The school environment is safe and orderly. Students' scores on standardized achievement tests are above the county and state mean. Low absenteeism and turnover rate among both the students and staff indicate a stable school community. The student population is quite homogeneous with 91% of the 1139 students Caucasian, 5% African-American, 3% Hispanic and 1% Asian. The school enjoys a reputation for excellence in academic and athletic endeavors. The award winning high school offers 26 Advanced Placement classes in addition to many honors and college-preparatory classes. The faculty contributes to the scholastic environment with over 40% of the staff holding post-baccalaureate degrees. With over 70 extra-curricular clubs, the school strives to meet the needs and interests of all students.

Gender equity at Garden State High School is vital to the development of the full potential of both females and male students. Although female students comprise the majority in many Advanced Placement and honors classes, data clearly show that female students are underrepresented in computer science and applied technology classes and traditionally male-dominated elective classes (see Appendixes B, C, D and E). Females rarely enroll in advanced computer classes, spend time in the computer labs after school or participate in maintaining the school website.

A major concern regarding technology use and enrollment in high schools is that all students are equally prepared and equally engaged. While Garden State High School girls are using the Internet for communication and the web for information retrieval, it is predominately the boys are who are programming the computers and designing the school website. During intervention events, like the "Celebration of Women in Technology," many girls expressed their unfamiliarity with the school computer science lab and shared that they had never entered the lab prior to the event.

The "boys' clubhouse" perception of the Garden State High School computer lab influences the cultural perceptions surrounding technology and the computer science classes (Margolis & Fisher, 2002, p. 4). One female teacher, Ms. Bennett, and one male teacher, Mr. Merrill (both pseudonyms), instruct all the computer science classes offered by the math department. The computer room is Mr. Merrill's home base and the domain of the Web Team members. Little interest or expertise in teaching computer science classes exists among the remaining female teachers in the math department.

The Sample

I became more deeply aware of the significant gender gap in computer science at Garden State High School while seeking a class for this study. Due to the declining enrollment of girls in the entry-level computer science classes, my choice was limited to one entry-level Web Design 1 class with the enrollment of two girls and fourteen boys. Working within these limitations, it was important to me to represent a variety of perspectives on the experience of being a student in a high school computer science class and to focus on the similarities and differences in the students' perspectives. Using enrollment data and teacher recommendation, I identified four students, two girls and two boys, as focus group participants.

While securing participation in the study, I encountered resistance from some parents. The parents were concerned that their children's participation in the study would require "extra work" and steal "valuable time" from an already filled-to-capacity schedule. One parent shared that her son declared, "I just can't do another thing." With so many Garden State High School students carrying rigorous course loads, participating in sports and extra-curricula activities, and holding part-time jobs, I reconsidered my original research plan and altered some of the components to accommodate the students' busy schedules. By reassuring the parents and the students that participation in the study would not result in additional class assignments and adjusting the scheduling of interviews with the focal students, I was able to secure the necessary permission for participation. My original plan culminated in one focus group at the end of the semester. However, to accommodate the students' demanding schedules, I conducted two focus groups; one with the girls and one with the boys.

I conducted this case study in accordance with the general ethical principles of qualitative research, as well as the procedures established by the Human Subjects Review Board (HSRB) at Rutgers University. I informed the students who elected to participate of the nature of their participation in the study, the intended use of the data collection, their rights to confidentiality and their option to leave the study at any time with no penalty to them. Additionally, I concealed identifying details that would jeopardize the participants' anonymity and confidentiality to minimize risk to the participants (Hatch, 2002).

Data Collection

Case studies rely on document analysis, interviewing and some form of observation for data collection with the aim of verifying findings (Marshall & Rossman, 2006). I devoted extensive time to collecting data through multiple sources of information (see Appendix A). In keeping with a case study design, the data include a survey, classroom observations, curriculum documents, formal and informal interviews, and two focus groups.

As part of the class procedure, I asked the students in the Web Design 1 class to complete a survey at the beginning of the course in February 2010 (see Appendix F). The survey established the context of the students' perceptions of computer science, previous experiences with computers and computer science classes, and their expectations of the Web Design 1 class.

Classroom observation, curriculum documents, and interviews were the primary data collection method. I conducted seventeen, forty-three minute classroom observations throughout the semester. I noted all aspects of classroom communication and formal and informal interactions between students and between teacher and student(s) in detail. The teacher, Ms. Bennett, and I met before or after each classroom observation to discuss different aspects of the class activities: the rationale for particular projects, her assessment of the students' understanding of the content or her interpretation of a classroom occurrence.

I interviewed the four focal student participants, Charles, Edward, Elizabeth and Jane (all pseudonyms), twice during the semester (see Appendix G). The first student interviews were conducted in person in March 2010 and focused on the participants' experiences in the computer science class and how their expectations compared with their experiences in the class. A protocol gave structure to the interviews; however I added and revised questions when necessary to probe for more detail and clarity (see Appendix G). I audio-taped and transcribed the interviews and emailed the transcription to the participants to verify accuracy and to clarify meaning where necessary.

I conducted the second interviews in April by email (see Appendix G). I asked the participants to share their thoughts and feelings regarding their overall experiences in the class, their recommendations for encouraging more girls to enroll in computer science classes at Garden State High School and their plans for scheduling future computer science classes at Garden State High School or at college.

Finally, I conducted two focus groups at the end of the semester, one with the girls and one with the boys, to provide an opportunity for the student participants to share their overall experiences in the class, their thoughts regarding computer science as a continued area of study or future career option and their opinions on why so few girls are enrolled in the Web Design 1 class (see Appendix I). I included direct quotations from the participants to provide richness and depth to the descriptions. Whenever possible, I used the participants' own words to explain their opinions and perspectives.

Similarly, I formally interviewed the classroom teacher, Ms. Bennett, twice during the semester (see Appendix H). In the interviews with the teacher, I explored how her experiences as a computer science student and prior work as a computer scientist influenced her teaching practice and how her expectations of teaching the computer science class compared with her lived experiences.

The students' and teacher's insights present the greatest potential for an original contribution by this study. Their interpretations and perspectives of their experiences in the Web Design 1 class are essential to understanding why girls are underrepresented in computer science classes at Garden State High School. Additionally, the interviews and focus group discussions with the students and the interviews with the teacher served as a means of clarifying and confirming the data collected through field notes of classroom observations and curricula artifacts.

Furthermore, I interviewed two Garden State High School guidance counselors, Ms. Hanson and Ms. Moore (both pseudonyms). After requesting and analyzing the enrollment data for all the elective courses at Garden State High School, I discovered a disparity in gender balance between the core academic subjects and the elective courses. While the enrollment in the core academic subjects verified gender balance, the enrollment in most elective courses revealed an imbalance along traditional gender lines (see Appendixes B, C, D and E). I asked the guidance counselors to share their perspectives on the gender imbalance in elective courses and to comment on the course selection and scheduling practices. Additionally, I interviewed the male computer science teacher, Mr. Merrill, to gain insight into the Web Design 1 curriculum theory and development. Mr. Merrill had established the foundational skill set for the course at its inception and he continually collaborates with the Ms. Bennett to ensure that the curriculum reflects the changes and upgrades in the available technology.

Table 1 – *Timeline for the Research Study*

December 2009-February 2010	Recruitment of the participants Discussion of the Web Design 1 curriculum with the teacher
February 1, 2010	First Web Design 1 class of the spring semester Completion of the survey by the Web Design 1 students
March 2010	First interview with the focal students First interview with the teacher
April 2010	Second interview with the focal students
May 2010	Interview with the two Guidance Counselors Interview with the male Computer Science teacher
June 2010	Two focus groups conducted Second interview with the teacher

Data Analysis

Data analysis is a systematic search for meaning. All qualitative research is characterized by an emphasis on inductive rather than deductive information processing (Hatch, 2002). Inductive analysis begins with an examination of the particulars within data and moves to looking for patterns across individual observations (Hatch 2002).

Decisions regarding interview questions and scheduling classroom observations evolved from the data analysis. To construct a comprehensive account of classroom action, I incorporated my fieldnotes into the classroom observation transcripts. Following this system allowed me to capture both the conversation and the action within the classroom. Consistent with a case study design, the data include a survey, classroom observations, formal and informal interviews, and two focus groups. The interviews and focus groups provided insight into the participants' thoughts, opinions and perspectives and proved to be a rich source of data. Additionally, I reviewed many documents and artifacts including curriculum guides, student work, student handbooks and program of studies booklets.

To begin the process of analyzing the large volume of data generated from the surveys, transcripts, fieldnotes and documents, I read and reread my entire data set to gain a general sense of what I collected. I wrote notes, reflective memos, thoughts and insights to generate some categories and themes. Next, I sorted and coded the data into manageable segments to discover patterns. I began the process of grouping and sorting by highlighting data that fit into a specific category, i.e., collaboration, instructional methods, prior knowledge and experience with computers and perceived or realized math ability. However, as I read and reread the data, I identified new categories, renamed categories and collapsed two or three categories into one. For example, my original categories of instructional methods, classroom rules and procedures, interaction between the teacher and student(s) and interaction among students were collapsed into one general category of classroom experiences. In this manner, I identified general categories from the patterns that were later combined to narrower themes and perspectives (Marshall & Rossman, 2006). Six major themes emerged from the data: course curriculum, classroom experiences, prior knowledge and experience with computers, teacher beliefs and attitudes, perceived or realized ability in mathematics and culture surrounding technology at Garden State High School.

The iterative process of reading, rereading, grouping and regrouping the data was challenging and sometimes overwhelming because it involved constantly comparing and contrasting various segments to categorize and to re-categorize them. From the analysis of the data, I developed generalizations that linked my findings to the research questions. Finally, I selected and organized the different data sources that led to the same conclusion to support my finding presented by research question in Chapter Five.

The data analysis for this study began with the first collection of data, continued throughout the study and the writing process, and essentially shaped the direction of the study. Good research often raises more questions than it answers (Marshall & Rossman, 2006). My study led to two additional research questions and the discovery of institutional factors that influence students' interest, enrollment and persistence in computer science classes at the school. My original plan did not include interviewing guidance counselors. However, after reviewing the enrollment statistics in the elective courses and noticing the gender disparity between core academic courses and elective courses, I recognized the value of the guidance counselors' insights and opinions of this phenomenon and the need to investigate course selection and scheduling practices (see Appendixes B, C, D and E). The process of data analysis revealed the complex nature of the gender imbalance in the introductory-level high school computer science class at Garden State High School and provided a new understanding and insight into the gender pattern in course selection at the school.

Validity

Case studies require extensive verification. I employed five verification procedures to establish the strength and credibility of this study: (1) prolonged engagement and persistent observation, (2) rich, thick description, (3) triangulation, (4) member checking, and (5) researcher reflexivity (Cresswell, 1998).

I believe that this study satisfies the qualitative ideal of prolonged engagement and persistent observation. In an effort to reach a deep, comprehensive understanding of the how classroom activities and dynamics influenced the gender gap, I conducted seventeen classroom observations. The classroom observations, along with the student and teacher interviews and curricula documents, provided valuable information for rich descriptions and critical dialogue for direct quotations.

Triangulation, the act of bringing more than one source of data to corroborate, elaborate or illuminate a point, is an important indicator of quality research. I demonstrated the triangulation of information in this study by the use of multiple data-gathering methods. The many different sources of data and methods of data collection included curricula documents, student work, field notes, classroom observations, formal and informal interviews with students, teachers and guidance counselors and enrollment statistics.

A primary measure of credibility in this study was the participant's confirmation of results, a process known as member checking. I made every attempt to verify that I correctly understood each participant's meaning by repeating responses and asking for clarifications during conversations and interviews (Lincoln and Guba, 1985, p. 314 in Cresswell, 1998). Finally, I disclosed my personal beliefs, values and biases that could impact the study.

CHAPTER IV. CASE DESCRIPTION

This chapter is composed of a description of the Garden State High School's daily program and graduation requirements, selected curricular sequences, the Web Design 1 classroom setting, the demographics of the Web Design I class and the profiles of the focal students and the classroom teacher. The description, the demographics of the class and the profiles are intended to provide an opportunity for the reader to construct an image of the school and the classroom setting, to get to know the students and the teacher of the Web Design I class and to provide a context for understanding the students' and teacher's classroom experiences. The detailed description of this case and its setting is particularly important to guide the reader through the context of the case by situating it within its physical and social setting (Cresswell, 1998). Through direct quotations, I utilize the participants' voices to present their viewpoints on the issues of this case. The focal students' profiles are arranged in alphabetical order by their pseudonyms.

The School Setting

One of the aims of education must be to provide students with a broad picture of possibilities and to create an environment that is responsive to all learners. The seed for these possibilities can be presented in each classroom through student-centered curricula and instruction methods. A student-centered learning environment allows the learners to be active, to raise questions, to generate hypotheses, to test their own ideas and to construct their own meaning while the teacher takes a less active role. The learning activities must offer choice and be relevant to the students' individual needs, interests and aspirations. If the students fail to see themselves in the curriculum and the instruction, they most likely will fail to make the connection between school and their individual growth and development. This approach requires classroom strategies that keep students inspired about learning and motivated to seek deeper knowledge.

Personalized learning has been a long-standing initiative and guiding principle in the Garden State School District. Personalized learning is based on the idea that each student is unique. Engaging every student in a lesson depends on creating opportunities for each one to use the knowledge from the subject to increase his or her sense of competency within the class. Garden State High School teachers are encouraged to personalize learning by delivering relevant and meaningful curricula, incorporating varied instructional and assessment strategies and offering choice in assignments and working conditions to meet the needs and interests of all students. District efforts to encourage a student-centered learning environment are reflected in professional development opportunities and the teacher assessment process.

For example, a recent district-wide Professional Development Day was dedicated to providing opportunities for teachers to design activities based on their individual characteristics and needs or to select from various workshops facilitated by staff members. Individual teacher activities included opportunities to collaborate with colleagues and co-teachers and to investigate topics of interest, such as assessment development, brain-based teaching and differentiated instruction. The teacher-facilitated workshop titles reveal a focus on personalized learning: "Personalizing Literacy through Improved Assessment," "Personalization and Parent Communication," "Analyzing NJASK Data to Personalize Instruction," "Developing Personalized Learning Goals for Basic Skills Teacher" and "Personalizing Learning through Enrichment Cluster Development and Implementation."

Twenty-one Garden State District Goals clearly define how the Central Office and district administrators "continue to provide support for discussion, planning and focus in Personalized Learning" for staff, students and parents (District Goals, 2010-2011). All staff members are provided "professional development opportunities to explore, read and reflect on how personalized instruction and learning takes place in their classrooms and what can be done to increase it" (District Goal #4, 2010-2011). The Superintendent of Schools continues "to foster collaborative discussion with and among parents regarding Personalized Learning" (District Goal #2, 2010-2011). In an effort to personalize the learning of all students, parents are encouraged to "identify information and methodologies for getting student stories" to Garden State teachers and administrators (District Goal #2, 2010-2011).

Garden State High School students must fulfill credit, course and state testing requirements to earn a diploma. Course requirements include four years of English and Health/Physical Education, three years of Math, Science and Social Studies, two years of World Languages, one year courses in the Fine or Performing Arts and Career Education. Of the 140 credits required for graduation, 115 or the equivalent of 23 full year courses must be successfully completed in courses that are listed as "academic." Technology Literacy, consistent with the Core Curriculum Content Standards, is integrated throughout the curricula.

Garden State High School has an eight period day. In addition, some courses are offered during "zero" period. Courses offered during zero period begin at 7:30 a.m. and end at 8:13 a.m. The scheduling of courses during zero period allows for flexibility in students' and teachers' schedules. Students are required to schedule all eight periods of the school day. Tracking or ability grouping is used in some courses at the high school. The purpose of tracking is to somewhat narrow the range of individual differences so that academically talented students may move ahead at a faster pace and perhaps cover more material in greater depth. Likewise, some students benefit from a slower pace and material better suited to their abilities. Not all courses are tracked and tracking practices are reviewed yearly (GSHS Program of Studies, September 2009).

Garden State High School offers an extensive and varied program of co-curricular activities. There are over 60 activities that include choices in the following areas; school governance, honor societies, competitive clubs, publications, service-oriented groups, subject-related clubs and clubs that capitalize on leisure interests and hobbies. The diversity of the program attempts to guarantee every student the opportunity to participate outside of the classroom in an activity of interest to them. The co-curricular program subscribes to the overall school commitment to service-learning. All clubs are strongly encouraged to include a service component among the many activities in which they participate.

The Garden State High School students have a reputation with the faculty for exhibiting a passive and accepting nature in class and demonstrating a desire to “please the teacher.” While observing the class on Monday, March 1, 2010, I noted that the students were working on creating a phone keypad using a table. After a brief review of tables, Ms. Bennett asked, “Good so far? Any questions?” When no one asked a question, she said, “Alright, I know that you are going to have more questions. You are not asking them, so I will wait until you do.” I noted a similar response from students the following week. On Wednesday, March 10, 2010, Ms. Bennett was explaining the use of tables with Photoshop. She asked, "Any concerns? Questions? Thoughts? Ideas?" When the students did not respond, she said, "I think that you are saving some questions for later, you still may have some, and it's okay."

As part of the class procedure, Ms. Bennett signs a behavior contract with each student for a selected project during the semester. To add some structure and discipline while the students worked in teams on Project 4, the students and Ms. Bennett signed an agreement that set appropriate punishments if Ms. Bennett found them off-task. After the class, Ms. Bennett shared with me, "I'll be honest. I never had to go past the first offense." For the most part, the students are attentive, but passive, during classroom lectures and participate in classroom activities without issue.

Computer-Related Courses

Computer-related courses are offered by four departments: Applied Technology, Business, Fine Arts and Mathematics (see Appendixes J, K, L and M). The philosophy of offering computer-related courses in different departments is based on the focus and the function of the coursework and the expertise of the instructors and the supervisors of the departments. For example, the Applied Technology Department offers three courses in Computer Aided Drafting and Design (CADD) that are valuable for students who are interested in a career in the areas of interior design, art, architecture and all forms of engineering, construction and manufacturing. Additionally, the Applied Technology department provides four courses in Engineering. The two semester courses are Principles of Engineering and Pre-Engineering and Robotics 1 and the two full-year courses are Pre-Engineering and Robotics 2 and Advanced Pre-Engineering and Robotics (see Appendix J).

The Business Department offers hands-on experience learning Microsoft Office, including such programs as Microsoft PowerPoint, Microsoft Excel and Microsoft Access. Additionally, they offer Multimedia Publications and Presentations which is a course designed to give students a comprehensive understanding of multimedia applications using desktop publishing (see Appendix K). The Fine Art Department offers three courses in Graphic Arts. The Graphic Arts classes emphasize the use of the computer for design as a method of communication (see Appendix L).

The Math Department offers three courses in Web Design and two courses in Computer Programming: Web Design 1, Web Design 2, Web Team, Computer Programming and AP Computer Programming (see Appendix M). The semester Web Design courses are designed to develop skills in creating pages for publication on the Web. The full year Web Team class designs, maintains and updates the Garden State High School website on a daily basis. Students interested in joining the Web Team complete an application process before enrolling in the class. Admittance to this prestigious class is based on exemplary completion of the Web Design 1 and Web Design 2 classes and willingness to devote extensive time maintaining the school website. The Computer Programming class is a semester course that introduces the students to the fundamentals and logic of computer programming. The AP Computer Programming course follows the general outline suggested by the College Entrance Examination Board (CEEB). All the computer science classes offered by the math department are recognized as "academic courses" that fulfill graduation requirements.

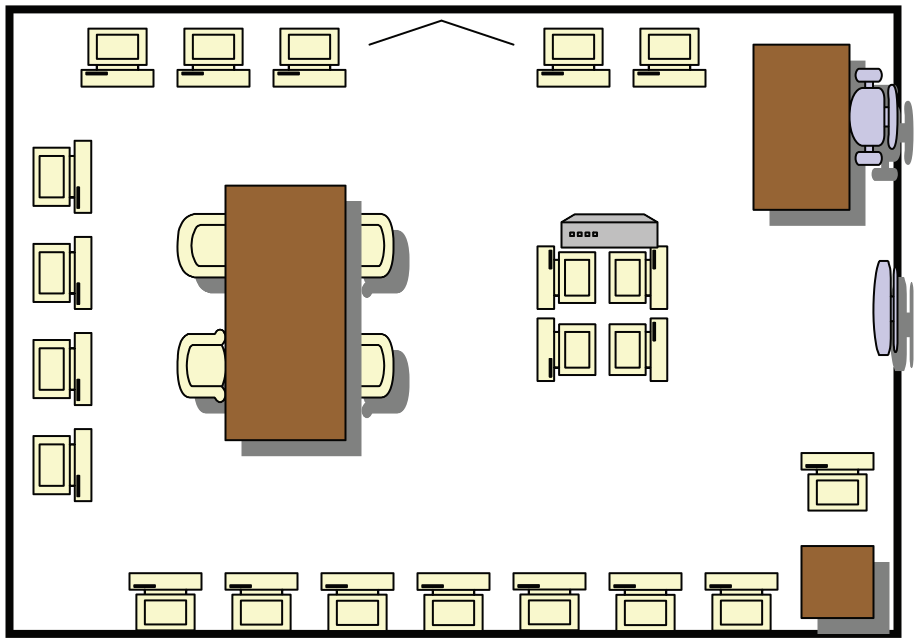
Although female students comprise the majority in most advanced math and science classes at Garden State High School, data clearly indicate that female students are underrepresented in the computer courses offered by the math department as well as computer courses in other departments (see Appendixes B, C, D and E). Females rarely enroll in high-level computer classes, spend time in the computer labs after school or participate in maintaining the school website. Although two math teachers, Ms. Bennett and Mr. Merrill, instruct all the computer science classes in the math department, the computer room is Mr. Merrill's home base and the domain of the web team members.

The Classroom Setting

The Web Design I class met in one of the five computer labs in Garden State High School. The large rectangular classroom, 30 feet by 22 feet, is located on the third floor of the school building at the intersection of two main hallways. The south wall of the room faces the front of the school building and contains a wall of windows. For most of the school day, the southern exposure brightens the room with natural light. There are seven student computer stations along the south wall, oriented toward the windows.

A double-door entry and five additional student stations are positioned opposite the wall of windows. A SmartBoard and projector are mounted on the center of the east wall, just beside the teacher computer station. Additionally, there is a teacher desk and a file cabinet flanking the SmartBoard and wall-mounted projector. Along the west wall of the room are four student computer stations. A large conference table, four additional student stations and a printer station share the space in the center of the room. The lab contains a total of twenty student computer stations and one teacher station. The rolling casters on the student chairs allow for easy seated movement. The students were assigned seats during the first week of the semester to provide easy and time-saving logons.

Figure 1 – *Floor plan of the Web Design I classroom*



The classroom was recently redecorated with new paint and floor tiles. The soft blue walls and blue-gray speckled floor tiles combine to produce a clean, calming and peaceful environment. More than just a physical setting with desks, bulletin boards and posters, the classroom environment also communicates subtle messages about what is valued in learning. The large and small posters adorning the walls of the classroom include messages intended to inspire, such as "Courage, Wisdom and Power" and messages intended to counsel, such as "Results and Responsibility, Not Excuses."

The Dell computers are approximately four years old and are programmed with many software applications, including Adobe CS3 and other Microsoft software packages. The initial logon process for the students can take up to four minutes because of the server's limited capabilities. The SmartBoard and overmount projector were newly installed last year.

The Web Design I Students

The enrollment in the Web Design I class continually changed from December 2009 though March 2010. In December 2009, I began the recruitment process by requesting a Web Design I class roster for the spring semester from the Guidance Department. With advice from guidance counselors, Ms. Moore and Ms. Hanson, and Web Design teachers, Ms. Bennett and Mr. Merrill, I identified four focal students, two female and two male, and mailed the appropriate informed consent letter to the homes of every student in the class. As the first day of class approached, student schedules were changed and the resulting Web Design I class roster did not include the two male students originally identified as focal students. Additionally, the enrollment continued to change during the first six weeks of the class due to various circumstances: schedule changes, student illness (school phobia) and transfer to another school.

From March 10, 2010 to the end of the semester, the Web Design 1 class enrollment stabilized to include sixteen students, two girls and fourteen boys. The class was comprised of two senior girls, Elizabeth and Jane, and five senior boys, five juniors, two sophomores and two freshmen. The Web Design I class was the first computer science experience for fourteen of the students. Two of the focal students, Charles and Edward, had enrolled in the Introduction to Computer Programming course during the fall semester. However, most of the students possessed some prior experience in applied technology classes. Six of the seven seniors, including the two female students, had completed a popular applied technology class at the high school, Graphic Arts 1. Three of the senior boys had continued their studies of graphics in Graphic Arts 2; and two senior boys had deepened their understanding of graphics in the Advanced Graphic Arts class. Only one senior boy, new to the district last year, had not completed an applied technology class at the high school.

In the survey, I asked the students to identify the types of activities they carried out on the computer. Nine of the sixteen students identified “looking up stuff” as their major use of the computer. Other uses of the computer included completing homework, playing games and listening to music. The students enjoy these activities and consider them a form of entertainment.

None of the students in the Web Design 1 class had taken a computer course outside of school. When asked if they had ever considered a career in computer science, seven of the male students had considered a career in game design, animated videos or computer repair. However, only two students, Charles and Edward, having enrolled in the Introduction to Computer Programming class during the fall semester, knew which courses were needed to be prepared for a college major and a career in computer science.

An interesting result of the survey relates to the stereotypes surrounding computer science. Approximately 64% of the students in the Web Design 1 class perceived computer science as a solitary activity. Researchers have found that this narrow image of computer science can be discouraging and could lead to decreased interest and persistence for girls (Margolis & Fisher, 2002). When Margolis and Fisher (2002) conducted 230 interviews with over 100 male and female students at Carnegie Mellon University, they found that two-thirds of the female students compared to one-third of the male students were alienated and resistant to the geek norms and solitary image of the computer culture.

Charles

> I try to learn from what the other students do in terms of HTML and design. I like when they offer constructive criticism of my work. When I offer comments on their work, I always try to say something in a positive way (Charles, 2010).

Charles was a senior in the Web Design 1 class at Garden State High School. He is a handsome young man with long blond hair and a tall, slim build. He was very involved in the school's Ice Hockey and Lacrosse teams, holding a key position on both. He had played hockey since the third grade and had some "great experiences." He was very proud to share with me that he had won a hockey tournament on the same rink that the Men's 1980 USA Olympic Hockey team won its gold medal. The two things that Charles cannot live without are his blackberry and his Jeep. His phone keeps him on schedule because he is a "very forgetful person." He finds texting a very easy way to communicate with his friends.

The Web Design 1 class was the second computer science course offered by the math department that Charles scheduled at Garden State High School. During the fall semester, he completed the Introductory to Computer Programming class. He believes that computers are "interesting in and of themselves" and that they are an important "tool to be used to get other things done." Charles uses the computer for "making videos, research and homework." He believes that working on computers takes "teamwork and interacting with people." When asked to describe someone who works in computer science, Charles was one of only two students in the class who identified the teacher, Ms. Bennett, as a computer scientist.

Charles identified his academic strengths as math and English. However, Charles did not schedule a math class during his senior year. Although three years of math is a graduation requirement at Garden State High School, it is customary for students to schedule four years of mathematics. Charles explained, "I took Computer Programming in the fall and I'm taking Web Design now. That is very much like problem solving."

Charles has decided to major in Computer Information Systems and specialize in Video Game Design in college "because of the rising job opportunities in the world involving computers." He explained, "Until my junior year, I wanted to be an accountant. But then I decided to go into computers." When I asked Charles if anyone had sparked his interest in computers, he identified his uncle as influencing his interest and choice of career. "My uncle is very good with computers. I thought it was interesting going over to his house, seeing his whole set-up and understanding how everything worked. He wanted to teach me [computer programming] when I was in 8th grade, but I couldn't get the grasp of it."

Ms. Bennett commented on Charles' recent interest in pursing a career in computer science and his work ethic. She believes that he will find his first year in college computer science classes very challenging because of his "late start" in learning code. However Ms. Bennett feels that a key factor in success is hard work and that "he is up to the challenge."

> Charles just realized that he wants to get into computers this year. I can see this being an area that he will do well in. His work ethic will keep him going. He may need support during his first year because it will be more challenging than he saw this year. He definitely would have had an advantage in college if he had taken AP Computer Science, but he has a certain level of maturity that is a little bit different than the other students. He is reflective and independent. He has been very diligent about completing his work during the semester. He checked in with me periodically to be sure that he was doing what was expected, and then he worked on his own or collaborated with other students. I'm glad that he did well his semester and he seemed to enjoy the course (Bennett, 2010).

Charles is not attending the college of his choice in the fall. However, he has gained a conditional acceptance to that college for the Spring 2011 semester if he maintains a 3.0 grade point average (GPA) during the fall semester. He plans to work diligently to meet that requirement.

Overall, Charles had a "positive experience" in the Web Design 1 class. He feels that he "learned a lot of basic skills and core knowledge for creating websites." As a result of his broader knowledge base, his interest in computer science has increased and he is motivated to continue in the computer world. In his words, "Now I'm getting ready to exceed the core."

Edward

> In Project 4, the students worked in pairs to create a website for an academic course of their choice. As part of the project requirements, the authors created a quiz for the viewers of the site. Edward was very interested in the Chemistry website presented by two of the boys in the class. He smiled and laughed throughout the presentation and answered every quiz question. I observed Edward's obvious enjoyment of the game-like quiz and pride in his knowledge of the Periodic Table of Elements. Similarly, Edward answered all the questions about kitchen safety asked after the Food and Nutrition presentation (Classroom Observation, April 29, 2010).

Edward was a junior in Web Design 1 class. A handsome young man with curly brown hair and glasses, Edward enjoys exploring the Internet, listening to music, reading, fishing, swimming and kayaking in his leisure time. He uses his iPod to download an eclectic collection of music from the public library. He said, "Most of the music is different styles of rock and metal. The oldest music on my iPod is Frank Sinatra."

Edward believes that working with computers is "fun" and allows students to be "creative." He uses his computer for schoolwork and games. He is not shy about bragging about himself. "I was in the Introduction to Computer Programming class during the fall semester. It was a lot of fun programming in the Alice program. I don't want to brag about my final project, a video game, but it was one of the coolest [in the class]." Edward has successfully completed three Pre-Engineering and Robotics classes at Garden State High School. Although the robotics software does not directly transfer into the web design class, Edward believes that his knowledge and experience with the software have fostered his confidence to "try new things."

Edward attributes his interest in computers to "playing a bunch of video games while in elementary school." He always "wanted to know how the games were created" and playing the games was something that he enjoyed. His first formal experience in computer science classes was in two required middle school courses: Computers and Applied Technology. When I asked Edward if the middle school computer-related classes had prepared him for his high school classes, he described the middle school Computer class as "just typing." However, he praised the Applied Technology class for including some programming skills with robotics and providing experience with the Alice program used in the high school computer programming course.

Edward believes that he is a "strong student" in his math, computer science and applied technology classes. He identified his strength as "helping others" in these class. Ms. Bennett confirmed Edward's appraisal of his computer skills and praised his consistency to go "above and beyond" the requirements of the course.

> Edward is very independent-minded. During the semester, he searched for new skills and taught them to himself. He extended every project a step or two more than what was required. I haven't always had that level of enthusiasm and experience in my classes (Bennett, 2010).

Although Miss Bennett appreciates Edward's motivation and links his success with his willingness to try new things, she is concerned that what she perceives to be his immaturity could prevent him from reaching his potential.

> If his immaturity doesn't get in the way, he is somebody who could work on the school website and lead us in different directions. The immaturity is the thing that can sometimes hold students back. Even for all the silliness and goofing around that sometimes would happen [at after school activities], he was always a level or two above the accomplishments of most students in the class (Bennett, 2010).

I cannot confirm Ms. Bennett's perception of Edward's immaturity. During classroom visits, I observed his attentiveness during lectures, discussions and student presentations and his motivation during group work. His projects consistently exceeded the requirements and he was always willing to help students in need of assistance. Moreover, he actively participated and thoughtfully responded to questions during the interviews and focus group discussion.

Edward has been encouraged to pursue a career in the field of computer science by his parents, teachers and guidance counselor. His experiences in the Web Design 1 class have increased his "interest in computers" and his "desire to take more computer science classes." Edward knows which courses offered at Garden State High School are needed to prepare for a career in computer science. Accordingly, he has scheduled Web Design 2 and AP Computer Science as part of next year's schedule.

Elizabeth

> The hallways at Garden State High School are always buzzing with conversation between class periods. The three minute passing time provides an opportunity to update friends on the events of the day. In the midst of the hustle and bustle of social exchange, Elizabeth stood alone, quietly waiting for Ms. Bennett to unlock the computer lab door. She did not interact with her Web Design classmates or the students who passed by on their journey to the next class (Observation, March 10, 2010).

Elizabeth was a senior in the Web Design I class. She is a pretty young woman with long dark hair. She has been involved in sports from a very young age. She has participated in gymnastics since the age of three and she has played field hockey during her four years of high school. Elizabeth plans to continue playing field hockey on a club team in college. Elizabeth loves listening to music in her leisure time.

Elizabeth believes that "computers are a tool" best used for research. She explained, "I enjoy the fact that if I need to know about something, I can look it up on the computer." She was uncertain if "working on computers takes teamwork and interacting with people" since she enjoys "working on computers alone." Elizabeth rejected my compliments on her artistic web designs and downplayed her creative ability. She said, "I'm not a creative person, so it's easier for me to look for images on the computer than to draw them." Elizabeth commented that Web Design is not like other classes. Since all the work is done in class, marking period grades rely on project grades. She clarified, "It's not like another class where homework can get you a 'C.' You actually have to do the work that is assigned."

Elizabeth was an independent learner and often worked alone on class assignments when a choice was offered. She was very quiet in class and responded with one word answers or nods during class discussions and during interviews. She was very nervous and visually distressed when she presented her projects to the class, both individually and in a group. She stumbled on her words and stated, "I just can't talk."

Elizabeth did not plan to take the Web Design 1 class. Ms. Bennett explained that Elizabeth needed a course that would fit into her schedule. Knowing that Elizabeth had previously enrolled in the Graphics 1 and Graphics 2 classes, her math teacher, Mr. Merrill, encouraged her to schedule the Web Design 1 class during the spring semester.

> Mr. Merrill was Elizabeth's Algebra 2 teacher. When she was looking for an elective that would fit into her schedule, he suggested Web Design. I don't think it's something that she will spend a lot of time with. She was definitely someone who gave me exactly what I asked for, but that was all she did. She was helpful to other students in the class. When we did group work, she assumed a leadership role which is not always comfortable for her (Bennett, 2010).

Although Elizabeth voluntarily participated in this study, she was reluctant to share her thoughts with me. Her shy and quiet nature prevented her from answering most of my questions. However, when I asked her to think about what she would tell a friend about the Web Design class, she said, "I would tell her to take it because I liked it a lot."

Elizabeth regards mathematics as her academic strength. She intends to major in Accounting in college in the fall. After completing two accounting courses at Garden State High School, she is confident that she is "prepared for college." Although Elizabeth had a "great experience" in the Web Design 1 class, she does not see a future for herself in the field of computer science. "I will definitely take another computer class, but I wouldn't major in it [computer science] or work in the field."

Jane

Ms. Bennett:	The class is working on an Internet safety project. Jane, you volunteered to create a poster for the classroom on Internet safety. Are you going to do it?
Jane:	Do you want me to?
Ms. Bennett:	It's up to you. Your poster will be the only one I hang up. I have a place of honor for it. A spotlight! But, it's up to you. It's entirely up to you.
Jane:	I'll make the poster.

Jane was a senior in the Web Design I class. She is an attractive, seventeen-year old girl with long blond hair. She has enjoyed being a cheerleader her "whole life and plans to continue in college." The highlight of her cheerleading career was the opportunity to cheer for the pre-game show of the NJ All-Star team. She loves the beach and driving her new car.

Jane uses the computer for homework and "looking up things." She strongly agreed that "computers are tools to be used to get things done." It is not surprising that Jane does not consider computing a solitary activity. She elected to work in a group for each project assigned during the semester. Furthermore, during my classroom visitation, I observed that Jane was very talkative and enjoyed attention from members of the class. Before the beginning of class, she often circulated and spoke to each classmate. Typically, she offered a simple greeting of acknowledgement, but sometimes she engaged in conversations about an upcoming event. During the months of May and June, she was very interested in discussing prom dates and graduation parties.

Ms. Bennett could always rely on Jane to present her projects to the class, bake cupcakes for the class celebrations or complete a poster for the classroom when no one else volunteered. Ms. Bennett commented on Jane's work ethic and sociability.

> Jane was very impressive, very confident. Jane always finished projects on-time and did not seem to struggle with the coursework. For many of the girls I have had in the Web Design class, it seems to be a trend. Often they are seniors, some very social, some not scholastically-minded, however they enjoy the course. They love designing sites about their music interests or the actors they like. Jane volunteered to model every project (Bennett, 2010).

While at Garden State High School, Jane enrolled in many of the entry-level computer-related courses offered by different departments: Microsoft Office 1 and 2, Graphics 1, Pre-Engineering and Robotics 1, Introduction to CADD and Web Design 1. Although there are multi-levels of each course, she elected not to study any particular area in depth. Jane demonstrated great confidence when she was the first person in the class to present Project 1, *All About Me*, and to share that she is dyslexic. Ms. Bennett was "very impressed" with Jane's work. She explained,

> Computer programming can be a frustrating and difficult course for students with dyslexia. Often, the students reverse letters and cannot see why their programs are unsuccessful. Jane didn't seem to struggle that much. Most of her mistakes were in her paragraphs, not the concepts, so they [mistakes] didn't put her behind at all (Bennett, 2010).

At the end of the semester, Jane identified her academic strengths as "math, problem solving and designing websites." She aspires to be an Early Childhood Education major in college. She is drawn to teaching as a way to be a role model and mentor to students. Her positive experience in the Web Design class has encouraged her to schedule additional computer science classes at college with the future goal of creating websites for students and parents.

The Web Design 1 Teacher: Ms. Bennett

> When Ms. Bennett introduced style sheets to the Web Design 1 class, she had never used them before. Ms. Bennett shared her unfamiliarity with style sheets with the class. "There is a way to change the font or indent for the whole page. I don't know a lot about it, but let's try a few things." She modeled her problem solving process by thinking aloud and accepting suggestions from the class. "I love this because we indented everything without a table. Without style sheets, it would get very complicated, very quickly. This is a wonderful new thing that we can do that I have never used before today. Yeah, first time. It's fun to learn something new (Classroom Observation, April 12, 2010).

Ms. Bennett joined the staff at Garden State High School as a computer science and mathematics teacher in September 2004. She is an attractive woman in her late 30s, who looks much younger than her age. She wears her long blond hair in a simple and becoming style. She usually dresses casually for class; donning slacks, sweaters and flat-heeled shoes. Ms. Bennett's reserved and understated appearance contrasts with her determined, self-sufficient character.

Ms. Bennett graduated from a state university with a degree in computer science in 1994. She attended school on an academic scholarship. She developed an interest in computers in middle school. She explained, "Our school's first computer lab opened when I was in middle school. The teacher was very encouraging and I enjoyed the new elective course. She hired me to assist her with a small summer enrichment class for younger students." Computer science attracted Ms. Bennett because it seemed like a field where she could make a good income and because she "was very good in math." She tutored students in math as a high school and undergraduate student. As she advanced in high school and college, Ms. Bennett noticed fewer women students and later many working professionals in her computer science classes.

> As I advanced there were fewer and fewer women in the classes. The one thing in my college experience that differs from a lot of other majors was that many of the classes were offered at night because there was a lot of working professionals in the classes. So you had a lot of people who already had degrees. They were working [during the day] and attending school [at night]. That changed some of the [classroom] dynamics too. In some regards I didn't have peers, even though there were women in the classes, there were not peers so much; they were moms. And I was a teenager or a 20-something at that point (Bennett, 2010).

As an undergraduate and graduate computer science student, Ms. Bennett found most of her professors "intimidating" and "not very helpful." Classes were simple lecture style which caused her to feel "overlooked and ignored."

> The instructors left a lot for the student to do. There was always lecture and you did everything [application] on your own later. They expected you to make a lot of the leaps yourself. If you tried to get anymore information, they would say, 'That was up to you to figure out. I'm leaving that up to you.' They were very hands-off which created a competitive spirit in the students. So we didn't work collaboratively, which is very different from how I conduct my class. When I was in school, it was very intimidating (Bennett, 2010).

After completing her bachelor's degree in May 1994, Ms. Bennett began her career as a systems programmer for a company that worked exclusively on naval contracts. As a systems programmer, she led the infrastructure and support team to develop the first easy-to-use, online help system to minimize training. She boasted, "I was the first employee to research and begin the development using web technologies, when Mosaic, HTML and 'the web' were very new concepts."

For a brief time between October 1995 and May 1996, Ms. Bennett joined the staff of a major corporation to continue to design and develop information retrieval/search software systems and web-based user interfaces. Massive lay-offs in May 1996 resulted in a career move to a software development company where she worked on web-based multimedia tutoring systems to support desktop training for financial traders of major international banks and trading institutions. This position "required self-management, client relationship management, multimedia authoring and delivery tools and creativity."

In 1996 she decided to return to school for a master's degree in computer science. In the same year, Ms. Bennett secured a position with a leading company in the field of computer science. During the next four years she worked with a small, highly talented team of programmers to develop a network-distributed web browser and led a user interface team that worked with artificial intelligence. In her final year with the company, she evaluated and recommended new web technologies and new statistics software for the company website. She completed the master's degree in 1998 while working full time.

From March 2000 though November 2002, Ms. Bennett joined a start-up company providing Internet performance management to customers. Here she led the design and development for the web-based service and user-interface team. She said, "I was creating an online help-system. In some ways my work was very independent, but I had the opportunity to meet with people periodically. I enjoyed the work and the people."

After eight years in an unpredictable and ever-changing computer science field, from May 1994 to November 2002, Ms. Bennett decided to pursue a teaching career. She was drawn to teaching because of her "extensive experience with training staff, making presentations and tutoring mathematics." Additionally, she was encouraged to enter the teaching field by her mentor who was teaching at Rutgers University at the time.

After serving as a long-term substitute in the Garden State School District, Ms. Bennett joined the staff at Garden State High School as a computer science and mathematics teacher in September 2004. She teaches the Web Design classes, Computer Programming and AP Computer Science, in addition to teaching Algebra 1 and Algebra 2. She is a member of the Northern New Jersey Chapter of AP Computer Science Teachers, the Association of Computing Machinery (ACM) and the National Council of Teachers of Mathematics (NCTM).

Ms. Bennett is a highly respected member of the Garden State High School community. She shares her experiences as a computer scientist with the staff and students at Garden State High School. Ms. Bennett has facilitated many professional development activities for the staff. Most recently, she trained the Garden State High School staff on Pearson PowerSchool Student Management System. She has collaborated with colleagues to write the Web Design 1, Web Design 2 and Computer Programming curricula.

Ms. Bennett believes that "technology plays an important role in the students' lives and must be part of the educational process." Through her computer classes, extra-curricular clubs and specially-designed recruitment sessions for the students, she encourages students to participate in computer-related activities. Additionally, she serves as an instructor for PSAT and SAT prep sessions at the high school. As part of the district mentoring program requirements, Ms. Bennett's action research project involved investigating strategies to address the persistent gender gap in the high school computer science classes. These strategies included all-girl events and clubs to spark interest in computing and to build confidence. However, her consistent efforts to recruit more girls into the computer science classes have not been successful. The Guidance Department reports that seven boys have requested AP Computer Science for the 2010-2011 school year.

Conclusion

Although the student participants varied greatly in personal characteristics, career goals and the details of their stories, there were some common threads among their experiences. Each student had previously enrolled in a computer-related course offered by the high school Applied Technology, Business or Fine Arts departments. Three of the students, Charles, Elizabeth and Jane, had completed Graphics 1 and Edward had completed all three levels of Pre-Engineering and Robotics. The students shared their value of the computer as an important tool to complete school work and to research areas of interest. An important and somewhat unexpected parallel is that all the students identified mathematics as their academic strength even though their transcripts do not confirm their assessment. Additionally, all the students had a positive experience in the

Web Design 1 class and intended to take additional computer classes at Garden State High School or in college.

In Chapter Five, I address the answers to the research questions introduced in Chapter One. In Chapter Six, I discuss my findings more in depth in the context of the literature base presented in Chapter Two.

CHAPTER V: FINDINGS

> This is a really great project. Jane included a lot of things that I am looking for. Everything looks good: form, font, tags, HTML. Jane set a high standard today. You might want to go back and check *your* projects before presenting (Ms. Bennett's comments to the class following Jane's presentation, February 23, 2010).

The profiles of Chapter Four provide a brief sketch of the Garden State High School daily program and graduation requirements, selected curricular sequences, the Web Design 1 classroom and class members, each focal student and the classroom teacher. In this chapter, I present the results of my research, organized by research question. My goal was to learn about the factors that could help explain why so few girls enroll in the advanced computer science classes at Garden State High School. In the process of examining the structure, pedagogy and culture of the entry-level computer science class, additional research questions regarding institutional factors emerged: What institutional factors influence gender imbalance in the computer science classes at Garden State High School? To what extent do institutional factors influence girls' and boys' interest, enrollment and persistence in the computer science classes? The institutional factors discovered in my investigation include course selection, scheduling practices and prerequisites, teacher beliefs and attitudes, students' prior experience and knowledge of computers, transition from middle school to high school computer science classes and computer-related opportunities outside the classroom.

Additionally, the analysis of enrollment data for all the academic and elective courses at Garden State High School reveal a disparity in gender balance between the academic subjects and the elective courses (see Appendixes B, C, D and E). While the enrollment in the academic courses verified gender balance, the enrollment in most elective courses, not solely computer science electives, expose an imbalance along traditional gender lines. The enrollment statistics prompted and guided additional interviews with two guidance counselors to determine possible causes for the gender imbalance in the elective courses. Major themes that emerged in response to the discovery of institutional factors and to my research questions are discussed and illustrated with quotations from the participants.

Institutional Factors

The Garden State School District's Equal Education Opportunities Policy guarantees to all students "equal and bias-free access to all academic programs within the learning environment" (GSPS Policy 5145.4). Each staff member is expected "to regard each student as an individual" and "to promote a learning environment that encourages fulfillment of each student's potential by adapting instruction to individual needs" (GSPS Policy 5145.5). The district's affirmative action program is part of each academic program to ensure that all pupils receive an education in an environment that is conducive to learning and personal growth and consistent with the district's commitment "to providing learning opportunities for students that support equity and diversity" (GSPS Policy 5145.5).

Gender equity in the high school is vital to the development of the full potential of both females and male students. A major concern regarding technology use and enrollment in high schools is that all students are equally prepared and equally engaged. Female students comprise the majority in many honors and AP math and science classes at Garden State High School, yet data clearly show that female students are under-represented in computer science classes (see Appendixes B, C, D and E). A small number of female students enroll in entry-level Web Design classes, but they rarely schedule advanced computer science classes (see Appendixes B and C). Garden State High School girls are using the Internet and the web for completion of class assignments and visiting social networking sites, but it is predominately the boys who are enrolling in introductory and advanced-level computer science classes, programming the computers and designing the school website. Often, it is the boys' perspectives and priorities that are garnering attention in the computer science classrooms and on the school website. I share an account of an incident that was conveyed to me by a district administrator to illustrate this claim.

The Webmaster Team is a prestigious course that meets daily to maintain, design and update the Garden State High School website. The number of students varies from five to eight members every year, typically all boys. Depending upon the content, the Webmaster Team classroom projects that are posted on the school website are subject to approval by different school administrators.

Approximately three years ago, the Webmaster Team, then comprised of all boys, decided to feature extra-curricular clubs on the school website. Each Webmaster Team member wrote a brief description and selected an image to represent a particular club. One team member selected a "mad scientist" image for the Science Club. When an administrator objected to the image on the grounds that it was stereotypical and dated, the entire team protested. After a meeting was facilitated to discuss how the selected image might influence student participation in the club, the Team resubmitted a more gender-friendly alternative portraying two young students, an African-American girl and a Caucasian boy, working together in a laboratory. However, according to the administrator, this incident caused conflict and tension in the administrator's future relationship with the Webmaster Team members.

Scheduling Practices and Prerequisites

While examining enrollment statistics for selected Garden State High School courses, I noticed that Garden State High School girls are well-represented in the advanced-level *academic* courses but not in the advanced-level *computer science* classes (see Appendixes B, C and D). Enrollment statistics for all Advanced Placement (AP) courses confirm that 391 of the 694, or 56.3%, of the students enrolled in Advanced Placement Courses are girls (see Appendix D). Additionally, 22% of the girls compared to 15% of the boys enrolled in Advanced Placement math and science courses this year (see Appendix B). Similarly, during the 2008-2009 school year, 23% of the girls compared to 11% of the boys enrolled in Advanced Placement math and science courses (see Appendix C). Furthermore, 14 of the 16 students in the Web Design 1 class were enrolled in standard college prep-level courses during the 2009-2010 school year. The two freshman boys in the Web Design 1 class were the only students enrolled in an honors course, Honors Geometry, having completed the Algebra 1 requirement in eighth grade.

I decided to approach two veteran guidance counselors, Ms. Moore and Ms. Hanson, to provide insight into the course selection and scheduling practices at Garden State High School. Ms. Moore explained that students begin to take AP courses in freshman year and schedule multiple AP courses during their junior and senior years (see Appendix D). During the 2009-2010 school year, there were 641 AP exams in 26 different courses taken at the school.

> When I counsel students, I ask them where [which college] they want to attend. I push AP courses because you are proving yourself on a daily basis. What message are you giving to that admission's officer? As an admissions officer, I know the curriculum in AP Calculus or AP Physics, but I have no idea what is included in Web Design (Moore, 2010).

Ms. Hanson described the advanced-level students' dilemma when selecting elective courses. If the students have scheduled multiple advanced courses, they already have a good idea of their academic strengths and future plans.

> These courses are rigorous courses, so if they have room for electives, they often base their choice on what will align with what they plan to do in the future. Most students feel they just don't have it in them for one more advanced course when they are taking AP Physics and AP Calculus. AP Computer Science is just too much. So they think of it very practically, at least from what I've seen of students on that advanced level looking forward (Hanson, 2010).

In addition, Algebra 1 is a prerequisite for the Web Design 1 course. The Algebra 1 prerequisite allows the students to enter the course with experience and skills in logic, patterns, problem solving, and deductive and inductive reasoning. Approximately 70% of the freshman students are not eligible to take the Web Design class because they have not studied Algebra 1. Ms. Moore said that she would not advise students to take Web Design in their freshman year because of the freshman schedule.

> Freshman schedules are too academically challenging. They have more academic classes than most seniors because they have two required electives. They come to this big place and they are not ready for seven academic classes. So I recommend Foods or Art freshman year (Moore, 2010).

Ms. Bennett explained that very few advanced-level students enroll in the AP Computer Science class. Typically, the students in the AP Computer Science class are junior and senior boys. "The AP Computer Science class is the only advanced course they consider. It's the reverse with the girls. Because they have more advanced courses, they think it [AP Computer Science} will be too much work. So they try to go with something else as an elective." As previously stated, enrollment data substantiate Ms. Hanson's and Ms. Bennett's assertion that more girls enroll in Advanced Placement courses at Garden State High School. Furthermore, enrollment statistics reveal that few girls schedule advanced computer science classes (see Appendixes B, C and D).

Computer-Related Extra-Curricular Opportunities

The Computer Honor Society is an extra-curricular activity that meets every Tuesday after school for one hour in the computer lab. Membership to this prestigious club is by invitation only. To add a personal touch, Ms. Bennett, the club advisor, issues invitations to students enrolled in the various computer science classes or to students with prior experience or expert knowledge in computers.

> In the past, I announced it [a club meeting] to the whole class and membership was open to anyone. I found that sometimes people would show and sometimes not. Now, I write invitations to students from my computer classes and the web team and send them through their homeroom or math teacher (Bennett, 2010).

Ms. Bennett explained that she invited four boys from the Web Design 1 class this year. Edward was invited, but Charles, Elizabeth and Jane were excluded. I asked Ms. Bennett to share her thoughts regarding their membership in the club.

> In the beginning, I thought they might find it interesting. But being seniors and having the course in the spring, makes it harder. They are welcome, but I don't see them staying with it. I have not had female students in there for the past few years. They have other social things that they do (Bennett, 2010).

Membership in the Computer Honor Society provides opportunities to gain knowledge and to collaborate with other students. Each time the club meets, it takes a "different direction" depending on who is leading the activities during the meeting (Bennett, 2010). Ms. Bennett explained, "Sometimes we are more programming-based and sometimes more web-based. Maybe, a web team member will demonstrate software, like Flash. Last year, we created a game, so there was programming and a little bit of graphics involved."

Perceptions of Factors Contributing to Gender Imbalance in Computer Classes

Educators' Perceptions

In additional to course options and prerequisites, the computer science teachers and the guidance counselors identified several institutional factors that contribute to the gender imbalance in the computer science classes at Garden State High School. These factors involve the way courses are described and linked in the Program of Studies booklet, the students' prior knowledge and experience with computers, the transition from middle school to high school computer science classes and the students' limited general knowledge of computer science and other STEM fields.

The Web Design 1 teacher, Ms. Bennett, shared her theory regarding why girls are well-represented in the advanced academic courses but not in the advanced computer science classes: She believes that the tracks for academic courses are clearly delineated and easy for students to follow from freshman year. For example, an eighth grade student currently enrolled in Algebra would typically follow the honors track into Geometry, Algebra 2 and Trigonometry, Pre-Calculus and AP Calculus. The department flow charts outline sequences of courses within that department, but they do not provide an interdisciplinary sequence that would outline where elective courses could support academic courses and career preparation. In addition, she emphasized the influence of families and friends and the students' prior experience in middle school computer science classes as important factors in course selection.

> I think that many young women take the advanced-level academic courses because the academic track they are on clearly indicates which courses to take.

> I also think if they have freedom in their schedule for electives, friends and prior experience factor heavily into the choice. For example, elementary and middle school courses include a variety of courses in the arts to give students an introduction into various art programs at the high school. I have found that the main introduction to computers in middle school is simply word processing and typing, which do not compel students to seek advancement (Bennett, 2010).

The Garden State High School students' middle school computer experiences include required courses for all students in Applied Technology and Computers in grades six, seven and eight. In reviewing the Applied Technology courses curricula, I noted that the curricula are well-defined for each grade level and build on previous classroom experiences. In sixth grade, the students work in teams on foundation level problems as they cycle through technology stations, which include robotics, electricity and computer animation and design, aerodynamics and digital speech. In seventh grade, the students engage in engineering and design challenges of vehicle design and Lego "Mindstorm." The students continue to focus on engineering through bridge building and airfoil design in eighth grade. In contrast to the Applied Technology curricula, I found that the middle school Computers curricula did not delineate for each grade level or identify outcomes at the end of each year. The students confirmed that the classroom activities in the middle school Computer classes consisted of word processing and PowerPoint presentations.

Ms. Moore, a guidance counselor at Garden State High School, agreed with Ms. Bennett's attention to the students' middle school experience and the influence of friends on selecting courses. She believes that there is a need to provide career counseling in the district's middle schools so that students can make informed decisions when selecting courses for their high school years.

> We don't provide career counseling in the seventh and eighth grade. Do they [seventh and eighth grade students] know what Web Design is? I don't think the word is out there. There is a stigma and stereotype attached to computer science.

> The enrollment in our elective courses is very traditional and stereotypical. Adolescent girls want to be cool. If a girl thinks that she going to be with a bunch of geeky boys, she may not be interested (Moore, 2010).

Furthermore, another guidance counselor, Ms. Hanson, confirmed Ms. Moore's experience that most students attend counseling sessions with a general lack of knowledge of computer science and other STEM fields. Recently, Ms Hanson attended a program on Women in Engineering at Stevens Institute. She was impressed with the program because the women engineers from Revlon and Mars emphasized problem solving as a key function in the field of engineering.

> I don't think people think of engineering in that way. The same is true with computer science. It's the way we present it or what they [the students] hear from others. We create and reinforce the myth. Even in the tone of our voices, we refer to STEM programs as difficult and students pick that up. And students think, 'Maybe I'm not prepared for that [course] or I can't do that' (Hanson, 2006).

Ms. Hanson validated Ms. Bennett's thoughts regarding the gender balance in AP Calculus and other advanced-level academic courses by attributing the balance to "having a route or track that takes them [students] there."

Finally, Mr. Merrill, the male computer science teacher, emphasized the significance of the students' prior experience acquired from informal exploration and the different ways that the students use computers on their own time as factors in persistence in computer science. While Garden State High School girls are using the Internet for communication and the web for information retrieval, it is predominately the boys who are programming the computers and designing the school website.

> I know one of the guys on the web team works on coding his iPhone and his iPad. I don't know if the girls are really doing that as much. At least the girls that I talk to are not. The girls are into Facebook; they are always on it, talking about it and sending notes through Facebook or email. More girls than guys are using social

> networking sites. The guys say that don't have time for that kind of thing (Merrill, 2010).

During my classroom observations and review of student projects, I noticed that Charles and Edward incorporated additional features in each project. For example, Edward added music and a video to Project 1 and sound to the quiz component of Project 4. Charles added additional text and images to his story in Project 3. The freedom to enhance projects by "trying new things" was motivating to both Charles and Edward. The flexibility in the curriculum allowed them to personalize the coursework, incorporate prior knowledge and to work at their own pace. In contrast, Elizabeth and Jane met the minimum requirements for each project and did not attempt anything above or beyond the assignment. Since the class was the first computer science class for Elizabeth and Jane, their needs were met by focusing on the foundational skills of web design.

Ms. Bennett believes that most boys are willing to experiment with new web design elements and techniques. She explained that girls are sometimes reluctant to extend their work and to "take a chance" because "they don't want to do anything wrong."

> One of the things you start to find with students is that they are afraid to try something. There are only a few things they could do that would mess things up, but for the most part I want them to try. Most boys are willing to try things. Sometimes girls seem to be resistant to that because they don't want to do anything wrong (Bennett, 2010).

Furthermore, Ms. Bennett has formed some general opinions about girls who enroll in computer science classes at Garden State High School. She explained, "For many of the girls I have had in the Web Design class, it seems to be a trend. Often they are seniors, some very social, some not scholastically-minded, however they enjoy the course. They love designing sites about their music interests or the actors they like."

Students' Perceptions

Throughout the semester, I asked the focal students to share their experiences and insights regarding the gender imbalance at Garden State High School. Although they all acknowledged the gender imbalance in the computer science classes and other elective classes they had completed, their responses were very different. Charles settled some blame for the imbalance on girls for not "broadening their horizons." When I asked Charles if he had any idea why so few girls enroll in Web Design 1 and the other computer science classes at Garden State High School, he echoed the comments of the guidance counselors regarding the traditional enrollment in the elective courses and the stereotypes surrounding computer science.

> I honestly don't know why [girls do not enroll in computer science classes]. Maybe they [girls] feel that computers are for boys. I don't know why they think that. Maybe they need to broaden their horizons. They need to get into it. Just take a chance and take a [computer science] course instead of just sticking with Sewing or Chorus. There are less girls in classes like Criminal Justice and Forensics, too. Very traditional (Charles, 2010).

Additionally, Charles could not identify anything about the Web Design 1 class that would have to change to encourage more girls to enroll. I sensed that he was very protective of Ms. Bennett and did not want to say anything that could be interpreted as a criticism of the class or her teaching practice. Perhaps, he had no critique to share. However, when I asked him how he would describe the class to a perspective Web Design 1 student, he said, "It's a really great class, it's a great environment and Ms. Bennett is a really great teacher."

During an interview session with Edward, he identified the "disproportionate" number of boys in a class as "a big factor" in girls' course decisions. When I asked Edward if he had any idea why so few girls enroll in Web Design 1 and the other computer science classes at Garden State High School, he did not respond immediately. With further probing, he referred to the culture that is produced and reinforced when the existing gender imbalance discourages girls from enrolling in the class. He indicated four courses that he had completed at Garden State High School where few girls had enrolled: Criminal Justice, Woodworking, Pre-Engineering and Robotics, and Forensic Science. He astutely considered and analyzed his experiences with gender imbalance and articulated, "It's really a stereotype that boys take computer science classes and girls don't, but it's a culture thing here."

Like Charles and Edward, Jane and Elizabeth struggled to account for the gender imbalance in the computer science classes at Garden State High School. Both girls were unable to explain why girls do not schedule the introductory class. None of Jane's friends had enrolled in the Pre-Engineering and Robotics class or the Web Design class with her. She described them as "weird" for refusing to schedule the classes. When I asked Jane if she thought that the classroom dynamics change when there are few girls and many boys in a class, she responded,

> If there are a lot of boys in the class, I would want to take it. Last year, I was the only girl in my Pre-Engineering and Robotics class. Everyone picked on me, in that guys-make-fun-of-girls way, but that's okay. Like, girls are horrible drivers – that kind of thing. It didn't bother me (Jane, 2010).

When I asked Jane to explain how she was "picked on," she assured me that she was not bothered by what she described as "teasing" and she enjoyed being the only girl in the Pre-Engineering and Robotics class. However, Jane's account of her experience in the

Pre-Engineering and Robotics class reveals how gender can impact the classroom climate.

The term “chilly climate” is used to describe how men and women are treated differently at work or at school because of their gender, race, age, or other characteristics or beliefs (Sandler, 2010). It describes the small everyday inequities that typically go unnoticed by the person it happens to or by the person who is responsible for it (Sandler, 2010). However, when these behaviors reoccur and are ignored or misunderstood, they can create a chilly environment that affects girls’ self-esteem, confidence and participation (Sandler, 2010). Although Jane was not conscious of sexist behavior, gender bias or discrimination in the Pre-Engineering and Robotics class, a chilly climate could have existed without a conscious attempt to discriminate (Sandler, 2010).

Although I made many attempts to repeat and to rephrase the question of gender imbalance with Elizabeth, she was unable or unwilling to offer an explanation or a remedy for the situation. While acknowledging the question, she responded with a shrug or said, “I don’t know.” When I asked each student if they had previously reflected on the gender imbalance issue in courses at Garden State High School, they freely shared that they had not considered the issue before the interview. I concluded that although Charles, Edward and Jane recognized that an imbalance existed in some classes, they were not motivated to question or take action to change the situation. They accepted the gender imbalance as a natural course of events at Garden State High School.

As students interact with their teachers and peers, differences in classroom treatment for girls and boys often seem inevitable, natural and freely chosen (Spencer, Porche, & Tolman, 2003). The students perceive the different treatment in the classroom as equitable because of their beliefs about the nature of girls and boys, i.e., their gender ideologies (Spencer, Porche, & Tolman, 2003). Despite unnoticed, ignored or misunderstood behaviors in a classroom environment, many small inequities can accumulate and cultivate a chilly climate.

Institutional Factors Summary

Several institutional factors that encourage or discourage girls' and boys' interest enrollment and persistence in computers emerged during this study. The educators identified several factors that they perceive influence girls' enrollment in computer science classes. Students at Garden State High School have extensive course options. Since the sequence for academic courses is clearly delineated in department flow charts, students can easily select and schedule courses needed as graduation requirements and prerequisites. However, the Program of Studies does not define how elective courses support academic courses or career goals. Students must depend on advice from teachers, guidance counselors, friends or family to understand the connection between the academic and elective classes. Under these circumstances, prior knowledge and experience with computers are assets in the decision-making process.

Although the students acknowledged the gender imbalance in the computer science classes and other elective classes at Garden State High School, they had difficulty generating reasons and/or remedies for the circumstances. They acknowledged that they had not previously questioned gender imbalance in their classes or considered its social or academic ramifications.

Additionally, the issue of equal access to extra-curricula computer activities emerged. The "by invitation only" practice for selecting members of the Computer

Honor Society limited access to important academic and social resources to a few male students in the Web Design 1 class during the 2009-2010 school year.

How do the existing structure, pedagogy and culture of the entry-level computer science class at Garden State High School encourage or discourage girls' and boys' interest, enrollment and persistence in the advanced computer science classes?

The Web Design 1 Curriculum

The Web Design 1 class is offered to students in grades 9 through 12. The prerequisite of College Prep Algebra 1 has restricted most freshmen from enrolling in the class. Only students who have completed Algebra in eighth grade are eligible to schedule the Web Design 1 class. Because the course is an elective, Ms. Bennett and Mr. Merrill are seeking to attract more students into the course and the computer science program. "Anyone can take the class and there is definitely a wide range of students with many different ability levels. We have honors students and students who are in replacement classes. So the fact that we keep most of them happy is impressive" (Bennett, 2010).

The Web Design 1 class is intended to develop skills in creating pages for publication on the Web through a platform of seven short-term projects. The students are introduced to the Internet infrastructure; the networks, servers, clients and components comprising the web. Throughout the course, students are expected to act responsibly and to consider current ethical and social implications of computer use.

The seven Web Design 1 projects provide opportunities for the student to work individually and in groups. The first project, *All About Me*, requires the students to apply their knowledge of HyperText Markup Language (HTML) and create a personal web page using different fonts, formatting, images, lists and links. The students are guided in background color and font selection to achieve an eye-pleasing site. In Project 2, the students work in a group to create a fictional company website. The site must include images that relate to the company, readable text and a company banner. Students earn extra credit points for including a product list, the history of the company and a mission statement. The students create a story based on pictures in Project 3. The pictures can be personal photos taken from a vacation or the students can opt to use Ms. Bennett's vacation photos. Using style sheets, the students create a format for their site that reduces the amount of HTML used in each page. Font tags, table tags and body tags all have at most one attribute and define the style sheet. The goal of the project is to create a similar format on each page that can be changed by altering one file.

Project 4 allows the students to work in pairs to create a website for an academic course of their choice. The site must describe some aspect of the course core knowledge which could include conjugating verbs in a foreign language, a battle from the Civil War, methods to solve a quadratic equation or chemical compounds and their uses. The basic qualities of the project should encompass clarity of thought, rich content, organization, layout and attention to details. As a final requirement of the project, the students create a quiz for the viewers of the site with a link to the answers. Internet safety is the focus of Project 5. The students prepare presentations about their favorite websites. Many high school students visit social networking sites, like MySpace and Facebook. This project draws attention to the dangers of using the web and emphasizes ways to keep safe.

In Project 6, the students create different types of forms including surveys, order forms and registrations forms for the fictional company that they created in Project 2. By using text boxes, password boxes, radio buttons, checkboxes and menus, the students are able to expand the company website to include an interaction with the client or customer. Finally, in Project 7, the students combine the six projects that they created during the semester into a final portfolio. Using Photoshop, the students create a picture and a link for each of the six projects that allow the client or customer to connect to each website from the initial page.

Mr. Merrill established the basic skill set for the course when he joined the staff at Garden State High School in September 2003. Keeping in mind that sometimes there are years between a student's enrollment in the Web Design 1 and Web Design 2 courses, Ms. Bennett and Mr. Merrill maintain a base line consistency in the Web Design 1 curriculum so that they can reference something in Web Design 2 from the earlier course.

> We want to keep updating it [the curriculum] because technology is changing so quickly and the students' skill sets have been increasing over the past few years. The majority of the students have a computer at home. They are typing more of their papers and the teachers are taking them to the labs during their classes. They are feeling a lot more comfortable doing things on a computer. So when we ask them to do things, like copy and paste, they are much quicker at it. Years ago, we had to spend quite a bit of time explaining how to set things up, how to save and what the things meant. Now, there are very few students who need that kind of help. It's great because it allows us to get to more interesting things for students to do. For those who finish the projects early, we are able to extend the projects and offer something more challenging that they can work on. And I think that what keeps their interest in the course and gets them talking about the course to their friends (Bennett, 2010).

The Web Design 1 curriculum is consistently updated with different projects. Ms. Bennett commented, "Every time I teach the class, I come up with different examples and different projects to sustain student interest." To promote creativity, Ms. Bennett selectively shares models of each project.

> If I share too many examples, all they [the students] do is copy. And that's not really what it is about. There have been quite a few times that I've only shown them a model in Microsoft Word because I don't want them to just copy. I want to expand their thinking and get to some creativity (Bennett, 2010).

Pedagogy

> After presenting a brief overview of Project 2 to the class, Ms. Bennett met with the students individually and in small groups at the conference table. She explained, "All the details and requirements for the project are right here [on the paper]. I want you to have fun with this project and to make it interesting." The students had an opportunity to discuss initial plans for the project, to ask questions and to receive feedback from Ms. Bennett and their peers. Ms. Bennett reminded the students, "If I can help with anything, if it becomes overwhelming, let me know. Okay, have fun" (Classroom Observation, March 17, 2010).

Ms. Bennett created a challenging classroom environment where the students were active participants. The varied instructional strategies that she incorporated into her lessons provided opportunities for review, feedback, critical thinking and individual preferences. She often assumed the role of facilitator to allow the students to take responsibility for their learning and to encourage collaboration with peers. She said, "I try to assign partner or group work to keep students from feeling isolated. Neither of these instruction methods was used in my learning experiences. The students in my computer science classes were always very competitive."

Ms. Bennett believes that her college and work experiences have greatly influenced her teaching practice.

> I try to refrain from lecture style as much as possible. Throughout my schooling, I felt a disconnect between the class lecture and my time in the computer lab Sitting in a lecture is not as interesting to students as having hands-on activities and online activities. I think activities hold the students' interest. When the students had a hard time connecting, I tried to bring in more student engagement. But it is very different from the way that I was taught (Bennett, 2010).

From the first day of class, February 4, 2010, Ms. Bennett's general practice included presenting brief lessons that featured specific skills and then providing time for individual or group exploration and practice. While the students worked, she circulated to answer questions and to assist them. During this time, Ms. Bennett often differentiated instruction by providing mini-lessons for those students who had completed the work and were ready to move on to more advanced topics or to topics of special interest to them. Additionally, she offered support for those students who were struggling with a concept and modified assignments if needed. She explained, “Students often enter the introductory class with different starting points and I want to challenge and support all of them.”

For example, on February 12, 2010 the students were preparing to launch their first project, *All About Me*. Approximately half-way through the class period, six boys had completed exploring the two internet tools that were introduced at the beginning of the lesson, Firefox and Internet Explorer, and were ready to begin their project. Ms. Bennett announced, “For the people who are finished, we are going to move on and start the first project.” After reviewing the requirements of the project with the small group of students at the conference table, Ms. Bennett circulated to assess the progress of the other students. As I followed Ms. Bennett around the room and observed the students’ work, I saw her whisper to a young man. Later, she shared the conversation with me. She asked him, “Do you have any questions? I’m not sure I understand why you are so far behind, but I am here to help you and I will give you extra time to finish.”

Similarly, on February 16, 2010, the students were working on Project 1. She announced to the class, “I want to walk around to talk with everyone because I want to know where you are, but I have a good sense from yesterday that most of you are well on your way.” As she spoke to each student in the class, she offered comments and suggestions tailored to the specific student’s project. When the students presented their projects on February 23, 2010, she said "This is the best part, when we present. We have some people who included extra features in their projects and hopefully they will show you some different things." The requirements of Project 1 included three links to websites and three images. When reviewing the final projects, I noted that eight boys, including Edward, who included music and embedded a video from YouTube in his website, and Charles, who included additional pages and links, exceeded the minimum requirements. I was not surprised that Edward and Charles enhanced their projects as it reflected their familiarity with computer applications.

By March 17, 2010, the students had completed Project 2. On March 1 and March 10, 2010, I observed Ms. Bennett devoting considerable time to Elizabeth's group. The group consisted of Elizabeth and four boys. The project featured the use of tables and required a list of company administrators, five company products or services, a history of the company, a company banner image, an image relating to the each product or service, three web pages and a navigation table for the links to other pages.

Elizabeth's group was struggling with the use of tables and disagreeing on a theme. During a mini-lesson with the group, Ms. Bennett reviewed different aspects of using tables, answered questions and made suggestions. Before moving on to work with other students, she said, "I will keep coming around, but you guys did a terrific job listening to me. I appreciate it. I know you will produce a great project." After the mini-lesson, I observed Elizabeth assume a leadership role when she selected the theme of the website and assigned different aspects of the project to each member of the group. The final project featured a fictional gymnastics school website that promised a "fun, safe environment" and "an extensive selection of gymnastics equipment." The appealing combination of “learning and having a good time” and “always open to new ideas” were marketing strategies that the group incorporated in their colorful web pages. Interestingly, Elizabeth listed herself as the president of the company.

All the Web Design 1 project requirements were carefully outlined for the students and provided an opportunity for the students to apply their knowledge and skills from class lessons. Throughout the semester, Ms. Bennett allowed students to complete the projects at their own pace and to include additional topics according to their interest and readiness. Some projects built on previous projects to reinforce skills and to encourage the transfer of skills from one learning experience to another. For example, the fictional company website created in Project 2 became the basis for creating different types of forms, including registration and order forms, in Project 6.

Research findings emphasize that the relationship between teachers and students is particularly significant for girls and underscore the importance of high school teachers devoting personal attention and fostering potential in girls (Margolis & Fisher, 2002). Ms. Bennett said she usually does not “think about teaching girls differently than boys.”

> For the most part, I don’t really think about it except when I notice that there is one girl in the class. She might comment about it to me and we’ll talk about sticking together. Once in a while, if there is an example or a program that I am showing, and I feel like it is somewhat limiting, I try to offer choice on different topics and to be conscious of the different interests. Examples that I give, scenarios that I share, even color schemes give variety for all students. Why not? We think about how to design things for different audiences. I try to incorporate variety for individual students, but for most things, I don’t really do anything differently for girls (Bennett, 2010).

Contrary to her own experiences as a student, Ms. Bennett encourages collaboration and teamwork. She has a rule in her class: *Ask Three then Ask Me.* The students must ask three other students for help before they ask her.

> It works well with most students. There are some [students] who refuse to go beyond their one or two friends in the class. When that happens, I identify a person for them to ask. There is always someone in the room who knows what he or she is doing, so I make them the expert for that skill (Bennett, 2010).

By the end of March and the beginning of April 2010, I noticed a decrease in the amount of questions directed to Ms. Bennett and an increase in the number of questions directed to other students. During the April 23, 2010 class period, I noted that all student questions were directed to other students. Although Ms. Bennett circulated and provided encouragement, all the students in need of assistance reached out to other students for information. As the semester progressed, I recorded that the students relied exclusively on each other for help during the April 29, May 21 and June 8, 2010 classes.

Throughout the semester, I observed that a considerable amount of class time was devoted to group projects. Except for Project 1, *All About Me*, the students always had the option to work individually or in a group. Although some students worked individually on short practice assignments, all the students elected to work in a group for the remaining six projects. Group membership was fairly consistent; however the option to change groups was always available. The formation of the groups was counterintuitive to Ms. Bennett's expectations. Elizabeth and Jane did not collaborate on any projects and elected to work with the boys who were seated nearby.

> Having two girls in the class, who know each other, was nice. I expected them to pair-up and they never did. For the most part, if they had a question, they went to somebody else and not to each other. That was not what I expected. I thought the girls would stick together. Some of the young women I get in here are more independent and they will work with anyone they have a connection with (Bennett, 2010).

When I asked Elizabeth and Jane to comment on their choice of group partners, they both said they worked with their "friends."

How do girls and boys perceive their experiences in the entry-level computer science class at Garden State High School?

The participants shared similar opinions about the Web Design 1 class. Their positive view of the class grew out of their positive experiences. During the focus group discussions, Edward shared that he felt "challenged" by the projects and "enjoyed the opportunity to be creative." He also said that the Web Design 1 class was "fun" because there was "a lot of freedom."

When asked to identify the best aspect of the class, Charles said, "I think how everyone can work individually, but also have the opportunity to work together. Because some people need help, you have a chance to teach people what to do. You can learn that way - by teaching other people. I think it is a great way to learn." Edward expressed the same idea. "Teaching other students has been a focus in this class. People in here are very friendly. I like the varied ways we worked. Group work and individual work was a good part of the class." Elizabeth and Jane enjoyed the group work as well. Jane elaborated, "There was always someone ready to help you. And Ms. Bennett was always around to answer questions too."

As the semester progressed, I noticed how the students' social interaction supported their learning experience. By March 2010, approximately the middle of the semester, I noticed an increase in the students' participation and willingness to provide each other with assistance. The students increasingly relied on each other for help and support for the remainder of the semester. Collaboration and teamwork were part of their everyday classroom experiences. Additionally, the learning activities were presented and learned in an authentic context that provided practice in what web designers actually do in the real world. The students learned content through these learning activities rather than acquiring information through lecture.

The characteristics of the Web Design 1 learning environment correspond to the framework of a situated learning approach where knowledge and skills are learned in the context that reflect how that knowledge is obtained and applied in everyday situations. To situate learning means to involve other learners, the environment and the activities to create meaning (Lave & Wenger, 1991). The Web Design 1 class provided a "community," an opportunity and a setting for the social interactions and learning (Lave & Wenger, 1991). According to Wenger (2007), three characteristics are crucial in distinguishing a community of practice: the domain, the community and the practice. In the Web Design 1 class, the domain was the students' shared competence in web design. The community was the group of students in the class who engaged in joint activities and discussions, helped each other and shared information. The students' relationships enable them to learn from each others. Finally, the students in the community were practitioners who shared experiences and ways to solve problems.

All the focal students identified math as an academic strength. I found it interesting that the participants expressed the idea that their math and problem solving ability supported their work in web design. Edward said, "You have to be organized and be able to problem solve to be good at creating websites." Elizabeth liked "all kinds of puzzles" and Jane told me that she was "a good problem solver." As mentioned earlier, Charles did not schedule a math class during his senior year, however he contended that taking computer programming in the fall and web design in the spring was "very much like problem solving."

Three of the participants' interest in computer science increased as a result of taking the Web Design 1 class. When asked to comment on his interest level at the end of the semester, Charles responded, "Definitely increased, because now that I have a broader knowledge of what I am doing, I want to continue in the computer world." Similarly, Edward said, "It definitely increased my interest in the subject. Next year I'm taking more computer science classes." Elizabeth said, "I will probably take more classes. I like it [web design]. I will definitely take another computer class, but I wouldn't major in it or work in the field." Jane acknowledged an increase in knowledge, but not a significant increase in her interest in computer science. However, she said, "It [the class] was fun and it was easy. I would definitely take the second class, but I won't be here."

A common thread in the students' comments about the Web Design 1 class was an appreciation of the opportunity to manage their learning environment by working individually, working in a group and working at their own pace. Charles and Edward valued the opportunity to try new things and Edward recognized the class as an outlet for his creativity. For all the students, their actual and/or perceived ability in math and problem solving seemed to provide the confidence needed to succeed in the Web Design class.

What kinds of opportunities occur in the entry-level computer science class at Garden State High School to foster the construction of the identity of a computer scientist for girls and boys?

Adolescence is a time of continued identity formation. Students acquire a sense of themselves as strong or weak in certain areas and make decisions about courses relating to those beliefs. The comments that teachers and guidance counselors make and the encouragement they give, or do not give, to take certain courses influences how students see themselves. Additionally, friends and families play a role in the students' course selection.

The act of learning not only changes "what the learner knows" but "who the learner is" (Wortham, 2004, p. 715). When students become involved in a new practice, e.g., learning web design, they participate in new activities and change their positions with respect to other people (Lave & Wenger, 1991). In this way, learning involves both cognitive and identity development (Lave & Wenger, 1991). How teachers create classroom events that link students' own experiences to the curricula can "facilitate overlap between identity and academic learning and have various effects on students' identities (Wortham, 2006, p. 277). Learning can change identity and the self (Wortham, 2006).

Prior Experience

One of the challenges in high school computer science classes is that many boys enter school with a great deal of formal and informal experience (Margolis & Fisher, 2002, Bravo & Kearney, 2003). This phenomenon seems to result from boys' interest and exploration of computers at an early age (Margolis & Fisher, 2002, Christie, 2005).

Charles and Edward entered the Web Design 1 class with a future computer-related career in mind. Charles' interest in computer science was guided by his uncle during his middle school and early high school years. He did not enjoy his middle school computer class experiences. When I asked Charles about his middle school Computer class, he responded, "I honestly don't remember anything." He explained, "Until my junior year, I was going to be an accountant. But then I decided I wanted to go into computers. Since then, I have taken a number of computer science classes."

Similarly, Edward entered the class with a strong interest in computers and considerable knowledge of computer programming and software. Ms. Bennett was "impressed with Edward's motivation and drive."

> He seemed to have a lot of prior knowledge and was not afraid to try things. He was in the Computer Programming course in the fall and spent a great deal of time outside of class working with computers. He always seemed to take it to another level. When he finished early, he enhanced his project. That is also a part of Edward's success; he's willing to try things. He has that type of motivation. By adapting the curriculum to meet the individual student needs, it allowed Edward to work at his own pace and to grow academically (Bennett, 2010).

In contrast, Elizabeth and Jane entered the class with little prior knowledge or desire to enter the field of computer science. Elizabeth needed a class that fit into her schedule and Jane had exhausted the list of entry-level classes in most departments. Nevertheless, opportunities for novice students to narrow the experience gap by acquiring knowledge and developing a deeper level of engagement in web design were available.

The class activities were organized to allow all the students to become part of the learning community and to provide time for projects to be completed during class. However, the students were encouraged to practice skills, to explore and to enhance projects at home. Additionally, students were encouraged to arrange appointments with Ms. Bennett for extra help. In this way, the learning resources to personalize the curriculum and to excel in the class were equitably available to all students. When I asked Ms. Bennett if any of the focal students had arranged appointments for extra help during the semester, she did not recall meeting with anyone before or after school.

Identity construction hinges on a student's perception of self. At some point a student must have a crystallizing experience that brings the idea to the forefront: *I like this. I am good at this. I am a computer scientist.* This signal motivates the students to devote attention toward a goal. By the end of the semester, the students acknowledged a change in themselves as a result of completing the class. Jane discovered a new area of academic strength – web design. In the focus group, Jane modified her academic strengths, identified earlier in the semester as math and problem solving, to include "math, problem solving and designing websites" at the end of the semester. Charles increased his knowledge and interest in computer science. Charles felt that he "learned a lot of basic skills and core knowledge for creating websites." As a result of his broader knowledge base, his interest in computer science increased and he is motivated to continue in the computer world. Elizabeth is also motivated to enroll in additional computer science classes. She stated, "I like it [web design]. I will definitely take another computer class."

From my observations and Ms. Bennett's comments on Edward's work during the semester, I sense that Edward's identity as a computer scientist was reinforced and enhanced by his exploration of content, expert status and social experiences in the class. Obviously, my data do not support a claim that any one of the focal students constructed the identity of a computer scientist during the semester. However, I believe that my description of the students' interaction with a curriculum that afforded them the freedom to work at their own pace, to pursue topics of interest and to manage their learning environment demonstrates that opportunities to acquire knowledge and to develop a deep level of engagement in web design existed in the class. In spite of these opportunities, some nagging questions remain regarding how other factors, including teacher beliefs and attitudes and student prior knowledge and experiences with computers, influence which students take advantage of the opportunities and ultimately impact student achievement.

Curriculum and Pedagogy

Over the past five years, the Web Design 1 curriculum has been revised to reflect the advances in technology, the popularity of social networking sites and the computer savvy of the students. Mr. Merrill explained, "We geared it [the curriculum] more for the Facebook generation and the MySpace kids. Our enrollment has grown, but it's obviously not [gender] balanced."

The Web Design 1 projects promote and support 21st Century skills. They provide opportunities for critical thinking and problem solving, communication, collaboration and creativity. The students are actively engaged in using technology as a tool rather than passively receiving information from the technology. The cornerstone of the Web Design 1 curriculum is student choice. Throughout the semester, Ms. Bennett provided an opportunity for the students to manage their learning environment by allowing them to work at their own pace, to work individually or in groups and to add additional features to the project requirements The students had freedom to determine the themes of their websites as long as the content is of a "legal and decent nature." They focused on topics that were meaningful to them rather than working on contrived assignments.

For example, in Project 2, the students worked in groups to create a fictional company website. The project requirements included a home page, mission statement, history and products or services. Charles and Jane worked together to create a cheerleading website, “Jane’s All-Star Cheerleading,” reflecting her long-term involvement in cheerleading. She designated her parents as co-presidents of the company, her boyfriend and herself as co-vice presidents of the company and Charles and herself as receptionists. The company specialized in working with cheerleading teams, not individual cheerleaders. In addition, the company sold a variety of products, including uniforms, shoes, bows, pom-poms and megaphones. Although Jane selected the theme and company administrators, both she and Charles provided the images and wrote the code.

Edward teamed with two boys in the class and created a spoof on companies that sell motivational posters. His “Demotivational Posters” website advertised “sardonic, witty remarks on situations captured on cameras for generations to come.” As I observed the class, it was obvious to me that Edward enjoyed working on Project 2. The website served as a representation of his creative and witty nature. Project 6 broadened the scope of Project 2 by adding additional pages to the company website using text boxes, password boxes, radio buttons, checkboxes and menus to create the order forms and registration forms.

This year the Web Design 1 students were required to present their projects to the class. This added dimension can be difficult for shy students like Elizabeth who struggle with public speaking. Mr. Merrill provided an explanation for the presentations. “Many students hate public speaking, but it is good for them to speak in front of the class. It gives them an opportunity to show off their work and creativity. It makes them proud of what they’ve done.”

The Web Design 1 projects are personalized to address the students' needs, interests and aspirations. The students are empowered to reach "above and beyond" the requirements of a project and to try new things. Additionally, the Web Design 1 curriculum promotes connections between computer science and other disciplines and is delivered through teaching methods that appeal to a broad variety of learning styles.

How do perceptions of Computer Science as a discipline influence high school girls' interest and enrollment in advanced computer science classes?

Culture plays an important role in guiding women toward traditional careers. There is no way to know the direct influence of socialization that affects students' selection of courses. Furthermore, it is too easy to downplay the differences within each gender and within each individual and to attribute the gender imbalance in computer science classes to differences in women and men. We know that the important factors in the decision of women to study computer science include the comments that teachers and guidance counselors make and the encouragement that family and friends give (Margolis & Fisher, 2002). Ms. Hanson, a guidance counselor at Garden State High School, commented on the influence of friends on student choices.

> It's very much word of mouth and what courses friends take. I don't know if young women feel that computer classes are kind of geeky and nerdy, and they'll be sitting in front of a computer all period. It appears that they take more of the web design classes, and I don't know if it's because they [web design classes] are more artsy or creative. I know that no girls have enrolled in AP Computer Programming in many years (Hanson, 2010).

Home environments also influence students' interest in computer science (Margolis & Fisher, 2002). The careers and interests of a girl's parents have a major influence on whether she pursues an interest in science or engineering (Margolis & Fisher, 2002). Coming from a computing or engineering family provides an opportunity for parental mentoring and eliminates the intimidation factor associated with STEM fields for many students (Margolis & Fisher, 2002). Ms. Hanson also emphasized the families' effect on students' choices.

> I still think that in today's world, boys think robotics and girls don't, and I'm not sure where that comes from. I feel that when young women are encouraged and come from families that believe that women can do anything, it creates a more conducive environment to seek higher level math, engineering and computer science classes (Hanson, 2010).

Classes and groups of students have reputations in a school. Computer science is often perceived as "geeky." Geek is a slang term used to describe a person who is perceived to be overly intellectual or obsessed with computers. In my interview with Ms. Moore, she discussed society's image of the computer science student as a "loner." From her experience as a guidance counselor, she believes that many girls do not want to be associated with that image or with students in the computer science classes.

> There is a stigma and stereotype that is attached to the students who study computer science. You see how they portray computer science on TV. Girls don't want to be a geek or a nerd. They want to be cool. You have a stereotype that is part of the culture at this school and I don't think we are doing anything in our classes to overcome it (Moore, 2010).

Students' attitudes toward computers

The students' responses to the survey revealed a comprehensive view of computer science as a field of study. Charles, Elizabeth and Jane strongly disagreed with the "geeky" perception of computer science and agreed that working on computers can be creative. Edward did not agree or disagree with the geek perception, but also found working on computers to be creative. While the majority of the students in the Web Design 1 class, approximately 64%, rejected the geek image, they perceived computer science as a solitary activity. Furthermore, these same students did not think that "working on computers takes teamwork and interacting with people." Elizabeth was the only focal student to perceive computer science as a solitary activity.

Thirteen students, including Charles, Edward, Elizabeth and Jane, strongly agreed or agreed that computers are "interesting in and of themselves," and that "computers are tools to be used to get other things done." Fourteen students, including the four focal students, strongly agreed or agreed that working on computers gave them an opportunity to be creative. All sixteen students said that working with computers was "fun."

The students identified "hardware, software, the Internet and computer games as the things that came to mind when thinking about computer science. Collectively, the students did not feel that there was anything about the field of computer science that discouraged them from taking computer courses at the high school or pursuing a career in computer science. Only one student, Edward, had received warnings from friends regarding "some of the higher math and learning programming languages."

The Web Design 1 students seemed to have similar constructions of computer science as a field of study and similar views regarding computer use. However, the students did not form a consensus on a description of someone who works in computer science. Ten of 16 students in the class, including Elizabeth, perceive computer science as a solitary activity. Overall, one student's characterization of a person who works in computer science as "intelligent and works alone" summarized the opinions of the majority of the students in the class.

The Girls' Perceptions of Computer Science

Most women in computer science are self-described math and science people who enjoy problem solving (Margolis & Fisher, 2002). Both girls in the Web Design 1 class, Elizabeth and Jane, identified mathematics as their academic strength. They entered the Web Design 1 class knowing that there would be few girls in the class and that the classroom dynamics would be affected. As previously discussed, Jane enjoyed her prior experience as the solitary girl in the Pre-Engineering and Robotic class last year. She believed that her math and problem solving skills supported her achievement in the class. During the focus group discussion she explained, “I love math. I have dyslexia, so I’m not good at English. Math just comes easily, so it makes me like it.” When I asked Jane if she thought that her math ability supported her success in the Web Design class, she responded, “It made a big difference for me. I like the class. It was fun and it was easy. I would definitely take the second class, but I won’t be here.”

Similarly, Elizabeth gave an affirmative nod when I asked if she would enroll in the Web Design 2 class after her experience in Web Design 1. The Web Design 1 class was Elizabeth’s first experience in a gender imbalanced class. Despite her shyness, Elizabeth pushed herself beyond her comfort zone and met all the requirements of the class, including the project presentations. The nervous behavior that I observed during the large group presentation of Project 2 on March 17, 2010 contradicted the take-charge attitude that I observed in the small group setting on March 10, 2010. Although she had assumed a leadership role by organizing and managing Project 2, Elizabeth assigned the majority of the presentation to her group members. As the semester progressed, Elizabeth was able to develop a level of comfort with the culture of the Web Design 1 class and successfully complete the class with an “A.” Similarly, Jane successfully completed the class. Jane’s sense of accomplishment and confidence was demonstrated by the identification of web design as an "additional" academic strength and her willingness to take future computer science classes.

For some girls, the message that computer science is unfeminine may be an obstacle. Many girls acquire status from their attractiveness to boys and downplay their accomplishments to avoid the alienation of their peers and the discredit of their activities (Crawford, 2006). This was not the case with Jane and Elizabeth, as each assumed a leadership role in their group work. I observed that the girls presented an attractive, feminine image via their choice of hair styles, trendy clothes, fancy flip-flops and manicured nails. Without challenging society's views about gender-appropriate roles, Jane and Elizabeth managed their conduct in relation to the normative conceptions of appropriate attitudes and activities for one's sex category. Jane fulfilled the stereotypical role by volunteering to bake cupcakes for the class and creating a decorative poster on Internet Safety protocol for the classroom. Elizabeth's demeanor was always quiet and polite. Even when organizing group work, I observed her manner as courteous and reserved.

Jane's friends did not enroll in a computer science class in high school. Although Jane would definitely take Web Design 2 if she could, she understood why "some girls may not feel comfortable in a class with mostly boys." She shared, "I tell my friends about the class, but they are not interested. They say they don't want to do that [enroll in a class with few girls]." When I asked her to explain why her friends did not want to enroll in the class, Jane said, "They are already scheduled for next year or they have the classes they need to take for college. But I think bringing more girls into the class is a good idea."

Chapter Summary

The Garden State School District has established policies to ensure equal educational opportunities for all students. Gender equity is vital to the development of the full potential of all students. Enrollment statistics confirm a gender imbalance in computer science classes at Garden State High School (see Appendixes B and C). A small number of female students enroll in entry-level Web Design classes, but they rarely schedule advanced computer science classes. Moreover, scheduling practices reveal a pattern of girls' enrollment in advanced-level *academic* courses but not in advanced-level *elective* courses (see Appendixes B, C, D and E). Furthermore, enrollment in elective courses is divided along gender lines (see Appendix E).

The process of examining the structure, pedagogy and culture of the entry-level led to the discovery of institutional factors that influence the gender imbalance in computer science classes at Garden State High School. The institutional factors include course scheduling practices and prerequisites, teacher beliefs and attitudes, students' prior experience and knowledge of computers, transition from middle school to high school computer science classes and computer-related opportunities outside the classroom. Some factors, both inside and outside the classroom, reveal a subtle but prevailing bias surrounding computer science. Teacher beliefs and attitudes regarding students' interest and confidence levels and potential for success often impact persistence in computer science (Margolis & Fisher, 2002). In the Web Design 1 class, the students who completed projects that exceeded the requirements were divided along gender lines. Furthermore, opportunities to participate in extra curricula computer-related activities were available by teacher-invitation only.

The educators' perceptions of factors that influence gender inequity in the computer classes relate to the students' middle school computer experiences, the substantial enrollment of girls in Advanced Placement courses, the significance of prior experience from informal computer exploration and the lack of a clear pathway delineating how computer courses support the academic courses in all departments.

The students' were unable or unwilling to offer an explanation or remedy for the gender imbalance in the Web Design 1 class and other elective classes at Garden State High School. Research findings indicate that as students interact with their teachers and peers, gender imbalance is reproduced and seems inevitable, natural, and freely chosen (Spencer, Porche, & Tolman, p. 1801). The focal students had not previously considered the gender imbalance in their classes and accepted it as a natural part of school life.

Personalized learning has been a long-standing initiative and guiding principal in the Garden State School District. The Web Design 1 curriculum is meaningful and relevant and offers choices to meet the needs and interests of all students. Choice is the cornerstone of the curriculum, e.g., selecting project themes, working individually or in a group, working at one's own pace and trying new things. The positive classroom experiences of the students in the Web Design 1 class illustrate how a student-centered curriculum and instructional methods that address the needs and interests of individual students support student learning. Additionally, the accounts of the focal students and the classroom teacher identified the realized or perceived ability in mathematics as a common factor that influenced confidence levels in computer science

Despite the advantage of prior experience with computers, learning opportunities to acquire knowledge that can narrow the experience gap and foster a deep level of engagement with computer science existed in the Web Design 1 class. The structure of the Web Design 1 curriculum and learning activities fostered a link between the students' experiences and the real world. As the students participated in new web design activities, they changed their relationships with respect to other people. By the end of March 2010, I observed a decrease in the amount of questions directed to Ms. Bennett and an increase in the number of questions directed to other students. The *Ask Three than Me* rule provided opportunities for students to be acknowledged and identified by peers as "experts." Additionally, opportunities to assume leadership roles in organizing and managing projects allowed students to be recognized as classroom leaders. In this way, the act of learning involved both cognitive and identity development.

In the next chapter, I discuss these findings in depth in the context of the literature on gender and technology. Although the Web Design 1 class offers great opportunities for students to learn and apply computer skills and to personalize and enhance projects much more is needed to break down the existing gender barriers, to encourage more girls to enroll in the introductory computer science class, to bridge the computer science experience gap and to change beliefs and attitudes about computer science at Garden State High School. I also make recommendations for how the Garden State School District might more effectively support students in the computer science classes. Finally, I suggest a focus for further research.

CHAPTER VI: DISCUSSION AND CONCLUSION

> When 90% of a class is male and a small percentage is female, you have to be a pretty strong person to handle that. The dynamics [of the class] are different, even the conversation in the class. It might influence the girls' selection of courses, and it's unfortunate because there are such great opportunities here [at GSHS]. We can easily schedule the class. I guess the question is: How will they [the girls] feel when they are in it (Hanson, 2010)?

The Web Design 1 class at Garden State High School offers students an opportunity to engage in a comprehensive and relevant curriculum, to personalize their learning environment, to build confidence in themselves and to develop a deeper interest in computer science. After reading so many discouraging stories about computer science classes, it was comforting to see all the Garden State High School students succeed in the introductory computer science class. However, several factors, both inside and outside the classroom, revealed a subtle, but prevailing bias surrounding computer science. In the absence of institutional interventions that actively support them, girls must find their own coping strategies. What can and should institutions do to eliminate the negative factors associated with computer science?

Discussion

The findings presented in the previous chapters provide a comprehensive look at an entry-level computer science class. A few points in particular reinforced or questioned concepts I encountered in the literature.

The Role of the Teacher

Teachers play an important role in influencing persistence in computer science and recruiting students to computer programming (Margolis & Fisher, 2002). Additionally, teachers' expectations play an important role in a student's achievement and self-perception (Margolis & Fisher, 2002). Research shows that girls' interest in computer science is often quite different than boys (Margolis & Fisher, 2002). Many more boys report an early, intense and all-consuming involvement and connection with computers than girls. Teachers often use this male model to identify successful computer science students and look for girls who demonstrate their interest and commitment to computer science in ways that mimic the male standard of behavior (Margolis & Fisher, 2002). This was the trend in the Web Design 1 class. Both Charles and Edward entered the class with considerable prior knowledge and experience with computers and the desire to pursue a career in a computer-related field. Elizabeth and Jane entered with less experience and different career goals.

Based on her teaching experiences, Ms. Bennett has developed a profile of the girls who enroll in computer science classes at Garden State High School. She explained, "For many of the girls I have had in the Web Design class, it seems to be a trend. Often they are seniors, some very social, some not scholastically-minded, however they enjoy the course. They love designing sites about their music interests or the actors they like." Additionally, Ms. Bennett believes that boys are risk-takers and girls are not. She explained, "Most boys are willing to try things. Sometimes girls seem to be resistant to that because they don't want to do anything wrong." Although she acknowledges a difference between the boys' and girls' interest and confidence levels, she does not "think about teaching girls differently than boys." Ms. Bennett clarified, "I try to incorporate variety for individual students, but for most things, I don't really do anything differently for girls."

The discrepancy in Ms. Bennett's statements reveals a disturbing, yet common, teacher belief (Margolis & Fisher, 2002). If teachers use a male model to identify potentially successful computer science students, many girls' will be overlooked since they often lack prior knowledge and experience with computers and demonstrate their interest in computer science in different ways. When teachers acknowledge issues of gender in their classes, they demonstrate that there is no single version of truth. All teachers must be open to a broader vision of what computer science is, who can succeed at it and what instructional methods are needed to build the confidence of all students.

Margolis and Fisher (2002) suggest that girls should be actively recruited to enroll in computer classes and to participate in computer-related extra-curricular activities. Furthermore, they warn that if teachers issued a generic announcement, only boys will show up. I see the merit of this suggestion most clearly with Elizabeth. When she was seeking an elective course, Mr. Merrill took a few minutes to speak to her about web design. That brief conversation of encouragement boosted her interest in enrolling in the Web Design 1 class.

The same holds true with Ms. Bennett's invitations to attend the Computer Honor Society meetings. Most likely, a student is flattered to receive a personal note from the Computer Science teacher and to be recognized as an asset to the computer science department. However, as encouraging as this practice may be for some students, it excludes other students from valuable opportunities for the guided exploration and extension of different aspects of computer science and computer-related social experiences.

This year, Ms. Bennett invited four boys from the Web Design 1 class. Edward was invited, but Charles, Elizabeth and Jane were excluded. When I asked Ms. Bennett to share her thoughts regarding the membership of the Computer Honor Society, she said,

> In the beginning, I thought they [Charles, Elizabeth and Jane] might find it interesting. But being seniors and having the course in the spring, makes it harder. They are welcome, but I don't see them staying with it. I have not had female students in there for the past few years. They have other social things that they do (Bennett, 2010).

I find the exclusion of the girls from this activity especially discouraging in light of previous recruitment efforts at the school and because it reinforces the 'boy's clubhouse" image of computer science. Furthermore, the important learning resources provided by membership in the Computer Honor Society are not equally accessible to all students.

Prior Experience

Prior experience is a critical factor that impacts persistence in computer science (Paloheimo & Stenmen, 2006; Margolis & Fisher, 2002). For girls, a high school computer science course is often the deciding factor in their decisions to major in computer science (Margolis & Fisher, 2002). For boys, the interest in computer science occurs much earlier, usually at home and with friends. This seems to be the rule rather than the exception at Garden State High School. The Web Design 1 class was the first high school computer science experience for seniors, Elizabeth and Jane. Edward and Charles had enrolled in a computer programming class during the fall semester.

Edward's interest in computer science was inspired by "playing a bunch of video games while in elementary school" and Charles was encouraged and supported by his uncle in computers before high school. Of the remaining 12 boys in the Web Design 1 class, 7 boys entered the class with knowledge of computers gained through informal exploration and are considering a future in the computer field.

Prior experience seems to encourage a willingness to "try new things" in the class. Ms. Bennett was "impressed with Edward's motivation and drive." She said, "He seemed to have a lot of prior knowledge and was not afraid to try things. Most boys are willing to try things. Sometimes girls seem to be resistant to that because they don't want to do anything wrong." Female students often enter the introductory courses with weaker computer skills and less involvement with computers than their male peers (Margolis & Fisher, 2002). I found this to be true for the girls in the Web Design 1 class. The survey results indicated that Elizabeth and Jane primarily used the computer for Internet research and communication while 11 boys indicated that they used the computer to play games and to try new things, such as animation and sound.

Although introductory courses do not have prerequisites, the courses usually move quickly through the fundamental principles. The fast pace is difficult for students encountering the concepts for the first time and can cause some students to become discouraged with their ability in computer science (Sackrowitz & Parelius, 1996). Sackrowitz and Parelius (1996) found that adjusting the pace of instruction in high school introductory computer science classes ensures that a student with little computer science background will have a reasonable chance for success and a student with more experience will be challenged. Moreover, Vilner and Zur (2006) suggest that more hands-on experiences in introductory computer science classes can narrow the initial experience gap that exists between girls and boys (Vilner & Zur, 2006).

The arrangement of the Web Design 1 curriculum into seven projects promotes the real world application of the fundamental principles of web design. The students' opportunity to personalize and enhance the projects addresses their individual needs and interests. As mentioned previously, Edward entered the Web Design 1 class with the most prior experience. He said, "It's been a really good experience. I like the hands-on, lab setting of the class and being able to add on to my projects with things I find on my own." Elizabeth and Jane entered the Web Design 1 class with little prior computer science experience. Their acknowledgement of positive experiences in the class, self-assessed increase in knowledge of web design and willingness to enroll in future computer science classes seems to confirm the value of hands-on experiences and the importance of allowing students to work at their own pace.

Collaboration

A widely held perception of computer programming as a solitary activity limits girls' participation (Vilner and Zur, 2006). Traditional classroom practices in introductory classes generally require that students work individually on their programming assignments, while collaborative methods are often used in higher-level computer science classes where group projects are encouraged. According to Barbara Rogoff (2001), educators should foster communities of practice because learning is in the relationships between people. She recommends that schools be places where learning activities are planned by students as well as teachers, instruction is build on students' interests and collaboration is a key component in planning learning activities (Rogoff, 2001). Pairing and grouping is particularly beneficial to female students because it addresses the initial experience gap that exists between girls and boys (Bravo, Albino, Gilbert, & Kearney, 2003; Werner, Hanks, & McDowell, 2005). Most importantly, the gender of the student's partner is unrelated to the confidence level of that student (Werner, Hanks, & McDowell, 2005).

Ms. Bennett was surprised that Elizabeth and Jane did not work together and that they elected to work with "other friends" in the class. Nevertheless, their success in collaborating with the boys in the class seems to confirm Werner, Hanks and McDowell's research regarding the insignificance of the gender of a student's partner. As previously described, I observed Elizabeth and Jane assume leadership roles while working in their collaborative groups on projects.

When I asked Jane if she thought that the classroom dynamics change when there are few girls and many boys in a class, she shared her experience of being the solitary girl in Pre-Engineering and Robotics class last year. She said, "Everyone picked on me, in that guys-make-fun-of-girls way, but that's okay. Like, girls are horrible drivers – that kind of thing. It didn't bother me." Jane's acceptance of the teasing is comparable to a teenage version of the "play" described by Barrie Thorne (1993) in *Gender Play* (p. 81). According to Thorne (1993), teasing is an ambiguous signal that can have sexual, romantic or aggressive meanings. It occurred to me that in the context of the Pre-Engineering and Robotics classroom, the teasing could have represented a flirtatious interaction common between adolescents. Although I did not observe any incidents of teasing in the Web Design 1 classroom, the teasing in the Pre-Engineering and Robotics class could also have been subtle undermining despite Jane's claim.

The Math Connection

Computer science skills are often associated with mathematical skills because both depend on logical and sequential thinking abilities. However, in studies with girls in computer science classes, the transfer of mathematical skills to computer science did not emerge (Yasuhara, 2005; Yasuhara, 2003; West & Ross, 2002). The findings indicate that female students did not relate programming concepts to mathematical concepts (Yasuhara, 2005; Yasuhara, 2003; West & Ross, 2002).

The findings of this study seem to confirm a connection between realized or perceived ability in math and computer science. All the focal students, Charles, Edward, Elizabeth and Jane, identified their academic strengths as mathematics and problem solving. Edward said, "You have to be organized and be able to problem solve to be good at creating websites." Elizabeth liked "all kinds of puzzles" and Jane told me that she was "a good problem solver." Contrary to practice at Garden State High School, Charles did not schedule a fourth year of mathematics. He explained, "I took computer programming in the fall and I'm taking web design now. That is very much like problem solving." Moreover, during my interviews with Ms. Bennett, she emphasized her math background and employment as a math tutor.

Comfort Level

Students fare better in their computer science studies if their comfort level is high. One of the factors in defining comfort level is how comfortable students are in presenting questions to other students and their teachers (Paloheimo & Stenman, 2006). In introductory classes, the typical gender distribution (majority male) in computer science classes lowers the comfort level of all students in comparison to the case with an even gender distribution. Palohimo and Stenmen (2006) reported that in the typical unbalanced class with one or two female students, the male students refrained from asking the teacher questions and conversing with peers (Paloheimo & Stenman, 2006).

The success of Ms. Bennett's practice of assuming the role of facilitator and allowing the students to take responsibility for their learning seems to question this research finding. The *Ask Three then Ask Me* Rule encourages student interaction, provides an opportunity for students to assume a leadership role and promotes a social environment in the class. During classroom visits, I observed Elizabeth and Jane, as well as the other students in the class, asking questions and offering assistance to classmates. Edward clearly expressed this sentiment. When asked for his advice for success in the class, he said, "Ask questions of everyone around you. People in here are very friendly."

Limitations and Lessons Learned

This study focused on the experiences of four students and one teacher in the Web Design 1 class in one New Jersey high school. I do not suggest that these findings represent the experiences of all high school students in introductory computer science classes. However, the students' and teacher's experiences, feelings and perceptions provide a valuable snapshot of an entry-level computer science class. Similarly, the guidance counselors' accounts of scheduling sessions provide insight into the students' decision-making process for course selections.

When I began this study, I did not anticipate how difficult it would be to recruit participants. I encountered resistance from some parents because many Garden State High School students carry a rigorous course load, participate in sports and extra-curricular activities and hold part-time jobs. Parents were concerned that participation in the study would require "extra work" for their children and steal "valuable time" from an already filled-to-capacity schedule. Additionally, the enrollment in the Web Design 1 class did not stabilize until the beginning of March. Each time I visited the class during the first month of the semester, I noticed some new students and the absence of others after securing their parents' permission for participation.

I reconsidered my original research plan and altered some of the components to accommodate the students' busy schedules and the changing enrollment in the class.

By reassuring the parents and the students that participation in the study would not result in additional class assignments, I was able to secure the necessary permission for participation. Originally, I planned to conduct one focus group at the end of the semester. However, to accommodate the students' schedules, I conducted two focus groups; one with the girls and one with the boys.

I found that scheduling and conducting interviews with the four focal students quite challenging. Their demanding schedules included various school, sports, extra-curricular and social activities. I decided to conduct the first interview in person and the second interview by email. Additionally, the students were willing to answer questions and converse about general topics with me before, during and after classroom visitations.

I found Elizabeth and Jane the most difficult students to interview. Elizabeth is very shy and usually responded with one word answers or nods. Jane is very talkative but often went off-topic and did not answer my questions. I struggled to find ways to ask the same question from different perspectives. Charles' responses to my questions were often guarded and protective of the teacher. He evaded my questions about ways to enhance the classroom experience by responding, "It's a really great class, it's a great environment, and Ms. Bennett is a really great teacher." I found Edward a most honest and open participant. His responses were simple and straightforward.

Implications for Practice

Female students often enter the introductory computer science classes with weaker computer skills and less involvement with computers than their male peers. The positive experiences of the students in the Web Design 1 class at Garden State High School demonstrate how a student-centered curriculum and differentiated instruction can help girls overcome the initial experience gap that exists in an introductory class. Hands-on activities and opportunities for collaboration proved to be a successful combination for the students in the Web Design 1 class. However, some simple, but important changes in (a) the curricula in the middle school, (b) the marketing of the high school computer science classes, and (c) the ways we recruit girls are needed to support and encourage girls' full participation in the high school computer science classes. These suggestions are detailed below.

The Middle School Experience

The district middle schools offer two computer-related courses, Applied Technology and Computers, in sixth, seventh and eighth grades. The Applied Technology courses focus on the development of technology and its application and impact on society. The curricula are well-defined for each grade level and build on previous classroom experiences. In six grade, the students work in teams on foundation level problems as they cycle through technology stations, which include robotics, electricity, computer animation and design, aerodynamics and digital speech. In seventh grade, the students engage in engineering and design challenges of vehicle design and Lego "Mindstorm." The students continue to focus on engineering through bridge building and airfoil design in eighth grade.

The Computers curricula focus on learning how to effectively create presentations using PowerPoint and Hypermedia tools in all three grades. Quite the opposite of the Applied Technology curricula, there is no delineation for each grade level in the Computers curricula or identified outcomes at the end of each year. Edward, Elizabeth and Jane described the focus of the middle school Computers class as "typing." For

Charles, the class was perfectly forgettable. When asked to describe what he learned in the class, he said, “I honestly don’t remember anything.”

The middle school Computers class is the first formal instruction that students receive in the Garden State district. Due to budget cuts, the elementary computer teacher and technology coach positions have been eliminated over the past three years. The middle school Computers curricula should include the preliminary computer skills required for a smooth transition into the high school Web Design and Computer Programming courses. A revision of the Computers curricula will address the experience gap that exists among girls and boys and will better prepared all students for the high school computer science classes.

Spreading the Word

Many students, parents and guidance counselors do not know what is taught in computer science classes. Moreover, they may not know how valuable computing skills can be in other disciplines (Margolis & Fisher, 2002). In an interview with Ms. Moore, she identified the need to “market” the computer science classes. She said, “We hand a course booklet to kids. Who knows if they even read it? Students know about courses through word of mouth. For web design, not enough girls are spreading the word.”

Ms. Moore suggested scheduling an open house to publicize the content and skills taught in the high school computer science classes and the educational and economic opportunities in the field of computer science field. Additionally, she recommended that “the computer science teachers visit the middle school math classes to discuss the entry-level courses and why they [the students] might be interested.”

Visiting an introductory computer science class would be a valuable experience for all the guidance counselors and for students considering enrollment in an introductory course. The opportunity to experience a computer class would assist the counselors when advising students on course selection and provide the students with the information needed to make informed decisions.

Recruiting Girls

Female students enroll in entry-level Web Design classes at Garden State High School, but they rarely schedule advanced computer science classes, spend time in the computer labs after school or participate in maintaining the school website. Garden State High School girls are using the Internet and the web for completion of class projects and assignments, but it is predominately the boys are who are programming the computers and designing the school website.

During the past seven years, recruitment attempts to remedy the gender gap in the computer science classes have included "all-girl" events intended to showcase girls' projects in the computer science classes and personalized outreach efforts by the math teachers. Despite these efforts, the gender gap in computer science classes persists at Garden State High School.

Margolis and Fisher (2002) suggest that "some of the best recruiters of girls are other girls" (p. 115). By visiting elementary and middle schools and sharing their classroom experiences, high school girls could serve as role models for younger girls. Girls feel less discouraged when they come together for communication and support (Margolis & Fisher, 2002). After school clubs, Saturday morning sessions in the computer lab and contact with community Girls Scout troops would establish a supportive network for girls. Fun-filled sessions that focus on robotics or video game programming can make technology come to life and begin to bridge the experience gap that exists between girls and boys in computer science.

Recommendations for Future Research

This study provides some insight into the classroom experiences of students in the introductory computer science classes at Garden State High School. The results suggest that student-centered learning environments encourage further participation in computer science. Additionally, the findings suggest some factors that encourage girls' decisions to enroll in computer science classes. Since these factors were identified by girls who elected to enroll in the introductory class, it would be extremely valuable to interview junior and senior girls who have never enrolled in a computer science class at the high school. Their perspective would add another dimension to the study and provide a deeper understanding of the factors that influence girls' participation in computer science classes.

The gender enrollment statistics in all electives courses at Garden State High School warrants further investigation. In the process of collecting data for this study, I requested the enrollment by gender for all elective courses at Garden State High School. The unexpected results revealed course selections along gender lines. Ms. Hanson commented, "I was very much surprised about the elective classes. The Economics class would seem like a natural match for girls who are interested in business. I see that there were no women in that class." Gender imbalance is prevalent in many elective courses (see Appendix B). I find it astounding that this information has never been requested nor systematically shared with department supervisors and guidance counselors.

Finally, it is crucial to examine teachers' attitudes and beliefs. Research shows that high school computer science classes can be critical for introducing girls to the field of computer science (Margolis & Fisher, 2002). Additionally, teachers are important for identifying and recruiting girls who would be interested and successful in computer science. If teachers use a male model to identify potentially successful computer science student, many girls' will be overlooked since their interest in computer science may be demonstrated in different ways. Teachers must be open to a broader vision of what computer science is and who can succeed at it. Very often teachers are surprised at the magnitude of the impact of their actions on student achievement and student persistence in computer science.

Teachers at Garden State High School must examine their beliefs regarding gender equity. Enrollment statistics in the elective courses reveal a gender disparity between core academic courses and elective courses. Additionally, the district should reaffirm its commitment to gender equity by examining the institutional hurdles that girls face and by providing professional development for staff in gender-fair practices. Forming a school-wide Gender Equity Committee and identifying gender-fair behaviors could be an initial step in this endeavor.

Conclusion

We do not assemble our identities like we quickly assemble pieces of furniture from IKEA. Our experiences begin when we are born and we are influenced by our environment and social interactions. Encouraging and discouraging comments from family, friends, teachers and guidance counselors influence the identities students construct for themselves. Classroom experiences in introductory courses impact decisions to move to advanced courses. The positive experiences of the girls in the introductory computer science class demonstrate that a student-centered learning environment that personalizes the curriculum and instructional methods that address students' needs and interests can encourage participation in advanced courses.

Women account for more than half of the work force yet hold only 28% of technology positions (AAUW, 2008). How much of the under-representation of women in computer science can be attributed to gender socialization and the inability of the women to image themselves as computer scientists? If girls continue to avoid enrolling in computer science classes and passing up the career opportunities that are available to them, computer science will remain a man's domain. Girls must be encouraged and supported to explore technology at an early age. The initial activities should be enjoyable, educational, and empowering so that girls will *savor the first byte.*

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APPENDIX A

DATA SOURCES

Research Questions	Data Source
What factors can help explain why so few girls enroll in the advanced computer science classes at Cranford High School?	Class survey Individual/small group interviews Discussions with teacher Classroom observations Enrollment data Curricula documents
How do the existing structure, pedagogy and culture of the entry-level computer science class at Garden State High School encourage or discourage girls' and boys' interest, enrollment and persistence in the advanced computer science classes?	Class survey Individual/small group interviews Discussions with teacher Classroom observations Enrollment data Curricula documents
How do girls and boys perceive their experiences in the entry-level computer science class at Garden State High School?	Class survey Individual/small group interviews
What kinds of opportunities occur in the entry-level computer science class at Garden State High School to foster the construction of the identity of a computer scientist for girls and boys?	Individual/small group interviews Discussions with teacher Classroom observations Curricula documents Student work
How do perceptions of Computer Science as a discipline influence high school girls' interest and enrollment in advanced computer science classes?	Class survey Individual/small group interviews

APPENDIX B

TABLE OF ENROLLMENT IN SELECTED COURSES 2009-2010

	Total Enrollment	Male Students	Female Students	Percentage of Female Students
Grade 9	287	157	130	45.3
Grade 10	300	166	134	44.7
Grade 11	278	145	133	47.8
Grade 12	274	144	130	47.4
Total Enrollment	1139	612	527	46.3
Computer Classes				
Web Design 1	38	30	8	21.1
Web Design 2	11	10	1	9.1
Web Team	5	4	1	20.0
Computer Programming	19	19	0	0.0
AP Computer Science	1	1	0	0.0
Advanced Math Classes				
Honors Geometry	60	29	31	51.7
Algebra 2 and Trig Honors	59	31	28	47.4
PreCalculus Honors	58	33	25	43.1
AP Calculus AB	37	21	16	43.2
AP Calculus BC	25	11	14	56.0
AP Statistics	35	17	18	51.4
Advanced Science Classes				
Honors Biology	66	28	38	57.6
AP Biology	25	9	16	64.0
Honors Chemistry	114	58	56	49.1
AP Chemistry	7	2	5	71.4
Honors Physics	43	29	14	32.6
AP Physics	10	7	3	30.0
AP Environmental	70	26	44	62.9
Applied Technology Classes				
Graphic Arts 1	92	58	34	37.0
Graphic Arts 2	39	33	6	15.4
Graphic Arts 3	13	10	3	23.1
Introduction to CADD	42	36	6	14.3
CADD 2	12	11	1	8.3
Advanced CADD	6	6	0	0.0
Pre-Engineering & Robotics 1	42	42	0	0.0
Pre-Engineering & Robotics 2	17	15	2	11.8
Principles of Engineering	16	15	1	6.3
Construction Technology	15	15	0	0.0
Auto Techology	55	53	2	0.4

APPENDIX C

TABLE OF ENROLLMENT IN SELECTED COURSES 2008-2009

	Total Enrollment	Male Students	Female Students	Percentage of Female Students
Grade 9	290	163	127	43.8
Grade 10	279	143	136	48.7
Grade 11	266	142	124	46.6
Grade 12	268	128	140	52.2
Total Enrollment	1103	576	527	47.8
Computer Classes				
Web Design 1	70	54	16	22.8
Web Design 2	14	8	6	42.8
Web Team	7	7	0	0.0
Computer Programming	9	9	0	0.0
AP Computer Science	6	6	0	0.0
Advanced Math Classes				
Honors Geometry	60	31	29	48.3
Algebra 2 and Trig Honors	58	31	27	46.6
PreCalculus Honors	56	28	28	50.0
Calculus	13	7	6	46.1
AP Calculus AB	35	17	18	51.4
AP Calculus BC	40	9	31	77.5
AP Statistics	24	11	13	54.1
Advanced Science Classes				
Honors Biology	64	28	36	56.3
AP Biology	24	3	21	87.5
Honors Chemistry	70	36	34	48.6
AP Chemistry	9	5	4	44.4
Honors Physics	35	17	18	51.4
AP Physics	7	3	4	57.1
AP Environmental	43	12	31	72.1

APPENDIX D

TABLE OF ENROLLMENT IN ADVANCED PLACEMENT COURSES 2009-2010

	Total Enrollment	Male Students	Female Students	Percentage of Female Students
AP Art History	11	2	9	81.8
AP Biology	25	9	16	64.0
AP Calculus AB	37	21	16	43.2
AP Calculus AB/BC	25	11	14	56.0
AP Chemistry	7	2	5	71.4
AP Computer Science A	1	1	0	0.0
AP Economics Macro	24	20	4	16.7
AP Economics Micro	22	20	2	9.1
AP English Language	36	11	25	69.4
AP English Language/Brit Lit	23	5	18	78.3
AP English Literature	53	15	38	71.7
AP Environmental Science	70	26	44	62.9
AP European History	10	6	4	40.0
AP German	6	1	5	83.3
AP Government/Politics: Comparative	13	8	5	38.5
AP Government/Politics: US	13	8	5	38.5
AP Human Geography	41	21	20	48.8
AP Latin/Virgil	13	9	4	30.8
AP Music Theory	5	2	3	60.0
AP Physics C	10	7	3	30.0
AP Psychology	66	23	43	65.2
AP Spanish Language	28	11	17	60.7
AP Statistics	35	17	18	51.4
AP Studio Art	10	3	7	70.0
AP US History	78	32	46	59.0
AP World History	32	12	20	62.5
	694	303	391	56.3

APPENDIX E

TABLE OF ENROLLMENT IN ELECTIVE COURSES 2009-2010

	Total Enrollment	Male Students	Female Students	Percentage of Female Students
Crafts 1	84	27	57	67.9
Drawing	83	47	36	43.4
Art 1	71	33	38	53.5
Art History 1	4	1	3	75.0
Art History 2	1	0	1	100.0
Photography 1	90	36	54	60.0
Woods 1	98	88	10	10.2
Introduction to Business	142	97	45	31.7
International Business	23	16	7	30.4
Entrepreneurship	61	41	20	32.8
Personal Finance	68	34	34	50.0
Accounting 1	56	29	27	48.2
Microsoft Office 1	114	77	37	32.5
Microsoft Office 2	32	18	14	43.8
Multimedia Publication/Presentation	35	15	20	57.1
Marketing 1	79	53	26	32.9
Marketing 2	21	15	6	28.6
Journalism 1	30	14	16	53.3
Journalism 2	10	3	7	70.0
Mass Media	39	26	13	33.3
Speech Arts	22	8	14	63.6
Film as an Art Form	49	26	23	46.9
Creative Writing	43	9	34	79.1
Yearbook 1	16	4	12	75.0
Yearbook 2	6	0	6	100.0
Independent Living	31	11	20	64.5
Journey to Discovery	44	21	23	52.3
Ready Set Teach	42	6	36	85.7
Sew Easy	27	1	26	96.3
Loose Threads	15	0	15	100.0
Advanced Sewing	8	0	8	100.0
Fashion	20	1	19	95.0
Interior Design	35	4	31	88.6
Foods 1	131	77	54	41.2
Foods 2	71	47	24	33.8
Culinary Arts	34	26	8	23.5
International Cuisine	22	14	8	36.4
Dynamics of Nutrition	16	4	12	75.0

APPENDIX E (continued)

TABLE OF ENROLLMENT IN ELECTIVE COURSES 2009-2010

	Total Enrollment	Male Students	Female Students	Percentage of Female Students
Music History	5	5	0	0.0
Music Technology	15	10	5	33.3
Music Theory 1	18	9	9	50.0
Music Theory 2	6	4	2	33.3
Health Care	27	7	20	74.1
Emergency & Clinical Care	27	10	17	63.0
Anatomy & Physiology	28	7	21	75.0
Marine Science	20	11	9	45.0
Forensic Science	46	25	21	45.7
Astronomy	44	33	11	25.0
Medical Science	23	6	17	73.9
Statistics	27	16	11	40.7
Discrete Math	33	19	14	42.4
Current Issues	21	16	5	23.8
Criminal Justice	96	69	27	28.1
Holocaust & Genocide	76	38	38	50.0
Economics	16	16	0	0.0
Introduction to Psychology	74	36	38	51.4
AP Government & Politics: US	13	8	5	38.5
AP Government & Politics: Comparative	13	8	5	38.5
AP Human Geography	42	21	21	50.0
Sociology	73	26	47	64.4

APPENDIX F

SURVEY

1. What types of things do you use the computer for?

____

____

____

2. Do you enjoy these activities? Why or why not?

____

____

____

3. Have you taken any computer courses outside of school (College for Kids, Girl Scouts, etc)?

_____Yes ____No

Please identify the classes: _______________________________

____

____

4. What comes to mind when you think of computer science?

____

____

____

5. Describe someone who works in computer science? What type of person comes to mind?

____

____

____

6. Have you ever considered a career in computer science? Please explain.

   _____Yes   ____No

____

____

____

7. Do you know which courses you would need to prepare for a career in computer science?

   _____Yes   ____No

8. Has anyone encouraged you to go into the field of computer science? If yes, please explain.

   _____Yes   ____No

____

____

____

9. Has anyone discouraged you from going into the field of computer science? If yes, please explain.

   _____Yes   ____No

____

____

10. Is there anything about the field of computer science that may discourage you from taking computer courses at the high school or pursing a career in computer science?

____

____

11. How strongly do you agree or disagree with the following statements? (Write a number on each line.)

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	2	3	4	5

_____The only people who go into computer science are geeks.

_____Computers are interesting in and of themselves.

_____Computers are a tool to be used to get other things done.

_____Computers are a toy.

_____Working on computers take teamwork and interacting with people.

_____Working on computers is creative.

_____Computers are for people who like taking things apart and interacting with machines.

_____Computers are boring.

_____Working on computers is something that people do alone.

APPENDIX G

STUDENT INTERVIEW PROTOCOL

Interview # 1

1. What subjects do you enjoy in school?

2. What do you regard as your academic strengths?

3. What extra-curricular activities do you enjoy?

4. What influenced your choice to schedule the computer science class?

5. What are your expectations of the class? What do you hope to learn?

6. How do you use your computer?

7. Tell me about any computer courses you have taken outside of school.

8. What comes to mind when you think of computer science?

9. Describe someone who works in computer science? What type of person comes to mind?

10. Have you ever considered a career in computer science?

Interview #2

1. Describe a typical class period.

2. Describe your experiences in the computer science class.

3. Is there anything about being a girl/boy that is influencing your experience?

4. How does the computer science class compare with your expectations? (Asked after reminding the participant of his or her response during the initial interview.)

5. What are the best aspects of the class?

6. What activities do you enjoy the most?

7. If you could change anything about the class, what would it be?

APPENDIX H

TEACHER INTERVIEW PROTOCOL

Interview # 1

1. How did you develop an interest in computers? Did anyone encourage or discourage your interest?

2. Tell me about your experiences in high school and college computer science classes.

3. Tell me about your work experiences as a computer scientist.

4. How have your classroom and work experiences influenced your teaching practice?

5. What are your experiences with teaching girls in the entry-level class?

6. What are your theories about why girls do not enroll in the advanced-level computer science classes?

Interview # 2

1. How does teaching the computer science class compare with your expectations? (Asked after reminding the teacher of her response during the initial interview.)

2. Do you think that your personal experiences in computer science influence how you are teaching the class? How? Have you changed your teaching methods, content, assignments, activities, etc.? Explain

3. What aspects of the computer science class did you find to be helpful to you as a teacher?

4. What would you do differently next time you teach the class?

APPENDIX I

FOCUS GROUP GUIDE

1. Did the Web Design 1 class meet your expectations?

2. Have your views of computer science changed after completing the Web Design 1 class?

3. What were some of the best aspects of the Web Design 1 class?

4. Is their anything you would like to change about the class?

5. Has your interest in computer science increased or decreased? Explain.

6. Will you schedule another high school computer science class in the future? Why or why not?

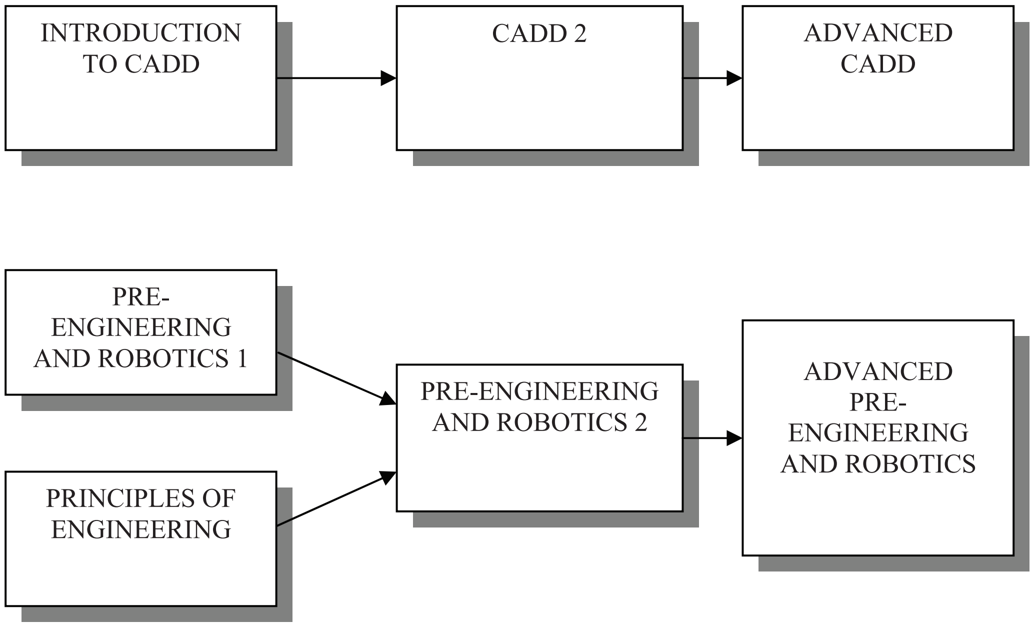
7. Do you have advice for new students? What will you tell a sister or a friend about the computer science class? Will you recommend the class to her? Why or why not?

8. Do you have any ideas about why so few girls are in the class?

9. Do you have any ideas about what would have to be different to attract more girls?

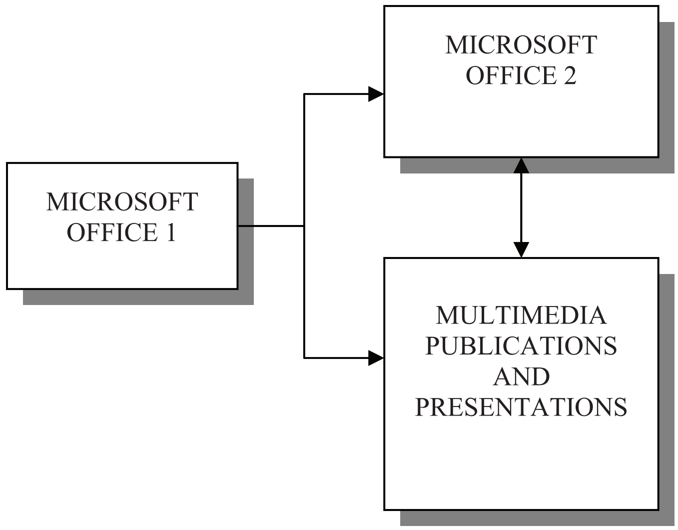
APPENDIX J

COMPUTER COURSES – APPLIED TECHNOLOGY DEPARTMENT



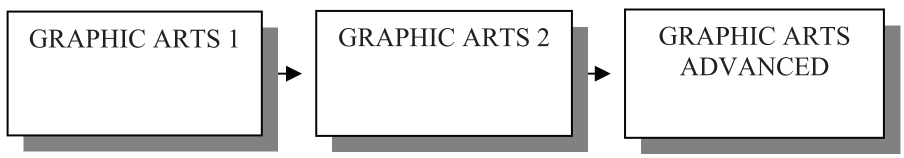
APPENDIX K

COMPUTER COURSES – BUSINESS DEPARTMENT



APPENDIX L

COMPUTER COURSES – FINE ARTS DEPARTMENT



APPENDIX M

COMPUTER COURSES – MATHEMATICS DEPARTMENT