Girls in Computer Science: a Female Only Introduction Class in High School

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

by

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Spring Semester 2010
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DEDICATION

This is dedicated to my husband and daughter, Michael and Jaqui, for supporting me in all that I do and to my parents, Cheryl and Elwin, for making education a priority.

ACKNOWLEDGEMENTS

I would like to thank the many friends, relatives, and supporters who have made this happen. My loving husband, Michael, provided me a sounding board whenever I needed one. Dr. Norton allowed me to follow my passion. Drs. Maxwell and Hjalmarson were of invaluable help throughout the writing process. Deb B., Kristin F., and Phil E. were great colleagues who helped at various stages. Finally, I'd like to thank the girls in my class who made the experience so rewarding.

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ABSTRACT

GIRLS IN COMPUTER SCIENCE: A FEMALE ONLY INTRODUCTION CLASS IN HIGH SCHOOL

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This study examined the impact of an all girls' classroom environment in a high school introductory computer science class on the student's attitudes towards computer science and their thoughts on future involvement with computer science. It was determined that an all girls' introductory class could impact the declining female enrollment and female students' efficacy towards computer science. This research was conducted in a summer school program through a regional magnet school for science and technology which these students attend during the school year. Three different groupings of students were examined for the research: female students in an all girls' class, female students in mixed gender classes and male students in mixed gender classes. A survey, Attitudes about Computers and Computer Science (ACCS), was designed to obtain an understanding of the students' thoughts, preconceptions, attitude, knowledge of computer science, and future intentions around computer science, both in education and career. Students in all

three groups were administered the ACCS prior to taking the class and upon completion of the class. In addition, students in the all girls' class wrote in a journal throughout the course, and some of those students were also interviewed upon completion of the course. The data was analyzed using quantitative and qualitative techniques. While there were no major differences found in the quantitative data, it was determined that girls in the all girls' class were truly excited by what they had learned and were more open to the idea of computer science being a part of their future.

Chapter 1: Introduction

General Statement of Problem

The first known computers were a group of eighty women calculating ballistics trajectories by hand for the War effort (World War II); the women's job title actually was 'computer.' When the ENIAC computer was built for the same purpose, six of the women were chosen to become the first computer programmers (Women In Technology International, 1997). However, times have changed.

In today's society, computers and technology are not only pervasive in most everything we do, but in today's workplace, the top three occupations with the fastest employment growth are computer science, computer engineering, and system analysts (Lanius, 2006). Yet, women as a whole are not availing themselves of these opportunities because women are pursuing education and careers in computer science at an alarmingly low rate as compared to their male peers. Statistics show that:

- Nationally, only 12% of the students completing an undergraduate computer science degree in 2007 were women. (Stross, 2008).
- In 1996, 17% of students taking the advanced placement computer science exam were female. In 2002, 14.3% were female, and in 2004, only 11% were female. Despite this decline, the overall percentage of

female students taking advanced placement exams has increased over the same time period (Gurian, 2006; Rothberg, 2006).

- In 2004, a survey of college freshman revealed that of students intending to major in computer science, 88% were male (College Entrance Examination Board, 2004).

This is a major problem on two levels – the individual level and the socio-cultural level (Margolis & Fisher, 2002). On an individual level, females are limiting their future options in a world that is surrounded by technology. On a socio-cultural level, diversity is important to generate new ideas, and females are not involved in many of the conversations surrounding technology because they do not have the knowledge.

Background of the Problem

There are many theories as to why female enrollment continues to be low and on the decline. The common thoughts about a computer scientist or the make-up of a computer science class provide many preconceptions for all students, but especially females, that dissuade them from ever entering a computer science classroom. Further, the lack of knowledge about what one can do with a computer science education compounds the problem. Finally, societal expectations inhibit females from realizing their potential in the subject matter, because they do not even realize it is an option to pursue.

It is also clear how important it is to increase female enrollment in computer science for both the student's benefit and society as a whole. Previous research discusses some ways at which this can be attempted, but this research will take it further.

Specific Problem

At a magnet high school for science and technology, there is a population of students primed to be scientific leaders in the future. An understanding of computer science is fundamental to a scientific career. As part of the school's commitment to providing diverse educational opportunities, all students are required to take Introduction to Computer Science. In addition, the school offers Advanced Placement Computer Science and post-A.P. computer science courses leading to the Computer Systems Lab as a Senior Research Course. While the courses are fully enrolled, female participation drops drastically after the initial required course.

- For the past five school years (2004-2005 through 2008-2009), female enrollment in Introduction to Computer Science is 45%.
- Over the same time period, female enrollment in Advanced Placement Computer Science is 20%.
- Female enrollment in Advanced Computer Science Electives (post-A.P.) for the same time period is only 9%.
- Female enrollment in the Computer Science Senior Research Laboratory is only 13%.

Statement of the Problem

Computer science is and will continue to be an integral part of modern society. Knowledge of and ability to use these tools in robust ways are necessary prerequisites for full participation. Many girls are either uncomfortable or reluctant to pursue a computer science education or career. Therefore, the problem of this study is to examine the

efficacy of an all girls' Introduction to Computer Science class as a viable option for promoting girls equal participation in the field of computer science.

Purpose Statement

The purpose of this study is to examine the impact of an all girls' computer science class and to determine if the all girls' class influences the students' attitudes towards computer science and their thoughts on their future involvement with computer science.

Research Questions

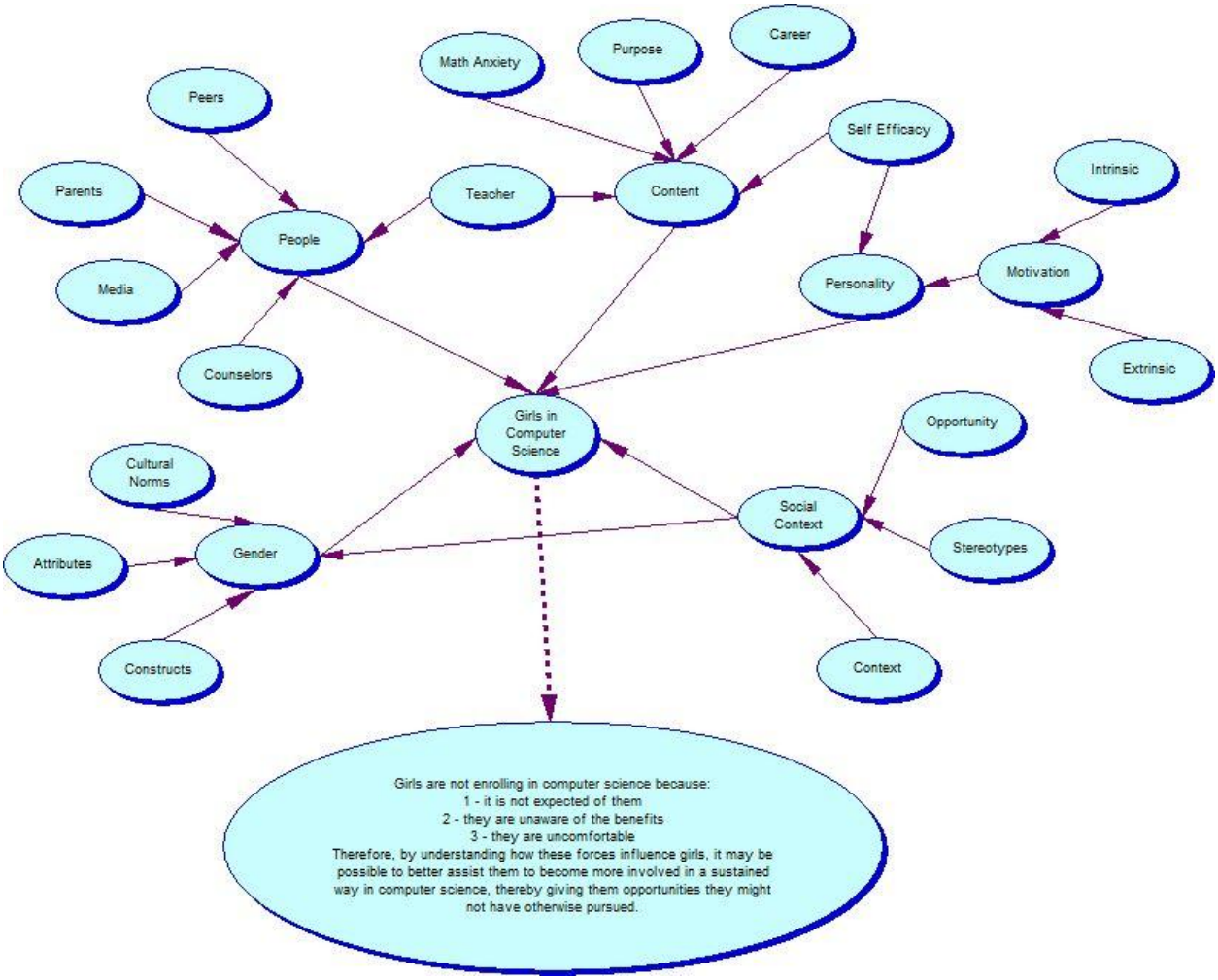
1. What are the impacts on self efficacy?
    a) Is there a difference in self efficacy towards computer science between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?
    b) What impacts did being in an all girls' class have on the students' attitudes towards computer science?
2. What are the impacts on a future with computer science?Is there a difference in anticipated future computer science enrollment in high school or college?
    a) Is there a difference in anticipated future computer science enrollment in high school or college between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?
    b) Is there a difference in anticipated future careers between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?
    c) What did students in the all girls' class think about their future work with computer science?

3. What are the impacts on the female students of an all girls' computer science class and do the female students benefit? Is there a difference in how students work together?
    a) Has the all girls environment impacted how the girls work?
    b) How did the environment impact the girls' learning of computer science?
    c) How did the class conform to and differ from the girls' expectations?

Conceptual Framework

High school students find themselves in a unique position. Often, for the first time in their lives, they are able to select what they would like to study. Yet, they have only been exposed to some of the many options available to them. Many factors influence their decision making. However, when it comes to computer science, too few girls consider choosing this path for their studies and potential career choice. The many factors which influence girls in computer science can be seen in Figure 1.

Figure 1. The many influences on girls in computer science and their relationships.



They may not be enrolling in computer science because they are not expected to learn computer science (Margolis & Fisher, 2002). It may be because they are unaware of the benefits of a computer science education (Eidelman & Hazzan, 2008) and, most importantly, it may be that they are uncomfortable in the computer science classroom (Swain, 2002). This discomfort most likely stems from a variety of sources. It may be

that the most important sources are mostly gender based (Lehmann-Haupt, 1997). By making the initial learning environment more comfortable for the females, it is expected that the students will be more open to the subject matter and seriously consider learning more computer science to better prepare them for career options that they were previously unqualified for.

Definition of Terms

Gender constructs. Gender constructs are determined and negotiated within social norms and relations.

Gender bias. Gender bias involves specific limitations imposed on others based solely on gender.

Computer science. Computer science is described as the design and implementation of software, devising new ways to use computers, and the development of effective ways to solve computing problems (Scime, 2008).

Chapter 2: Literature Review

In general, there is an insufficient amount of research on high school girls studying computer science. In order to properly ground the research, this literature review has looked at school populations of all ages and related academic fields, such as mathematics and science. In addition, general education and psychology theories about gender have also been reviewed.

Literature Search Procedures

Using *girls, computer science, technology, single sex, mathematics, curriculum, content, gender constructs, teacher support, teacher expectations, students* and *teachers* as keywords, ERIC, Psychinfo and Dissertation Abstracts were searched from 1980 to the present. The initial searches resulted in roughly 100 articles. These titles were scanned for relevancy to the topic.

A further hand search of relevant journals and organizations was conducted resulting in another pool of relevant articles. These were: *Computers and Education*, Institute for Electrical and Electronics Engineers, College Board, and Association for Computing Machinery.

Additionally, an ancestry search of references was done. Finally, an Internet search was conducted resulting in additional sources such as the Center for Women and Information Technology and Girl Scouts of America as producers of related sources.

Computer Science

Computing as a discipline. Computer Science is a somewhat murky discipline as it is a content of knowledge which has risen out of other 'standard' curricular areas and is constantly changing with the creation of new technologies on a daily basis. "Computing originated from interests in using the computer to solve problems, the theory of computation and the development of the computer and it's components." (Scime, 2008, p. 49). However, Scime continues, "in universities…depending on the interests of the academic faculty, computing studies originated from one of these reference disciplines," (mathematics, management and engineering) which have different ideas about how to use and thus, teach computers.

Content. As the backdrop for computer science can vary, so can the ways in which to teach it. There is much debate about the proper way to introduce computer science to students. The research is limited, essentially non-existent, on the best way to introduce computer science to high school students. However, there is some information on introducing computer science content to undergraduate college students which concludes that while a programming-first curriculum model for computer science has many flaws it is still the standard that will be followed for the foreseeable future (Joint Task Force on Computing Curricula, 2001). The main flaw with this model is that students have a limited sense of the computer science discipline if all they initially learn to do is code problems. This reinforces the misconception that computer science and programming are one and the same. However, if they do not learn basic coding in the beginning of their studies, students cannot understand how to use a computer to solve problems.

Teachers. While there are traits amongst all teachers which indicate good teaching, there are also domain specific traits for successful teaching when looking at computer science (Martin, 1981 as referenced in Carbone, 2007). The top level conception of success in computer science teaching is achieved when a teacher develops student thinking. This is described as,

> …inspiring students to engage in their own learning and express their own intellectual curiosity. The active engagement of the student is perceived as a form of success and efforts are made to engage students in the classroom. Successful teaching is conceptualized as enabling students to understand and synthesize materials so as to form their own opinions, make new connections, and apply their learning in new situations. (Carbone, 2007)

Thus, computer science teachers need to strive to not only teach the content to their students but to fully engage students in the content so they can make the connections to transfer the principles and ideas learned (Atherton, 2005).

All students need teacher support. It has been shown that a student's attitude towards a subject can be predicted by teacher support (Dorman & Fraser, 2009). Further it was found that male students feel their teachers are more helpful and supportive than female students (Eidelman & Hazzan, 2008). Thus, teachers have a major impact on the learning environment. It has also been proposed that teachers inadvertently favor boys over girls in areas that society deems are more appropriate for males, such as computer science, by providing the boys with better instruction (Voyles, 2008). This may be a major barrier for girls studying computer science.

Relationship to Mathematics and Math Anxiety. The link between computer science and mathematics is made in many places. More importantly, math anxiety is often discussed as a barrier to success for students as math anxiety inhibits achievement (Bracey, 1988). Further, Bracey (1988) found that computer achievement was strongly related to multiple factors: computer experience, computer anxiety, math anxiety, and computer aptitude. Therefore, success in working with computers and, more importantly, computer science may be lessened by math anxiety.

The Computer Science Student

Margolis, Fisher and Miller (2000) address a 'computer science world' that reflects the ways of a male-dominated hacker subculture. They further comment on how many female students are hesitant to join this subculture due to the fear that the other interests in their lives will 'disappear.'

There is the image of a "typical user as an antisocial, myopic, narrowly focused young male and an (inaccurate) image of computing as a machine-oriented, mathematical, solitary occupation which is unattractive not only to girls, but to many boys as well" (Ryba & Selby, 1995).

Purpose of Computing. Like most facets of life, it has been shown that boys and girls have a different outlook on the purpose of computing. At the base level, males enjoy working with and understanding computers for what they are – a machine to tinker with (Margolis, Fisher & Miller, 2000). In contrast, females attempt to connect computing with other fields, primarily of humanistic or social contexts – the female students want computers to ‘do something.’ Margolis and Fisher describe a female student who wants

to use computers to study diseases and, "solve the problems of science," (Margolis & Fisher, 2002).

Women and a Social Cause. The Institute of Electrical and Electronics Engineers (IEEE) published a report in 2008 discussing the alarmingly low rate of women undergraduates in electrical engineering and computer engineering programs. They attribute the gender disparity to women's desire to work for a social cause, "'Women seek areas where the societal benefits are very apparent,' says Diane Matt, executive director of the Women in Engineering Proactive Network, in Denver. 'They want careers that have a positive impact on the world.'" (as quoted in Giuzzo, 2008).

The Image of Computing. Unfortunately, many female students cannot find the connection between computer science and the humanistic fields and leave computer science altogether (Margolis, Fisher & Miller, 2000; Papastergiou, 2008). Students at a Scottish University chose not to study computing because they believed doing so would remove them from contact with others (Durndell & Thompson, 1997), something that has been shown to be very important to females. The IEEE feels this is because of the image that is portrayed by electrical engineers and computer engineers. They are not sending a clear message to potential students about the possibilities of the profession (Giuzzo, 2008). Eidelman and Hazzan (2008) agree with this sentiment and suggest the need to alter the 'public image' of computer science. Furthermore, they feel it is important to "present a broad and more realistic view of jobs that are available in CS areas, with an emphasis on the communicational, cooperative, and creative aspects of working in CS"(p. 415) in order to attract students in general, but specifically, female students.

Preconceptions about Computer Science

There is the feeling that computer science is "suffering from the stigma of being unfairly perceived as being boring and involving mundane, computer-based tasks" (Hendery, 2006). There is a “public image of a socially maladroit individual who hides away in a cubicle all hours of the night working using arcane programming tricks,” (Lazowska, 1999). Misconceptions of CS have been detected in high school students of both genders. Yet, the misconceptions are different based on the gender of the student. Boys tend to view CS as human and application oriented while girls view CS as a self referencing, machine and programming oriented discipline (Papastergiou, 2008).

Interestingly, in a study about computer attitudes, it was found that eleven and twelve year olds perceive interests in computers as a positive trait. However, by age fifteen, girls who are considered computer enthusiasts are viewed by their male and female peers as being lonely individuals who have entered into a ‘male domain’ (Young, 2000; Francis, Katz, & Yaacov, 1996).

Preconceptions are partly to blame for the low enrollment, particularly of females, in computer science. It has been found that females often have the following misconceptions about computer science: “CS is not for women, CS is only programming, CS is very difficult, careers in CS require long hours on the computer and consist of little human interaction” (Papastergiou, 2008, p. 595). One study has concluded that “it is not necessarily computers and technology *per* se that females avoid, but rather the competitive, male environment that surrounds the field.” (Canada & Brusca, 1991, p. 47).

The population of students that will be researched are required to take an introduction course in computer science. Currently, the girls often come into class with

these preconceptions and in a room mixed with boys often just fade into the background by doing the minimal work to get through the course. Thus, they are not only hurting themselves by not fully exploring the new content area but are also perpetuating the stereotype of computer science 'geeks.'

I have spoken with several female students who have taken the introduction course, some who did choose to continue their computer science studies and some who did not. All of the girls mentioned a stereotype of computer science in general and of 'the students who work in the systems lab' (the systems lab is a research lab for computer science where students can work on individual projects during their junior and senior year of high school). This stereotype always had negative connotations.

By creating a safe environment for the girls to learn computer science without the boys in the room, it is my hope that these girls will realize their preconceived ideas are not all true and be more open to learning and fully understanding the content and opening themselves up to a future with computer science.

Social Impressions and Gender Constructs

There are many widely accepted gender theories that conclude that males are more concerned with mastering the challenges of the outside world while females are more concerned with the well-being of others (Erikson, 1964; Bakan, 1966; Markus & Kitayama, 1991; Sidanius, Cling & Pratto, 1991; Spence & Hall, 1996). Research has shown that both elementary aged girls and boys exhibit stereotyped expectations about the occupations deemed appropriate for men and women (Spence & Hall, 1996). This shows that children have concepts of gender at an early age that can influence their future studies.

Gender constructs teach us that males and females have different roles in society based solely on their gender (Lorber & Farrell, 1991). This pretense, along with the research conducted by Spence and Hall (1996) with elementary aged students, lays the groundwork for why computing is preconceived as more masculine. In addition, Charles and Bradley (2005) have observed that sex segregation in computing is linked to cultural assumptions about gender difference. The gender constructs are furthered by the lack of female role models in computer science and information technology careers (Jepson & Perl, 2002).

It has been reported that girls have a stronger need to be perceived as successful and confident by their teachers and peers than boys do. In particular, when girls were enrolled in a course that is male dominated such as computer science, the girls felt it very important not to be perceived as 'a dumb girl' (Dentith, 2008). Instead of focusing on learning the content of the course, the girls were more focused on how they were perceived. This can make it difficult to learn to the best of one's abilities. Additional research shows that women are less confident in their math and science abilities than their male counterparts even when their achievements and accomplishments are equivalent (Fennema, 2000; Eccles, 1989; Eccles,1994).

Social constructs also tell us that boys have a tendency to show more aggressive behavior. This behavior can hinder girls' abilities to succeed in coeducational computer science classes (Swain, 2002). Boys have a tendency to rapidly gather what they need (i.e. computer resources) and then control the technology equipment available throughout a class period. This can severely limit a girl's exposure to the technology. Girls and

minorities need equal access to the technology at school so that their options for learning can expand rather than detract (Margolis and Fisher, 2002).

An additional influential construct is the relational aspect of computer self efficacy. It has been shown that a student's beliefs about their own abilities are shaped by those around them (Sieverding & Koch, 2009). Therefore, when females see over-enthused men in the computer classroom, they often feel that since they are not as excited by it or 'as into computers' as those around them, they must not be good at it. This is completely irrelevant of their achievement in computer science. An all girls' class might take away the component of the overzealous boy who makes the girls feel as though they are not as good.

The point of an all female class is not to simply turn out female computer geeks. Instead, it is to ensure that girls have access to all resources so that those who are interested in the technology get a chance to work on it (Lehmann-Haupt, 1997). It is my intention that the all girls' class will have that same focus – to ensure that girls can fully learn and explore computer science to determine if they do, in fact, enjoy the content.

Influences on Computer Science Studies

Family Computer Use at Home. Gender constructs influence how computers are viewed and thus used at home. Margolis and Fisher (2002) discussed a female student who wanted to better understand computers by 'pulling them apart' at home but did not because of her family's expectations. The student described her family's attitude as, "you're not supposed to be interested in that type of thing, and that shouldn't be so important or interesting to you" (p. 30). They discussed another student who had access to computers at home because both of her parents worked with them. However, she only

used them for typing because her brother was really into computers (Margolis & Fisher, 2002).

Family Computer Support at Home. Research indicates that home computers are used primarily by males (Papastergiou, 2008). Not only are computers used more by males in the home, but it has also been shown that parents give more computer support to boys than to girls, particularly if the families are white and of high socio economic status (Kekelis, Ancheta & Heber, 2005). Further research also supports same-sex modeling within families, thus limiting young girls' ability to associate computers with females and be open to using computers themselves. (Hess & Miura as cited in Shashaani, 1994).

Expectations. While one might think that the expectations of girls' success are coming from the students themselves that is not what female high school students feel. They feel as though males are given more leniency by adults, both parents and teachers. High achieving girls feel that adults often make comments like, 'Boys will be boys,' but expect girls to do better (Dentith, 2008). Thus, girls often feel the need to work harder and longer simply to gain the same acceptance as boys. This includes academics as well as athletics. In addition, girls feel as though they have more expected of them. Girls feel they must be smart and pretty, whereas they feel boys only need to be smart to be noticed (Dentith, 2008).

Females also have a tendency to enter careers based on perceived expectations. Women tend to enter occupations that are currently dominated by women because they internalize gender-role stereotypes and cultural expectations (Bartholomew & Schnorr, 1994). Girls do not receive the encouragement they need to pursue scientific careers (AAUW, 1992).

Motivation. High school girls' reasons for studying computer science tends to be more extrinsic, such as because there are good jobs in the field, than intrinsic, such as they have a personal interest in computer science. However, boys are motivated to study computer science for both extrinsic and intrinsic reasons, equally (Papastergiou, 2008). This is a problem as girls may only be looking at the extrinsic factors, and not fully opening themselves up to the potential enjoyment they could find in learning the content.

Computer Gaming. Papastergiou (2008) found that early familiarization with computing at home has a profound impact on a student's motivation towards studying computer science. In her research, she found that boys use the computer at home much more often than girls, thus further limiting girls' opportunities to find an interest in computer science. Computer games are one of the first ways that youngsters are introduced to computing. It has been shown that video game use is a male dominated leisure activity (Padilla-Walker, Nelson, Carroll & Jensen, 2008). Boys tend to begin playing computer games at a much younger age and for much longer periods of time providing them with more confidence in using computers (Sanders, 2005).

Learning Environment

Studies over the past 30 years have provided evidence which shows that the quality of the classroom environment is a significant determinant of student learning (Fraser, 1994, 1998). Furthermore, it has been shown that students learn better when they perceive the classroom environment to be a positive one (Dorman & Fraser, 2009). It has been said of the computer science classroom that "masculinity, not femininity, is the problem when boys retreat into the computer to avoid human interactions and when they consider themselves the hosts in that environment, with girls as guests." (Elkjaer, 1992 as

cited in Sanders, 2005, p. 29). It would seem as though this situation is not benefitting any students, yet is allowed to happen.

Single Sex Learning Environments

Logan (2007) cites a number of sources that promote single sex education as a benefit for both boys and girls. One of her main reasons in promoting single sex education for girls in computer classes is that, "girls interact differently when they are with boys and have a tendency to sit around and watch while the boys take over. This is particularly noticeable in computing classes" (p. 235). Research also shows that girls in a single sex environment behave very differently than in a coeducational setting; they are more eager to participate in discussions and willing to ask for help. By contrast, in coeducational settings, girls are found to sit passively and only talk amongst themselves. Furthermore, they acknowledge they are annoyed by the boys domineering behavior, but do nothing about it (Swain, 2002).

However, there is concern that a complete single sex learning environment, such as a single sex school, is not a good environment as it does not prepare students for the real world that they will graduate into for future employment. This concern has been voiced directly to me by students interested in pursuing computer science. A 10th grade girl told me she would not want to be in an all girls' class since she needs to learn to work with the boys. However, when speaking with the same student two years later after more computer science classes, she felt that perhaps an all girls' class would have been a good thing to help boost her confidence earlier on. The literature suggests that in order to get over this dilemma, it is best to provide some single sex classes within a coeducational setting (Parker & Rennie, 2002 as cited in Logan, 2007).

Single sex education is currently gaining momentum for a variety of reasons. Recently, Boston, Massachusetts and Montgomery, Alabama have put forth proposals for single sex schooling. One of the main ideas is that it will help to raise student achievement by removing distractions from the classroom. However, the American Civil Liberties Union (ACLU) is striking down many current proposed single sex classes on the basis that students in public schools must have an option of either single sex or coeducational to ensure an equal education (Wertheimer, 2009).

All Girls' Computer Science Class and Future Intentions

In a meta-analysis of self efficacy literature, Sanders (2005) found that females consistently underestimate their computer skills. They do this whether or not it is actually true. However, it has also been found that girls in groups tend to have a more positive outlook on female's skills in general. They tend to follow the mantra, "I can't, but we can" (Collis, 1985), indicating that girls working together in computer science might have a positive effect.

It has been well documented that all girl classes have a positive effect on female students' self esteem, confidence, and performance (Mael, 1998). In addition, Crombie, Abarbanel and Trineer (2002) have shown that females from an all girls' Computer Science class not only report higher levels of computer related confidence but also higher levels of academic and occupational intentions to pursue computer science than girls from a mixed gender class. This can be attributed to the theory of critical mass. Sanders found that it is not necessarily the presence of boys that discourages females but rather the absence of other females (Sanders, 1985). Therefore, by increasing the presence of

women in the computer surroundings, females will be more willing to stay with computer science (Cohoon, 2001).

Additional research has shown that girls in an all girls' section of computer science report higher levels of perceived teacher support than girls from a mixed-gender section despite the fact that it is the same teacher in both sections (Crombie, 1999). Again, this can be attributed to the critical mass of females created by an all girl's class. An all girls' section of computer science creates a better learning environment for the girls. It creates an environment where the teacher's support is perceived to be higher, the student's gain more confidence in their ability to work with computers and the students find more intrinsic value in working with computers (Crombie, 1999).

Conceptual Framework

It is commonly known that 'girls do not study computers as much as boys' so much so that my own parents never introduced me to the possibility despite my strong penchant for mathematics. However, when looking at the many underlying theories, it is evident that there are many reasons for that 'common knowledge.' In taking it a step further, when trying to understand why female students choose not to study computer science, it is evident that many factors influence their decision making. Not only do girls not understand the benefits of a computer science education, they often do not even know what computer science is because of the way computer science is mistakenly mischaracterized and because of their own preconceptions. By creating an inviting environment of only girls for learning the subject, it is hoped that the students will be more open to the subject matter and seriously consider learning more computer science to better prepare themselves for career options that they might otherwise be unqualified for.

Summary

The literature presents valid reasons for why female enrollment in computer science is historically low. However, the literature also shows why it is important to increase female enrollment in the subject for both the individual female student and society as a whole. It is my intention to follow Papastergiou's (2008) suggestion to extend her research and create a learning experience targeted at girls by offering an all girls' computer science class at a regional magnet school for science and technology. I hope to create a positive learning environment for the students where they can enjoy learning the content and realize the potentials of further education in computer science.

Cavanagh (2007) discussed the impact of summer science camps for girls and how they encouraged female students to develop an interest in science and mathematics. My hope is that by teaching the all girls' class in the summer where the girls can focus and have fun, the girls will take advantage of the more comfortable learning environment and realize the potential of a computer science education (Streitmatter, 1998).

Following Cavanagh's (2007) premise, the all girls' class will be offered in summer school where it will be the only class these girls are taking. However, this is through the school the students attend during the school year, and other students will also be in summer school so there will be other students in the building at all times. Therefore, the single sex environment will be embedded within the regular school norms.

In addition to being the only single sex class offered, the girls will have a choice. No one will be forced to enroll in the class, and there is a coeducational class available. The all girls' section will follow the same schedule, curriculum and use the same assessments as the mixed gender sections.

By working with a population of female students who have already shown an interest in Science, Technology, Engineering and Math (STEM) in an all girls' setting, I hypothesize that they will find the environment to be more positive, and in turn, they will feel more secure and be willing to explore the content of computer science in more depth. In this setting, hopefully their interest will be piqued; they will enjoy what they are studying; and they will be more inclined to work with computer science in their future, either in coursework or a future career.

Chapter 3: Methods

Computer science is pervasive in our modern world and will only continue to be more important. As such, it is imperative to ensure that female students have a solid understanding of the subject in order to reverse historical trends of low female enrollment in computer science courses and to better understand how to help female students in this area. This study investigated an all girls' Introduction to Computer Science course as an alternative that might provide an option to encourage girls' participation.

Setting

The research was conducted in a large school district in the United States. The school district has roughly 200 schools: about 140 elementary schools, about 20 middle schools, about 20 high schools, 5 secondary schools (7-12), and 15 alternative / special education centers. In the school district, roughly 90% of graduates attend a post-secondary program. The drop-out rate in the district is less than 2%. It is a racially diverse district with 11% African American, less than 1% American Indian, 18% Asian American, 17% Hispanic, 6% Multiracial, and 48% White. The district spans 400 square miles with urban, suburban and even rural communities.

The school where the research was conducted is a regional magnet school for science and technology. Students from the district and five surrounding counties must apply for admission to the school. Roughly 460 students matriculate each year for a

school population of roughly 1800 students. The students must have a strong academic background and show an interest in science or technology to be admitted. The school is racially diverse but not significantly different than the school division with 52% White, 2% African American, 3% Hispanic, less than 1% American Indian, 38% Asian American, 5% Multiracial.

At this school, all students must complete Introduction to Computer Science before their junior year. The course is offered during the school year and during summer school. Roughly 250 students take the course during the school year, and 180 take it during the summer. The gender distribution during the school year is roughly 45% female and 55% male. In summer school, the distribution sways a bit more towards the female population with roughly 52% female and 48% male. This is most likely due to the fact that many students choose to take computer science in the summer so that they can take additional music or art electives during the school year. Those courses have a higher female enrollment.

The research was conducted in the summer of 2009. Students eligible to participate in the study had just completed their freshman or sophomore year of high school and ranged in age from 13-16 years old. During the summer, there were 7 sections of Introduction to Computer Science. All sections followed the same curriculum, used the same textbooks, and were assessed by the same methods. All sections followed the same schedule. The schedule was as follows:

Figure 2. The schedule of instruction for all Introduction to Computer Science Classes

Days of Summer School	Topic Covered
Days 1 - 4	Unit 1: JKarel – an introductory unit to object oriented programming that has students writing code from day one.
Days 4 – 6	Unit 2: Graphics – students create graphical screens to enhance the viewing of their programs.
Days 7 – 10	Unit 3:User Interfaces - students learn how to create and work with graphical user interfaces.
Day 11	Supplemental Unit: Computer Number Systems
Days 12 – 15	Unit 4: Data Storage – students learn to create arrays to store data for their programs. The data may come from text files on the computer.
Days 16 – 20	Unit 5: Data Processing – students learn to work with arrays and strings to process information.
Days 20 – 21	Supplemental Unit: Boolean Algebra
Days 22 – 24	Final Project – students pull together all that they have learned to create an original application, often a game.

The units had been developed over time by the computer science teachers at the school. They were self published, and used throughout the county. They were available on the school's website for the public.

Design Overview

This research used a mixed methods design (Creswell, 2005), combining qualitative and quantitative methods. Based on the research questions, a complex understanding of the research scenario was desired. As Greene stated, "social phenomena are extraordinarily complex…better understanding of the multifaceted character of educational and social phenomena can be obtained from the use of multiple approaches" (Greene, 2007, p. 20). By looking at the research issue multiple ways, using a mixed methods approach, it was my intent to glean rich information to better inform practices

and help future students. This design permitted a quantitative comparison of attitudes, education plans, and career intentions between boys in a mixed-gender class, girls in a mixed-gender class, and girls in an all girls' class of Introduction to Computer Science as well as a qualitative component allowing me to delve deeper and better understand the implications of an all girls' class on the female students.

This design, in which the quantitative results were used to inform the interview questions and helped to plan the analysis for the qualitative part of the study, enabled me to generate deeper understandings of the situation from the qualitative analysis (Greene, 2007). In addition, these varied sources also allowed for triangulation to ensure validity in the findings (Maxwell, 2005). Further, this design provided me with a basic understanding of the differences between the classes before full exploration of the students' feelings through the interviews. I was able to look for an explanation of the findings through the interview process. It has been stated that an accurate description of a situation is an important step in the research process (King, G., Keohane, R. & Verba, S., 1994).

The groupings for the study were comprised of students from the all girls' section (only one section was offered), girls from the mixed gender sections (6 sections) and boys from the mixed gender sections (the same 6 sections). Mixed methods design worked well with the small sample sizes (Dunet & Reyes, 2006).

Quantitative Research Component

Subject Selection. The all girls' section was created by the students themselves. Once enrollment for summer school had completed, all female students received a letter from the school administration letting them know about the creation of an all girls'

section of Introduction to Computer Science. The letter further explained that if a student would like to be in the all girls' section, they needed to submit a form signed by themselves and their parents indicating their interest. This ensured that no one was forced into the class if they did not wish to participate and that parents were a part of the decision making process. Participants for the class were selected on a first-come, first-served basis. If there was a greater interest than could be accommodated, students were placed on a waiting list for the all girls' section and enrolled in a mixed gender section.

Once the all girls' section has been created, the administration created the additional 6 sections of the class, and each section was assigned a teacher.

Once the section rosters had been created for summer school, all students received a letter informing them of the research. Students in the all girls' section received a slightly different letter since their involvement in the research was different than the involvement of the rest of the students. The letter also included information about an information session if students or parents had further questions. Students and parents were asked to return consent and assent forms indicating their willingness to participate in the research to a co-researcher who was not directly involved in the study.

Instrument. The survey, Attitudes about Computers and Computer Science (ACCS) (Appendix A), was used as a pre- and post- test in order to get an understanding of students' thoughts, preconceptions, attitudes, knowledge of computer science, and future intentions around computer science both in education and career before beginning the course and after completing the course.

It was determined that no appropriate instrument existed to address the topics warranted for this research. Therefore, I developed the ACCS by modifying

Papastergiou's (2008) instrument. The instrument is comprised of six groups of questions. The *first* group of questions collects biographical information. The remaining parts of the survey include Likert-type responses where students are given statements and need to indicate how closely they agree or disagree with the statements. This question and answer type was chosen as it has been shown to be the clearest for questionnaire respondents (Dillman, 2007). The *second* group of statements pertained to students' high school studies and the computer science courses they were taking / planned to take in high school with statements like: *I plan to take more Computer Science classes in high school after completing this Introduction course.* The *third* group of statements relate to students' perceptions of computer science with statements such as: *I understand what computer science is*. The *fourth* group of statements refers to students' future with computer science, both in college and career with statements like: *I am considering a career in computer science.* In addition, these questions seek to determine who is encouraging the student to further their interest in computer science with statements like: *My mother is encouraging me to do more with Computer Science.* The *fifth* group of statements refers to computer use outside of the class with statements like: *When I get stuck using the computer at home, my brother helps me fix the problem.* These questions aim to find out how the student uses a computer at home and who influences their computer usage. The *sixth* set of statements is about students' self efficacy around computers with statements like: *I am good at programming.*

The ACCS was reviewed by an expert panel consisting of two University research faculty and two high school computer science teachers to determine its reliability.

Furthermore, it was pilot tested with a class of 50 students. After completing the survey, students were asked about the survey and if it reported what the students had intended.

Procedure. The ACCS was administered to the research participants twice- once on the first day of summer school and again on the last day of summer school. It was administered during class time so that students would not be impacted outside of school. Students had an unlimited amount of time to complete the survey, but it took them no more than twenty minutes.

Students completed the survey anonymously using a 4-digit code instead of their name. The code was only used to match pre- and post- surveys for analysis. The 4-digit codes were maintained by a research colleague.

I was not in the room during administration of the survey to her class. Instead, a colleague from the University not involved directly with this project administered the survey. In the mixed gender sections, the survey was administered by the classroom teacher.

Analysis. The ACCS surveys were analyzed using ANOVA tests and confidence intervals to determine if there is a difference among group means (Erford, 2008) for each of the categories: attitudes towards computer science, future education in computer science and future career with computer science. If the pre-test measures were not equivalent, an ANOVA test was used to analyze the change in means from the pre- to post- test to compensate for the differences in pretest means. If the pre-test measures were equivalent indicating that the groups were comparable, a second set of ANOVA tests was conducted on the post- data to determine if there were differences in the posttest means. Post hoc analyses were conducted to determine exactly where statistical

differences existed. The Tukey method of multiple comparisons was used to further test the results. (Erford, 2008, p. 388).

Qualitative Research Component

Subject Selection. The students' participating in the research from the all girls' section constituted the sample for the qualitative component of the research.

Data Sources. There were two qualitative data sources to create the evidence pool: student journals and interviews that I conducted with selected students. See Appendix B for the Interview Guide.

Procedure. For the student journal writings, each student had their own journal provided by me. They were asked to write in their journal at least every other day (and were given class time to do so). They were able to leave the room to do their writing so that they could be in a comfortable setting. For safety purposes, they could not leave the building, but they could go to the library or to the computer lab or a quiet place in the hall. They were also encouraged to write more often and at home as well. They were not given writing assignments, but if they had trouble figuring out what to write, there was a list of prompts on the board to get them started. They were encouraged to write about how they felt in class, how they liked working with others in the class, what they thought about not being in class with boys and what their friends / families thought of the class.

None of the journals were read until the course was over and grades had been submitted. This was for a variety of reasons. First and foremost, it was hoped that the students would write freely and openly to share their experiences. As their teacher, they would undoubtedly look at me as the authority figure that controls their grade. By not reading anything until after grades had been submitted, the students hopefully lost the

stigma of me only as their grader and wrote freely. By the same point, as their teacher, I did not want their writings to have any perceived influence on their grade. Their grade was based solely on their work in the class. Additionally, I did not want their writings to influence my teaching.

The interviews were conducted after the completion of the course and after the quantitative data has been analyzed. This was done to a) ensure that my role as teacher had concluded and b) allowed me to delve deeper into the results of the quantitative study and earlier qualitative data gathered to get rich descriptions of the phenomena which appeared to be occurring. I determined the number of students and which students to interview after looking through the data already collected to see who might provide additional information that benefited the research.

Analysis. The students' journal writings were the most revealing data as they enabled me to get inside the students' minds to understand what they were thinking and how they were feeling as they went through the course. I felt their journal writing would be eye opening for me and hopefully them. I read all of the journals of the research participants and coded comments that jumped out as meaningful and relevant passages. The relevant journal passages were coded using open coding techniques (Emerson, Fretz & Shaw, 1995). I read the journal entries and identified the ideas, themes and issues suggested by the writing. This ensured that I did not identify passages that only supported my beliefs. Instead, I let the codes come directly from the students' writing.

The interviews were transcribed and coded to determine categories and themes. I initially coded the interviews using the same open coding technique as used with the journals. On a second pass through the interview transcripts, I specifically looked for

passages which supported the codes generated from the journals. This helped to provide thick descriptions in developing the emerging theory (Glesne, 2006).

Anticipated Results

It was my feeling that an all girls' section would create a positive learning environment for the students, allowing the girls to work more freely and comfortably and enabling them to have a more positive outlook on computer science. This new outlook might help the girls realize that they can and should be open to computer science in the future, rather than shy away from it as so many of them currently do.

Limitations

Selection. Students were self selected. This was to ensure legality of the proposed method in a public school setting. However, in selecting participants this way, I needed to be careful about making generalizations about females studying computer science due to the fact that these students may have unique characteristics which account for their success in class (Sanders, 2005) or caused them to choose the class. I used internal generalizability (Maxwell, 2006), whereby I can generalize my findings within the group of female students at a magnet school who choose to be in an all girls computer science class. In order to have a better understanding of these girls so that perhaps I can make broader generalizations to the population of girls at a magnet school for science and technology, I asked the students to write in their journal about why they chose to be in the class.

Summer School. While the content and instruction is the same in summer school as it is during the school year, the two environments are not the same. In summer school, computer science is the only subject students are taking. Thus, they do not need to worry

about work for 5 or 6 other academic subjects at the same time. They can concentrate their attention on computer science. This creates a wonderful environment to learn computer science in. However, again I will need to be careful about generalizing the results.

The quantitative research was designed to find differences between the three populations of students. However, since the summer school students were not a full representation of the general student population, the results may not be as strong as if the study had been conducted during the school year. For scheduling purposes, the all girls' class currently cannot be offered during the school year so this study has been designed to the best extent possible. Care was taken to accurately report the results and generalize to the extent possible as allowed by the study.

Validity Threats

Research Location. One threat is that this research is "backyard research" (Glesne, 2006) since it is being conducted at the school where I teach and I, as the researcher, am also teaching the class. This can create a difficult situation on many levels. There are both ethical and political situations which could arise that I need to be aware of. In conducting the interviews, I may learn information about other colleagues or school personnel from the students. Ethically, I need to consider the student's best interests when determining how to handle that information. Unless I learn of illegal offenses, my role as researcher takes precedence, and I must keep information strictly between myself and the student.

Despite the limitations of backyard research, Glesne (2006) discusses how it can be beneficial in some cases. "Teacher researchers often study their own classrooms with

the purpose to improve schooling experiences for students…your being part of the organization is vital because the research is generally a beginning step in a longer, change-oriented process" (p. 33).

In addition, computer science classes in this summer school are standard across all sections. All classes move at the same pace and common assessments are used. I was sure to follow the curriculum exactly as the other teachers did. I had taught the course for five years both in summer school and during the school year, and I have a solid understanding of how to teach the course and was sure to offer students in the all girls' section the same course as all other students were receiving.

Perceived Authority. Several precautions were taken to ensure that my position as researcher did not influence my position as teacher. First and foremost, I did not know which girls in the class were participating in the research until the class was over and grades had been submitted. That way, their participation had no bearing on how I graded their work. In addition, I did not present any information about the research or hold the consent forms. An additional researcher, described below, had this responsibility. That ensured that students could in no way feel that I was coercing them to participate in the research. Students chose to participate in the class first and then were offered the opportunity to participate in the research. This way, participation in the research could not be perceived as a condition to enroll in the all girls' section. Furthermore, I did not read any of the student journals or conduct interviews until the course was completed and grades had been submitted.

Additional Researcher. I realized that I was very close to the research situation. As such, I had another colleague from the University involved in this research. This

researcher was a colleague in the Doctoral Program in the College of Education, but had a different concentration. They were aware of the research, but their research interests lie in a completely different field. This additional researcher presented the information sessions about the research to students and parents. They also collected and held onto the consent and assent forms to keep the participants' identities from me.

In addition, this researcher coded some of the data using open coding techniques. Our results were compared for inter-rater reliability. This helped to ensure that I was not only finding what I wanted to find but what was truly there.

Male Students. The all girls' section was intended for only female students and was advertised as such. It was the same class offered to all students in summer school (same content, same methods of assessment, same grading scale). However, if a male student would have liked to be in the class, he had the same right as the female students - first come, first served. It was intended to be a female only class, but if a male student was in the class, he would be a true minority. Should this have occurred the impact would have been discussed in the interviews to understand any differences which arose due to the male student(s) in the class.

Reactivity to Journaling. The girls in the all girls' class were required to write in their journal. As such, they were required to reflect on their experiences regularly, something that is not typically part of their educational repertoire. It must be acknowledged that some of what they shared might not be exactly as they experienced or thought as the class was going on, but manifestations from thinking back on prior events. It is hoped that their writings are as authentic as possible since they were encouraged to

write regularly, rather than waiting until the end to share all of their thoughts and experiences.

Importance

Computers and technology are only becoming more pervasive in all facets of life. It is extremely important for women to have a full knowledge of the backbone of this technology so that they can be well prepared for whatever their future may hold. If my study does indicate that an all girls section of computer science provides students with a more positive learning experience so that they are more open to learning and working with computer science in the future, the implications for future students would be great.

Chapter 4: Results

The results are a compilation of the quantitative analysis and the qualitative analysis, combining the statistical analyses of the survey data with the students' journals and interviews.

Summary of the Three Groups

The three groups - girls in the all girls' class (AG), girls in the mixed gender classes (MG) and boys in the mixed gender classes (MB) - had relatively similar characteristics. The average age in all 3 groupings was 15.1 years old. The average grade completed for all 3 groupings was the ninth grade. However, there were a larger number of older students in the all girls' class than the other groupings (26% of the girls in the all girls' class were 16, while 19% of the boys in the mixed gender classes and only 4% of the girls in the mixed gender classes were 16 years old).

There was a substantial difference in the reasons for taking computer science in summer school amongst the three groups. The different reasons for taking computer science in summer school were: It is the only way it will fit into my schedule, I want to make room to take more advanced computer science classes, I want to make room for more advanced science or technology courses (non computer science), and I want to make room for more arts or humanities courses. The girls in the all girls' class and the boys in the mixed gender classes were primarily taking computer science in summer

school because it was the only way that it would fit. However, the girls in the mixed gender classes were taking computer science so that they could create room for more humanities classes. Summary statistics for the participants are presented in Table 4.1.

Table 4.1

Summary Statistics

Grouping			Reason for Taking CS in Summer			
	N	Mean Age	Only way to fit	Room for more CS	Room for more Sci/Tech	Room for more Humanities
All Girls	19	15.8	42.1%	5.3%	21.1%	36.8%
Mixed Girls	25	14.7	20.0%	0%	32.0%	48.0%
Mixed Boys	21	15.0	42.9%	0%	33.3%	23.8%
Total	65	15.1	33.9%	1.5%	29.2%	36.9%

Overview of Data Types

Surveys. The surveys provided a unique insight for better understanding the students' experiences as they provided a comparison between the three different groupings of students: girls in the all girls' class, girls in mixed gender classes and boys in mixed gender classes. The surveys also provided an opportunity to identify quantifiable changes over the course of the summer.

Student Journals. Journals were introduced in the all girls' class as a way to get at the students' feelings while they were experiencing the class without needing to talk to them on a daily basis while they were students in my class. I provided students with

journals and assured them that the journals were theirs to use as they wished. I hoped that students would write about their experiences in the class, but if they wanted to write about something else, or draw, or not write, that was OK too, since it was their journal. They were also told that if they wanted to remove anything after writing it, that was fine.

The students were given class time to write in their journal but encouraged to do so more often if they wished. They could leave the classroom and find a comfortable space to write as well so that they could be more relaxed (Amy would go outside and sit under a tree every day to write in her journal). Writing prompts were posted in the classroom to give them an idea of what to write, but most did not use the prompts as they had ideas of what they wanted to write on their own.

Interviews. Interviews were conducted as a way to learn about a person's experiences. However, I have learned over time that interviewing high school students is much different than interviewing adults. While the students often have a lot to say, they need much prompting and prodding and are not always sure of what to say. This is complicated by the fact that in this case the interviewer was also their teacher. However, I selected students whom I felt would be honest and open and not bothered by the conflict of teacher as researcher.

When selecting students to interview, I tried to ensure that I had selected a varied group – some strong academically and some not as strong, some super social and some not as social. All students asked to be interviewed willingly accepted. The students I interviewed were: Jane, Jill, Lucy, Amy and Emma.

In general, the interviews were just a continuation of the students' journals. The only new information gleaned from the interviews was in learning about how the students

shared their involvement in the all girls' class with others and the others' reactions to their choices which will be further explored below.

Because the interviews allowed me to further explore each student, I am going to describe the students interviewed and then bring together what they had to say.

Amy. Amy is a 15 year old Caucasian sophomore. She is a bit of a different student than most in the class as she made it clear from the start of the summer that she loved music and arts and was not a strong math / science student. She often questioned why she was at a math-science magnet school but wanted to do her best nonetheless. She does struggle in these subjects and sometimes that can harm her confidence. She spent a lot of time writing in her journal about her life outside of class as she was also participating in a theatrical event outside of summer school during the summer, perhaps indicating where she would rather be.

Jane. Jane is a 14 year old Asian sophomore. Like Amy, Jane enjoys the arts but does well in math and science too. Jane's father is a professor in computer engineering. To this point, Jane has done her best to avoid the subject as she finds his papers "not interesting at all" and assumes the subject is boring. She only plans to take this one class in high school and get it done.

Emma. Emma is a 15 year old Caucasian sophomore. She spends a lot of time on the computer in an online community of artists. She likes to post her drawings and look at others as well. She is also a very strong math and science student. She is a bit reserved in class but does very well. Emma took computer science in the summer to open up room in her schedule for band. However, she is no longer taking band but decided to stick with her original plan of summer CS to keep some space in her schedule for the future.

Jill. Jill is a 16 year old Asian junior. She has taken some computer classes in the past, even attempted some programming, but found them very frustrating and was turned off. She is a strong student who likes technology classes.

Lucy. Lucy is a 15 year old Caucasian sophomore. She is taking computer science in the summer so that she can take chorus all four years of high school. She entered high school with the thought that "[computer science] was one of those classes that you had to take, and it was getting in the way of my taking choir, which upset me greatly."

Research Question 1

The overarching research question was: "What are the impacts on self efficacy?" In order to look at this question from all of the angles, it was broken into two sub-questions: "Is there a difference in self efficacy towards computer science between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?" and "What impacts did being in an all girls' class have on the students' attitudes towards computer science?"

In order to answer the first question, computer self efficacy scores from the ACCS were examined. The Efficacy score was obtained by averaging the results from four responses on the ACCS: 1) I enjoy working with computers, 2) I am good at using computers, 3) I enjoy programming in a computer science language, and 4) I am good at programming. The Efficacy scores are summarized in Table 4.2.

Table 4.2

Efficacy Scores

	Pre-Survey Data			Post-Survey Data			Overall
	N	Mean	S.D.	N	Mean	S.D.	Gain
All Girls	21	3.12	0.75	21	3.45	0.88	0.33
Mixed Girls	25	3.39	0.57	25	3.53	0.64	0.14
Mixed Boys	21	3.63	0.74	19	4.07	0.71	0.44
Total	67	3.38	0.70	64	3.58	1.09	0.20

In order to answer the second question, "What impacts did being in an all girls' class have on the students' attitudes towards computer science," the qualitative interview data was examined. During the interviews, students were directly asked, "When you began high school, what did you think of computer science? How has that view changed?" Their responses to those questions directly addressed their attitudes towards computer science.

Jill discussed her thoughts on computer science upon entering the class. She had a preconceived idea from courses she had taken previously. "I actually didn't have a positive idea about computer science, um, I didn't think that I was a computer science person, I did a camp at [a local University] for a little bit of Java and website things and I actually didn't like it. For some reason, I don't know, I just thought I didn't like comp sci and all and that I wouldn't like it." Yet, when asked how her views have changed, she said, " it's not bad, like I enjoy it, and it's not as hard as some people told me it'd be, it's actually pretty good, I like comp sci."

Jane had a similar thought process as Jill in her interview. When asked what she thought of computer science before taking the class, she shared, "I didn't want to take it

at all. I thought it was really boring, cause I'd read some of my dad's papers and they were not interesting at all." However, when asked what she thinks now that the class has ended, she very quickly stated, "It's better" with a bit of laughter / surprise in her voice.

Lucy also shared a similar sentiment. She said that before taking computer science, she "thought it was one of those classes that you had to take, and it was getting in the way of my taking choir, which upset me greatly. But, it wasn't bad. .. I actually really enjoyed it, I thought it was interesting to learn and it was definitely not as boring as I thought it was going to be."

Research Question 2

The overarching research question was: "What are the impacts on a future with computer science?" In order to fully explore this question, it was broken into three sub-questions: "Is there a difference in anticipated future computer science enrollment in high school or college between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?"; "Is there a difference in anticipated future careers between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?" and "What did students in the all girls' class think about their future work with computer science?"

In order to answer the first question, students scores for taking More Computer Science while in High School if Room Allowed and scores for taking Computer Science in College were examined from the ACCS. The score for MoreCSinHSifRoom was created by looking at the responses to the statement: If there was room in my schedule, I would like to take more Computer Science classes in high school after completing this Introduction course. It was determined that the score for more computer science in high

school if room allowed should be used due to the fact that most students were taking computer science in summer school because that is the only way it would fit in their schedule. The MoreCSinHSifRoom scores are summarized in Table 4.3.

Table 4.3

MoreCSinHSifRoom Scores

	Pre-Survey Data			Post-Survey Data			Overall
	N	Mean	S.D.	N	Mean	S.D.	Gain
All Girls	20	2.75	1.12	19	3.21	1.27	0.46
Mixed Girls	25	2.72	1.14	25	3.08	1.35	0.36
Mixed Boys	20	3.55	1.00	19	3.63	1.21	0.08
Total	65	2.99	1.13	63	3.28	1.29	0.29

In addition, scores were examined from intended computer science course enrollment in college. These scores were determined by looking at the responses to the statement: After this class, I will take more CS classes while in college. The CSinCollege scores are summarized in Table 4.4.

Table 4.4

CSinCollege Scores

	Pre-Survey Data			Post-Survey Data			Overall
	N	Mean	S.D.	N	Mean	S.D.	Gain
All Girls	21	2.81	1.03	20	3.20	1.11	0.39
Mixed Girls	25	2.60	0.87	25	2.64	1.08	0.04
Mixed Boys	20	3.15	0.67	19	3.63	1.21	0.48
Total	66	2.83	0.88	65	3.00	1.01	0.17

To answer the second question: "Is there a difference in anticipated future careers between the boys in a mixed gender class, girls in a mixed gender class and girls in an all girls' class?" student scores for having a career in computer science and using computer science in a career were examined from the ACCS. The score for CareerinCS was generated by looking at responses to the statement: I am considering a Career in Computer Science. The CareerinCS scores are summarized in Table 4.5.

Table 4.5

CareerinCS Scores

	Pre-Survey Data			Post-Survey Data			Overall
	N	Mean	S.D.	N	Mean	S.D.	Gain
All Girls	21	2.10	0.77	21	2.19	1.08	0.09
Mixed Girls	25	1.88	0.67	25	1.76	0.83	-0.08
Mixed Boys	20	2.45	1.00	19	2.63	0.96	0.18
Total	66	2.12	0.83	65	2.15	1.00	0.03

When looking at whether or not students intend to use computer science in their future careers, student scores for using computer science in a career were examined from the ACCS. This variable was calculated from the responses to the statement: I am not considering a career in computer science, but know that I will most likely use computer science in my career. Table 4.6 summarizes the UseCSinCareer scores.

Table 4.6

UseCSinCareer Scores

	Pre-Survey Data			Post-Survey Data			Overall
	N	Mean	S.D.	N	Mean	S.D.	Gain
All Girls	21	3.24	1.22	20	3.40	1.05	0.16
Mixed Girls	25	3.60	0.96	25	3.64	0.95	0.04
Mixed Boys	18	3.17	0.86	19	3.47	0.84	0.30
Total	65	3.36	1.03	65	3.66	0.78	0.30

In order to answer the third question: "What did students in the all girls' class think about their future work with computer science?" a thorough analysis of the student's journals and interview responses was conducted. It is clear from reading the journals that the majority of the girls took computer science in summer school "to get it over with" and never had any intention of looking at / working with computer science again. However, their journal entries later in the summer reflect a different sentiment: a possible future. As Colleen said, "Thinking into the future, I probably would not want to work only as a computer programmer, but I would consider taking a job that incorporates computer science." Carol even went further by saying, "As for CS in the future, I'll definitely look into doing more."

Elizabeth realized the impact on a future career, "I would like to learn more about potential careers in this field." She was a bit shocked by the realization that despite not having a career in computer science, the knowledge can still be helpful. Reflecting on a presentation by an alumnus who is working in marketing but using computer science, Elizabeth wrote, "I like to think about how I'll be in the future and what kind of career I will have. I especially found it interesting that her knowledge of computer science helps

her today in her work even though she isn't focusing on computer science." Unlike Elizabeth, Sue thinks she knows what her future career path will be – neurobiology. However, she had a slight change of heart, "Maybe I'll minor in computer science. Find a way to program the technologies that medical scientists use." While not a major focus, some of the students also realized the financial benefits to a career in computer science. Sue continued,

> But if computer science pops into my life sometime later, I'll be ready for it. With all the stories I've heard of people with different jobs, I'm sort of expecting it. Our teacher also showed us an article that said the top earning jobs were all engineers. It's sort of making me second guess what I want to do when I'm older. Money isn't everything, but it sure helps a lot.

Miranda had made it clear that she really did not want to take more computer science classes. Yet, she still wrote, "I especially loved the discussions on how computer science plays a part in many careers in the future." She even feels that perhaps she can marry her love of biology with technology for a future senior project. "I could really see myself doing this next year and maybe even something more advanced for my senior project!"

A fair number of the students discussed wanting to take more computer science but were unable to do so due to their tight schedule. As discussed in the literature many students come into high school with a plan and have a hard time changing that plan. As Andi said, "I really wish that I had more time in my schedule because then I would definitely take APCS [Advanced Placement Computer Science]." Amanda shares, "I'd probably take AP CS next year…But I like journalism (that's why I'm taking comp sci this summer), and there is NO WAY I would ever give that up for APCS." It was clear

that all of the girls interviewed had a changed outlook on their future with computers / computer science. They all felt that computers will be more a part of their lives than before. As Amy shared, “I think I’ll use computers more throughout [high school] now.”

Research Question 3

The third main research question was “What are the impacts on the female students of an all girls’ computer science class and do the female students benefit?” This question was broken into three sub-questions: “Has the all girls’ environment impacted how the girls work?”, “How did the environment impact the girls’ learning of computer science?” and “How did the class conform to and differ from the girls’ expectations?” Data from the journals and interviews was examined to answer these questions.

Impact of All Girls’ Environment. It took some getting used to, but many of the girls shared in their journals how happy they were with the environment being only female. Many of the girls discussed how the environment made them feel more comfortable. Jane shared, “Without the boys, I'm a great deal less self conscious. It's a more comfortable learning environment.” Elizabeth echoed the sentiment, “I find girls more approachable than guys so the atmosphere would be more comfortable.” Erica added her feelings on the environment, “this was probably the best way for me to have taken computer science. People were all very supportive and the classroom was a friendly environment.” Miranda shared, “I would like to restate that the all girls' atmosphere made me feel very comfortable about a foreign subject.”

Ruth discussed her ability to focus and, thus, do better in class, “The all girls thing is cool. I'm happy that I'm doing it cuz it's a lot easier to stay focused and I think I'm doing better than I would be doing if I wasn't doing the all girls thing.” Nancy felt that

she did better because she was in the all girls class as well, “I think the fact that it was all girls really helped me to do better in this class.”

Social aspects certainly played a part as well. Ali tells that she liked the class because, “The all girls atmosphere definitely made making friends easier.” This is something very important to high school adolescents, especially ones that have not grown up going to the same schools, such as these students who come from multiple school districts to the regional magnet school. Colleen said, “I do feel like I fit in.” This is another very important feeling for adolescent girls to have. As Jill put it, “I KNOW that I'll know someone in my class,” again, clinging to that feeling of being a part of something and not being an outcast. This is important in the self confidence of these young women as they are learning. As Carol said on choosing to be in the class, “I thought I might like the all-girls setting, and this way I knew I would be with some of my friends.” Randi added her sentiments on the camaraderie in the class, “I like this class because I think since we're all girls and we're about all at the same level with computer experience, we help each other more.”

Many of the girls did note the absence of boys and the impact they felt it had on the class. As Colleen put it, “It is not boys in the class that influenced my decision, but the worry of being the 'worst' in the class because there were the 'super smart geeky boys' to be jealous of.” Lucy shared, “it feels a little less competitive. Guys tend to be very open about their accomplishments so you feel the pressure to be doing as well as they are.” Carol had another angle on the absence of boys, “It is very quiet in the class. I think it might be because some guys aren't as concerned with getting the wrong answer in front of the class as a lot of girls are.” However, she went on to say that, “we can talk without

worrying if any members of the opposite gender can hear you…that sounds so secretive, but it's actually nice sometimes!" As Andi shared, "the biggest difference is that we waste less time in class because of interruptions." Ruth was happy that there were, "no guys being all over-achievers and stuff." Elizabeth shared, "I think that if you're in a class with boys, even if you don't do it on purpose, you may find yourself acting a little differently or worrying a little more about what you do."

Erica was happy with her progress in class and described her feelings towards her friends, "This kind of amuses me as I think to how some of my friends said it would be impossible to get through a tech class without help from guys." Randi shares how she felt less stressed, "I guess it's good that there aren't any guys in this class because a bunch of them would probably be way ahead and that would make me feel stressed." Later in the course, as it started getting difficult for Randi, she says, "Comp Sci is getting intense. I'm glad there aren't any computer-y boys who are like ha-ha I'm 20 labs ahead of you." Randi also realized the potential for immature comments from boys during some of the lessons, "Today we were doing boolean algebra - && and || and !. A - girl, B-boy. A&&B A||B, !A, !B; and I don't know, I bet if there were boys in the class, there would have been at least one who was trying to be 'cool' for his friends and said something like 'you're a boy' blah blah, So immature." Amanda felt good about being ahead of most of the students and realized that she might not have felt that way with boys in the class, "I've heard that guys are better at comp sci, so I guess it's nice to be ahead of most people, while perhaps in a class with boys I would not be." None of the girls wrote about missing boys in class, even those students who felt they would, such as Amy, who was only taking the class because her mother made her.

Miranda had taken some technology classes in the past and shared her feelings on the differences with this class,

> I've taken some technology classes before, but they were always a bit confusing and almost always all-guy oriented. Either they had previous experience and understood it instantly, or they raced ahead. I couldn't "slow the class down" so I never really understood my C++ or Java classes. However, I've always been interested in how code works - it's such a big part of the widespread Internet society. This also ties into the reason I'm taking All-Girls Summer CompSci. I could just imagine that an all-girl atmosphere in a technology-oriented class would be easier to ask questions and talk to classmates in. This first day has proved true to that - I'm glad I signed up for this special class.

As noted in chapter 2, when students are comfortable, they are more willing to learn and are opened up for more success in class. It is clear from these girls' statements that they enjoyed the all girls environment and felt it was a positive experience for them.

All of the students interviewed echoed the sentiments expressed in the journals about the comfort in the all girls' classroom. As Amy said, "the mood was like different than it would have been, kind of lighter for some reason." Emma shared, "I think I probably would not have enjoyed it as much if there were boys in the class [because] I just feel that like I get more out of it if I'm able to concentrate more without the distractions with that, especially when they're really loud." Emma goes on to talk about her friendships and says that even though she was not friends with everyone in the class, she still felt, "more comfortable around the [other girls] than I would have with boys I

didn't know." Jane comes right out and says of the class, "it was a really nice environment."

As discussed previously, a positive learning environment promotes better learning for the students, and these students clearly felt comfortable and at ease and able to learn due to the environment of the classroom without boys.

The girls went on to talk about the direct impact not only on the general classroom environment but also on their learning without boys. Jill felt that her learning was directly impacted in a positive manner by the absence of boys,

> Actually, I think I learned more, cause in my other classes boys tend to be, they tend to go off the subject and stuff, but then I noticed a lot of girls in my class, they tend to ask questions if they needed it and they weren't embarrassed to hold back because they think that some people might make fun… I felt like I learned a lot more than I would have learned with boys. Not that I have anything against them, it's just that sometimes they are noisy and they get off task a lot and the girls in my class, like I said before, they ask a lot of questions, and they are very organized, so it was good.

Emma had a similar sentiment when she exclaimed, "I just feel that like I get more out of [class] if I'm able to concentrate more without the distractions with [boys], especially when they're really loud."

When asked about a time when Emma was glad that boys were not in the classroom, she responded, "Most of the time, because it just, I don't know, it feels like when there are boys in the room, it feels more rowdy and you feel like you can't really … talk to people about things as much as you can when there aren't." On the absence of

boys, Amy said, “I didn’t feel like I had to split my attention between girls and boys…because boys make stupid comments that distract from question asking.”

Jill felt that the all girls environment had another important impact on all of the students in the room,

> I guess throughout the course I realized not having boys in the class kind of made the girls gain confidence in themselves because sometimes they intimidate you and stuff, but uh, I guess having the same sex in the whole room, it boosts a lot of people’s confidence in knowing that you know, they’re not as especially talented in an area, that’s OK, so I thought that was a good thing.

Self confidence is so important when opening oneself up to learn, so this realization is critical for all of the students.

Students Working Together. The girls clearly valued the importance of working together and helping each other. Colleen shared, “Today I was able to give help to my friends in understanding because I understand the concepts so well.” At another point later in the summer, she wrote, “I like the environment in which we learn, because I feel like I can turn to my peers as well as Mrs. Drobnis and the aides if I am struggling.” It’s important that the sharing of knowledge goes both ways, and Colleen has clearly found that.

Mimi was a student in class who always intended to take advanced computer classes (and currently is in Advanced Placement Computer Science). Yet, she realized the importance of working with her partner, “I finished the final with Ellen. She's amazing :) Wish I had her math skills.” Miranda is also a very strong student and shared a similar sentiment, “My classmate helped me get Lab 6 though! Thus again bringing up one of the

things I like most about this class. Peer help is great and never takes anyone out of their comfort zone."

Some students 'paired up' in the beginning and almost always asked for help from the same buddy. It gave them an additional sense of comfort. Amanda and Miranda were one of those pairs. As Amanda shared, "I'm waiting for Miranda to get to Lab 19 (she's on 17 now) so that we can work through the basics together." Miranda discussed working with Amanda when she said, "I'm also happy at the inward self-motivation I've found, a bit of friendly competition to keep me going through the labs. My friend (Amanda) happens to go through these pretty fast, and it's great that we can talk about the labs and ask each other questions." Erica and Jane did a similar thing. As Erica shared, "Jane and I are really making a good team by now. We work at the same pace and help each other out. We are able to explain concepts to each other and troubleshoot our programs together." Sue also created a pairing with another student which she described.

> Although technically there are no partners in this class, it is very helpful working with someone. When I work with Ann, we keep the same pace. If one person finishes a lab first, she will play around and wait for the other person or help the other person. So in a sense we are sort of like partners. When we keep the same pace, we do not have to worry about falling behind. We also like to set our own goals for the day and occasionally assign ourselves homework to keep somewhat ahead.

They clearly have a system which works for them. In addition, Sue shared, "Because of this class, I think I've actually gotten to know Ann better and become closer friends with

her." This is so important for girls at this age to feel comfortable with friends in an academic setting.

The camaraderie observed in this class was remarkable. Some Computer Science teachers have their students work in pairs as they feel this resembles 'real world work scenarios' more closely. However, I feel that students need to have a foundational understanding so that they can contribute to the team. As such, in my classroom, each student is responsible for completing their own work, but they are allowed to ask for help (from myself, the teacher aides, or classmates). On the final project, they team up and work as a group as the final project is intended to be real world and an extension of what they have learned. At this point, the students all have a basic knowledge so that all can contribute to the group.

The Girls' Excitement. It was very clear from the student's journals that not only were students excited by the class but, more importantly, they were more excited than they expected to be. As Jane said, "I'm enjoying this class a lot more than I thought I would." Jill took her sentiments a step further and said, "I can't believe how far I went from being a compsci-hater to the state I'm in now. I think the final project really formed the fact that compsci is fun and I actually like it!" Lucy had a similar feeling, "The class is going well, it is more fun that I thought it would be! That is VERY good." Carol does not go as far with her enthusiasm as the other students when she said, "I'm liking compsci a lot more than I thought I would," but she still is surprised by her positive feelings like the others. Colleen had a similar mindset as Carol, but instead of talking about excitement, she talked about her confidence level, "Computer science class is turning out not to be the dread that I feared it would be. I believed that I would struggle greatly with

the subject, but really I find myself somewhat confident in what I am doing." As discussed in the literature review, confidence is extremely important in one's ability to learn, so this is a great thing for Colleen.

In addition to excitement about the class, many of the students shared their excitement about what they did in class. Jill shared, "The feeling of having a lab work is unimaginable. It's as if all the stress that built up from programming was being wiped out the moment I saw my program run successfully." Lucy echoed the sentiment, "It was so cool to be able to create something out of nothing," when talking about her final project. Elizabeth shared, "I'm really enjoying comp sci. I really like this kind of problem-solving." She went on to say, "I feel really content and accomplished (I don't know if those are the right words to explain the feeling) when I complete a lab. There's something satisfying (I guess) about knowing I completed a lab myself." Erica shared a similar sentiment, "I'm so proud of our game. It's cooler than I thought it would be." Amanda discusses her surprise at liking programming,

> Computers and such have always been fun for me, although before, I've mostly just loved Photoshop graphics.... I've never even tried Java before this class - it's always looked so complex and foreign to me - but what we've done so far isn't so hard, much to my surprise. It actually makes a lot of sense, the words, and everything used. It's not totally foreign…

Like the others, Sue was excited by her new knowledge, "I really understand methods, calling them, and entering arguments for them now... I've even done a little bit of Javanese speaking, but it will probably stop after this class is over. And thankfully, I haven't dreamt in code yet."

Some students who were not as happy with the content still had positive feelings about the overall course. Ali was very up front about her seeming lack of abilities, yet she still was happy with what she had learned,

> The subject of computer science is really cool - and some of the things we've seen from upper classmen's work looked amazing. Unfortunately, I'm not very good at it because I don't really understand it. But I do think it's very, very cool. I mean we've done so much! We've made games (some of which are actually fun)!"

Dottie had very similar feelings to Ali, "Although I'm not entirely proud of my grade, I enjoyed the course and hope that others enjoyed working with me. I'm actually excited for school in the fall!" This positive attitude is so important when looking not only at learning computer science but also in approaching school in general. Dottie had taken summer school previously and not been as excited so this change for her is tremendous.

The students shared similar views in the interviews. Amy had the most insightful comments on her feelings of excitement as she truly was surprised by her feelings, "I felt really accomplished, 'cause um, I was really nervous about it at the beginning, so the fact that I finished the class with a good grade really made me proud of myself." When asked if she expected to feel that way, she replied, "No, I mean, no, not at all."

Emma had a similar sentiment, "I felt good that I'd completed [the course]… and I was really happy about that because I did extra credit labs and I did really well on the final." Again, when asked if she expected to feel this way, she replied, "No, I felt, I expected to feel that I'd just be like Oh, yeah it's over and that's the last thing I'm going to do with compsci, but it wasn't. I was just feeling really happy about it."

On completing the course, Lucy shared, “I actually really enjoyed it, I thought it was interesting to learn, and it was definitely not as boring as I thought it was going to be.”

Additional Insights from the Journals. In general, the journals seemed to be a positive experience for the students. They wrote less than I had hoped for (about every three days) but still wrote plenty. While the students in the class clearly have different demographics, there were several common themes which appeared in many of the girls’ writings. In addition to the passages discussed above in direct response to the research questions, some additional themes emerged from the journals.

Jill shared her thoughts on boys’ feelings, “Guys had this opinion that girls are naturally bad at compsci and having a room of girls would be like a room of infants - crying, complaining, and incapable to do anything.” Jill and the rest of the students in the all girls class proved them wrong when showcasing the final projects, as many of the other (non all girls class) students remarked about how original and complex the final projects from this class were.

Elizabeth discussed more than just the student make-up of the class, “I mentioned this earlier, but I think it's really great to have female TAs and a female teacher. I usually don't ask questions to male teachers, or at least it's more difficult for me to.” This is something so few students often recognize, yet has been shown time and again. With so few female students currently in computer science, it is difficult to find role models for the next generation.

One of the best entries was one written in code. It came as a total surprise and probably sums up the feelings of many students. Kathy shares:

```
CompsciStudent kathy = new CompsciStudent();
kathy.studyLikeAManiac(1);
kathy.comeUpWithFinalProjectIdeas();
kathy.goCrazyOverFinalProjectFormatting();
kathy.jumpForJoyBecauseTheButtonsArePrettyColors();
kathy.studyLikeAManiac(2);
kathy.moreFInalProject();
kathy.wowI'veLearnedLotOfCompsci();
kathy.sixDaysIsNotEnoughtToGetThisDone();
kathy.crapThereIsAQuizTomorrowOnMuchHarderStuffThanMatrices();
kathy.codeWritingforJournalEntries?_wowIHaveAProblem();
System.exit(0);
```

Additional Insights from the Interviews. One topic which was barely mentioned in the journals was the girls' peers outside of the class. Peers can be very influential on adolescents, so I delved into this topic during the interviews. The question posed to all of the girls was, "What did others think about your decision to be in the all girls' class?" Here are the responses:

Jill: Um, I was actually afraid to tell people about all girls comp sci, not really afraid, but hesitant because when I told it to one of my guy friends, he told me, Why are you in the class? I mean, people think, people have that general stereotype that girls are not good at comp sci, but I don't think that people should think that way. It's just the way people think about it and you know…

Jane: "They thought I was crazy" (said with a nervous laughter)

Lucy: "Um, some people were rather critical, they were like all girls, you're kidding, right…"

Amy: "Well, I think I wrote in my journal that one of my friends said I was a lesbian and (with laughter) and I don't really know what to think of that, because that's not true."

Emma: Um, some of them were like, Oh, I wish I had done it with you and then others were like, Why would you do that? And my really good friends thought it was a good idea and my parents thought it was a good idea, but people I like didn't really talk to a lot were like Oh, that's dumb, you shouldn't do that.

It is very clear from all of these responses that the girls' peers were fairly critical of their friends' decision to be in the class. However, the students who chose to be in the class were not deterred and stuck with the class.

Adults. The literature is very clear about the impact that adults have on students when choosing paths to pursue, such as computer science. However, the girls in the all girl's class rarely mentioned the adults in their lives. Despite there being a prompt to write about student's parental influences, the topic was seldom brought up. In fact, the only mentions of outside influences in journals were from Jane, whose father is a computer scientist and "made" her sign up for the all girls' class because he thought "it'd be a better idea," and from Amy whose mother forced her into the all girls' class so that she wouldn't be social with boys as she had been getting into some trouble.

The interviews shed a bit more light on other's influences but not much. It was clear from the interviews that none of the students discussed their decision to be in the all girls' class with their guidance counselors. Jill did not even tell her parents initially but did succumb when she needed to get their signature. She said of them, "They don't really care, they don't say much, it's just comp sci, they know it's the same teacher, I mean, you teach boys and girls, so…"

A further indication of parent's lack of involvement / misunderstandings can be seen in the following incident. There was a female student in one of the mixed gender

classes who was struggling a bit with the content and felt that the class was moving too fast. Her mother wanted to ensure her success so in a conference with the student's teacher and Assistant Principal said, "Can't she just be moved to the all girls' class, I'm sure they're moving more slowly." While all summer school classes follow the same basic schedule, this student's class was actually 3 labs behind the all girls' class at the time this statement was made.

Students' Looking Forward. The interviews afforded me a unique opportunity to fully explore what these girls intend to do in the future. Here's what they shared with me:

Amy. The interview with Amy was conducted the week before school was to begin in the fall. At the end of the interview, Amy shared with me that she would be leaving the math-science magnet school to attend a high school with a strong arts and musical theater program.

Jane. Jane knows that her schedule is tight, due to her interest in the arts, but plans to take more computer science classes while still in high school, much to her father's delight.

Emma. Emma is planning to take Advanced Placement Computer Science in her senior year of high school and is seriously considering taking more computer science in college, "especially if my major or whatever requires that." When asked about what she intends to major in, Emma shares, "I don't know, architecture, engineering, some sort of engineering, I might want to be a doctor," clearly she is undecided, but all focus around the sciences.

Jill. Jill realizes that her schedule is tight in high school since she is already a junior, but shares about college, "I definitely would take [computer science]…probably one of the earliest classes."

Lucy. Lucy still loves chorus and singing but has realized that she, "actually really enjoyed [computer science], I thought it was interesting to learn and it was definitely not as boring as I thought it was going to be…I might take some more in college."

Summary

The quantitative data from the ACCS did not have any major eye opening results. This is most likely the case because the study was done in summer school, where most students are taking computer science as a way to complete the requirement, rather than as a true potential option for themselves. However, the journals and interviews showed that the all girls' class did have an impact on the girls in that class.

It is clear from the girls' own writings that the experience was a positive one for them. The environment created by having a classroom of only females (including the teacher and the teacher aides), enabled the students to feel more comfortable and be more open to learning. The camaraderie fostered a sense of excitement and sharing that helped to create the positive learning environment. Finally, the girls were excited.

The interviews allowed me to hear first-hand what excited the girls and how they felt. I left every interview happier than I entered it as the joy in the girls' voices as they recounted their experiences bubbled over. It was clear that the experience in an all girls' class had been positive for each and every one of them. Not only did they enjoy the class, but they felt accomplished and had learned computer science, something many of the girls were wary about, yet is my main goal as a teacher. Most importantly, all of the girls

have opened themselves up to working with computers / computer science in the future which is becoming more important every day. Robert Reich, former Labor Secretary in the Clinton Administration feels that new jobs in the emerging economy will be heavily influenced by technology. He goes on to be quoted as saying, “Most of them will not be pure technology jobs, …but they will involve applying computing and technology-influenced skills to every industry.” (Reich, as quoted in New York Times, December 20, 2009).

Chapter 5: Conclusion

Summary

This study examined the impact of an all girls' classroom environment in a high school introductory computer science class on the student's attitudes towards computer science and their thoughts on future involvement with computer science. Using the knowledge that female enrollment in computer science is declining while knowledge of the content area is becoming more important along with literature related to computer science, single sex schooling, gender constructs, influences and motivation, it was determined that an all girls' introductory class could impact the declining female enrollment and female students' efficacy towards computer science.

Three different groupings of students were examined for the research: female students in an all girls' class, female students in mixed gender classes and male students in mixed gender classes. A survey, Attitudes about Computers and Computer Science (ACCS), was designed to obtain an understanding of the students' thoughts, preconceptions, attitude, knowledge of computer science, and future intentions around computer science, both in education and career. Students in all three groups were administered the ACCS prior to taking the class and upon completion of the class. In addition, students in the all girls' class wrote in a journal throughout the course, and some of those students were also interviewed upon completion of the course.

Three questions focused this study:

1. What are the impacts on self efficacy?
2. What are the impacts on a future with computer science?
3. What are the impacts on the female students of an all girls' computer science class and do the female students benefit?

Survey data was analyzed quantitatively, and journal and interview data was analyzed qualitatively. The results were combined to create a complete picture of the impact on the girls in the all girls' class and compare their experiences with the students in the mixed gender classes.

To answer the first two research questions, five variables were created from the survey data (Efficacy, MoreCSinHSifRoom, CSinCollege, CareerinCS, and UseCSinCareer). The variables were originally analyzed using ANOVA tests to determine if there were differences in mean scores, which resulted in minimal significance. Further analysis on the variables was done using descriptive measures and looking at overall gains in the mean scores.

To further elaborate on the first two research questions and answer the third question, the qualitative data sources were examined for common themes using an open coding approach. The themes which emerged were: thoughts on the all girls' class, excitement and frustration, future expectations, helping others and working together, and other people's thoughts.

Findings from this research have provided the basis for recommendations to the administration at the school where the study took place. In addition, recommendations

have been made for further research with the same sample of students and for additional studies.

Conclusions

The main goal of the research was to examine the impact of an all girls' option for an introduction to computer science class and to determine if an all girls' class would have an impact on the future enrollment / involvement in computer science for the students involved when compared with the students in the mixed gender classes. Several factors were examined to determine the impact. The following conclusions were supported by the quantitative data:

- All students' computer self efficacy scores increased after taking Introduction to Computer Science, but male students and girls from the all girls' class had a greater increase in efficacy scores than girls from the mixed gender classes. Male students had the greatest increase in efficacy scores;
- All students had an increase in their score concerning taking more computer science in high school if their schedule allowed after completing the summer school computer science course. The male students entered the class with a higher score, so there was not much room for their score to grow. Girls from the all girls' class had a greater gain in this score than girls from the mixed gender class;

- Both the girls from the all girls' class and boys from the mixed gender classes had large gains in taking computer science in college, while the girls from the mixed gender classes had minimal gains in this score;
- Girls in the all girls' class and boys in the mixed gender classes had an increase in score in pursuing a career in computer science over the course of the summer, while girls in the mixed gender classes had a decrease in score in pursuing a career in computer science over the course of the summer;
- The girls from the mixed gender sections had essentially zero gain in using CS in a future career scores, while the girls from the all girls' class and the boys had considerable gains;

The following conclusions were supported from the qualitative data:

- Females in the all girls' class were surprised by how much they enjoyed the class and clearly shared their excitement;
- Females in the all girls' class discussed being more open to a future with computer science. Most are not interested in a focus directly in computer science but realize that it could become a part of their future academic pursuits / career;
- Females in the all girls' class worked together quite extensively. They shared how much that enhanced their learning experience;

- Females in the all girls' class were very hesitant to share their participation in the class with their peers based on negative reactions from the few friends they did share it with;
- Females in the all girls' class felt that the environment without boys made them feel more comfortable;
- The girls from the all girls' class indicated that they are considerably more likely than before to take more computer science in college;
- The girls from the all girls' class indicated that they are considerably more open to the possibility of using computer science in a future career than before;
- The girls from the all girls' class indicated how important the girls felt it was to work together. Further, the girls discussed the comfort they felt at easily being able to ask anyone in the classroom for help, something they didn't think would have been as easy if boys were present;
- The girls from the all girls' class indicated how little they shared with their friends about computer science; and
- The girls from the all girls' class rarely discussed adults, indicating how unimportant this seemed to be to the students.

Discussion – Research Questions 1 and 2

Quantitative Data. As a math teacher, with an appreciation for statistics, I had hoped that results from the quantitative survey Attitudes about Computers and Computer Science would show irrefutable evidence that students in the all girls' class felt better

about their computer science studies and were more likely to pursue a future with computer science after completing an introduction to computer science class than their peers in mixed gender classes. That did not happen as there were few differences identified among the three different student groups from the ANOVA tests.

This indicates that the three groups studied were very similar and were impacted in the same ways. This can be attributed to several factors: students in each of the groups were similar, students in summer school were similarly focused, the content presented to all students was the same, and the duration of the program was short.

The fact that students in the groups were similar is consistent with the location of the research. It is a regional magnet school where students need to apply. As such, all students are academically advanced, motivated and have an interest / strong abilities in science, math and technology. While socio-economic status was not considered a factor in this study, these students primarily come from a high socio-economic class and have parents who are supportive of their educational pursuits.

Further, the students in summer school are similar in the way they are approaching computer science – this is most likely due to the fact that they are taking the class in the summer to 'get it out of the way' and make room for something else. By taking the course in summer school to 'get it out of the way,' students are closing themselves to the option of liking the class and wanting to pursue it further before they have any exposure, so this is a great hurdle to overcome. Consistent with the literature, girls (from both groups) were trying to make room for more arts / humanities classes while boys were trying to make room for more science / technology courses (Giuzzo,

2008). This unfortunately seems to reflect the perpetuation of the stereotypes that girls are better at humanities and boys are better in the more technical fields.

While the course groupings were different, the content presented to all of the students was the exact same. All classes used the same materials, followed the same schedule and were assessed in the same manner (with exactly the same quizzes and tests). The only thing that was different was the actual teacher. However, the group of teachers whose students participated in the research have been working together for so long that they probably deliver the content in similar manners.

Further explanation for the minimal differences among the groups can be attributed to the fact that summer school is only 5 weeks. It is very difficult to have any major changes in such a short period of time. Some of the girls even alluded to this in their journals.

Another consideration to the lack of powerful tests is that the samples were relatively small with approximately 20 students per group. This is unfortunately, unavoidable as the all girls' class only had 24 total participants.

Because of the minimal findings from the statistical tests, I decided to look at the ACCS scores as descriptive by looking at the means and changes over time. When looking at the data in this manner, certain phenomena were easily seen. The biggest eye opener is that for all of the variables except for MoreCSinHSifRoom, the gain scores for the girls from the all girls' class and the gain scores from the boys for all of tracked closely, while the gain scores for the girls from the mixed gender classes were well below, sometimes in the opposite direction. This is a strong indication that the girls in the

mixed gender classes are not having the same overall experiences as the boys or the girls in the all girls' class. This finding is consistent with what the literature says on the topic.

Another consideration when looking at the data in this manner is the trends occurring. The time difference for the two surveys was only five weeks, which is a very short amount of time for considerable change to occur. However, had the study been conducted over a longer period of time, it is possible that greater increases in scores would have occurred for the girls in the all girls' class, as indicated by the qualitative data.

The CareerinCS scores are very intriguing as this is the one score which had a decrease over the course of the summer for the girls form the mixed gender classes, while the other two groups had increases. This is a clear indication that the girls in the all girls' class are more open to a future with computer science than the girls in the mixed gender classes as a result of their experience in the all girls' class, which correlates with the qualitative data.

Qualitative Data. In the journals, girls form the all girls' class did indicate a greater chance of taking computer science in college. In their journals, the girls also shared a higher propensity to use computer science in their future careers. The girls also discussed at great lengths how they worked together and helped each other in class, indicating that this was a very important factor for them.

While the qualitative data sources did help to answer the research questions, it must be realized that no qualitative data was obtained from students in the mixed gender classes. Therefore, it is unknown whether these students would have had similar

sentiments to the girls in the all girls' class had they been given the opportunity to share their thoughts in the same manner.

Discussion – Research Question 3

The third research question was: "What are the impacts on the female students of an all girls' computer science class and do the female students benefit?" This question was refined by asking three sub-questions for a better focus:

a. Has the all girls environment impacted how the girls work?
b. How did the environment impact the girls' learning of computer science?
c. How did the class conform to and differ from the girls' expectations?

These questions were answered by analyzing the qualitative data from the girls in the all girls' class by looking at their journals and interview responses.

The literature indicated that the quality of a classroom environment is a significant factor contributing to a student's learning (Fraser, 1994, 1998). The girls extensively discussed the environment of the class, as it was the main difference from any other class they had been in. Like the literature, the girls felt that the all girls' environment had a strong impact in a positive manner on their learning.

The literature discussed at great lengths that girls in a computer science classroom have a tendency to fade into the background because of the male domination which takes place (Margolis, Fisher & Miller, 2000; Logan, 2007). Many of the girls shared their thoughts on learning more without the boys in the room, and from their writings, it was clear that the stereotypes discussed in the literature came through. This is probably the main reason why a single sex learning environment for computer science is

advantageous, so that the girls cannot simply fade into the background and will instead work to their full potential.

In addition to the sense of fading into the background as the literature suggests, many of the girls commented on a classroom environment with boys that would be a negative climate. They envisioned a class where they would feel like the weakest student because of the smart geeky computer boys or a class that was loud and disruptive because of boys' behavior or a class where pointless questions would be asked, wasting time and detracting from the content. Combining the girls comments with the quantitative data that showed minimal gains from the girls in the mixed gender classes, it is clear that there is a very different environment in the classroom without boys that is favorable to the girls learning.

The literature was also clear about the negative preconceptions which most students have about the field, but especially females – primarily that it is a field where you work in isolation and that is boring and unconnected with other, mostly humanistic causes (Hendery, 2006; Lazowska, 1999; Papastergiou, 2008). However, when looking at the girls' writings from later in the course, the tone had changed and the girls were enjoying it more. Again, based on the trend, this can be attributed to the environment that was created in the all girls' classroom.

Throughout their writings and responses, the girls discussed a feeling of camaraderie and were eager to work together. While I encourage students in all of my computer science classes to work together, I have never seen it occur as easily and rapidly as I did in this class, and the only difference was the all girls' environment. The fact that many girls discussed it as well shows how important it was to them. It is clear

that the environment fostered a sense of community and the ability to work together, which the female students clearly enjoyed.

Many single sex learning environments are not widely accepted because of the sentiment that it is not a real world experience. One way to combat this sentiment is to have select single sex classes in an overall mixed gender setting.

The IEEE acknowledges that the opportunities for students with a computer science background are not well presented (Giuzzo, 2008) and feel that this may account for some of the low numbers of enrollment in computer science courses. The students in this study clearly support this assertion, as is evidenced by some of the girls' comments.

Fortunately, for the students in this study, the course was designed to help them make those connections by having the students create a variety of computer programs to solve myriad of problems and by introducing them to different paths taken by former students. Connecting the course content to other fields which interest the female students helped to pique their interest in computer science. This is exactly what Margolis and Fisher have in mind when they describe a female student who wants to use computers to study diseases and, "solve the problems of science," (Margolis & Fisher, 2002).

Another way to make connections is to explicitly talk to the students about opportunities in the field and related to the field. Despite it not truly being related to the content, I feel that it is very important to do just that and spent some class time away from the computers talking about potential career paths, salaries in the related fields, and ways to use computer science in the future. The students seemed to find the information very useful.

According to the literature, it is very important to help the students make additional connections with other fields, so that their interest in computer science is continued, particularly female students (Eidelman & Hazzan, 2008). The College Board, in conjunction with the National Science Foundation, is currently working on changing the image of computing by creating a new Advanced Placement Computer Science course that is NOT focused on programming. Rather, the course will focus on implementing the following:

- Computing as a creative human activity
- Abstraction is the process of reducing information and details to solve problems
- Humans use computer programs to manipulate data
- Algorithms are tools for developing and expressing solutions to computational problems
- Programming is a tool for computational problem solving and the exploration and creation of knowledge
- Computer systems and networks facilitate communication and computational problem solving (Stephenson, 2010).

None of the key elements of the proposed course are programming for programming sake (as many courses currently are designed), but rather only using programming as a tool for the many important facets of computing and computational thinking. This new introduction could be a great way to appeal to not only more students, but more diverse students, such as women and minorities (Cuny, 2009).

The literature discusses the importance of the teacher and how their perceived support of students can drastically impact the students' attitude towards the subject (Dorman & Fraser, 2009). Furthermore, it has been stated that male computer science students feel their teachers are more supportive than female students (Eidelman & Hazzan, 2008). The girls in the all girls' class would strongly support this assertion, as many spoke about the importance of their teacher and the teacher's aides as an important factor of comfort. Role models are clearly very important to adolescent students, and unfortunately, female role models are lacking in computer science.

The data collected in the research differs a bit from what the literature shared on influences of computer science studies. The literature was very clear about home influences: who is allowed to use the computer at home, who helps the student on the computer at home, early introduction to the computer at home. However, none of these factors came up in the study. It is believed that this is the case because of the unique population of students in the study – the students are at a magnet school for science and technology and have grown up with computers, almost by default. Further, they are all required to be in this Introduction to Computer Science class, so at this stage, the decision to study computer science has been made for them, they are not choosing the subject based on other factors.

However, the literature and research certainly do overlap some when discussing motivating factors, particularly extrinsic vs. intrinsic. As Papastergiou stated, girls in high school tend to study computer science for extrinisic factors, such as money or a potential job, whereas high school boys tend to study computer science for both intrinsic and

extrinsic factors, equally (Papastergiou, 2008). Some of the girls who did talk about a future with computer science did in fact mention those extrinsic factors.

Through the course, all of the girls' opinions changed and they were clearly excited by the course, as they realized that you could collaborate with others, use computer science in other fields and create something from nothing. It's not their excitement which is surprising, but their personal surprise at how excited they were was unique and unexpected.

A unique finding is that not only were the girls in the all girls' class excited by what they had accomplished through the course, but that they were surprised by their excitement. In this way, the class definitely differed from the students' expectations in a positive way.

Recommendations

From this study, many clear recommendations can be given to help increase students' self efficacy towards computer science and increase future enrollment in computer science. While the focus is to promote both for females, many of the practices can be used to help all students.

Practice. The recommendations for practice are:

- Offer an all girls' option to female students taking an introduction to computer science course.
    - As a teacher who has taught the course for six years to 16 sections (3 in summer school and the rest during the school year) of roughly 24 students each, I can honestly say that for the first time, EVERY

student was not only proud of what they had learned in the class, but excited by their new found knowledge.

- All computer science classrooms should foster collaborative work.
    - The students were very excited by the collaborative experiences in class, whether formal or informal.
- Clearly define computer science.
    - It is clear from talking with the girls and looking at the survey data that many of the students did not know what they were getting into – they were only taking this class because it was required.
    - Preconceptions are out there based on media, peers, and parents yet these ideas are often incorrect.
- Students need to be made aware of the myriad opportunities available to them with a background in computer science.
    - Technology is only becoming more prevalent in society and students will be able to use their technology understanding in careers which they are passionate about as long as they are aware of the connections.
- Provide female role models in computer science to students.
    - This one factor will help to alleviate preconceptions of a field void of females.

Research. The recommendations for research are:

- Repeat this same study during the school year

    - This would create a sample of students that are not as tightly scheduled and thus, may have more room for future computer science courses in high school.
    - It also would enable the same teacher to teach both the all girls' class and mixed gender class so that teacher differences would not be a confounding factor.
    - It is extremely difficult to have a major impact / change in thinking towards something in only five weeks.
- Repeat this same study and collect qualitative data (journals and interviews) from all students, not just the girls in the all girls' class.
    - This would enable some of the conclusions that were drawn from the qualitative data to be more concrete and see if they are truly attributable to the all girls' class or if another factor is at play.
- Refine the survey instrument to better capture information on some of the themes which emerged in practice, such as the collaborative nature of the students in the all girls' class.
- Conduct a longitudinal study with girls from the all girls' class to see if they have changed their future path towards more computer science
    - To see the true impact of the all girls' class on these students, a longitudinal study should be conducted where these girls are contacted again:
        - at the conclusion of their high school career,

        - at the conclusion of their college career, and
        - after a few years of employment to determine if / how they are using computer science.
    - Repeat the study at a non-STEM school so that the results could be generalizable to a larger population of students.

Limitations

Many of the limitations to this study were identified before the study, and found to exist. However, the one limitation which proved to be more of a factor than anticipated in the quantitative results was the fact that this research was conducted in summer school. The pool of students in summer school was more similar across the three groups because they were primarily taking the class to get it over with. As such, I should have acknowledged that while they may have enjoyed the experience more than they had expected, they would not be as willing to change their focus for the immediate future to include more computer science courses.

Another major limitation on the study is that the groups studied were not independent samples. They were dependent on each other because they came from the same population – students enrolling in summer school in 2009. The females could be in one group or the other, and those groups were completely dependent. To account for this in the future, if the all girls' class was offered again during summer school, the ACCS should be given to those students and the results from that sample should be compared with the mixed gender groupings from the previous data set.

An additional limiting factor is that I had to be wary of some of the data since I was both the teacher and researcher. While I wouldn't consider doing the study any other way, this did force me to change the way I looked at some of the data. The literature does discuss the importance of perceived teacher support. There was also a question on the ACCS directly related to this, and as expected based on the literature, the girls in the all girls' class did have a statistically significant higher mean score for perceived teacher support. However, I could not report on this data, as I was the teacher they were referring to and I did not teach any of the other classes. This is why in the future, it would be ideal to redo this study with the same teacher teaching both the all girls' class and the mixed gender classes.

Reflections and Future Implications

This research project grew out of a curiosity I had about my own past. While I now have some answers to the questions of my past, I feel that more importantly, I have a solid understanding of the female adolescent's mindset about computer science, particularly for students who have already shown a strength in math and science, but are not open to computer science, such as the girls in the all girls' class of computer science.

When I began this journey into research, I thought it would be the culmination of a passion, giving me great insight and explanations for questions I had about my own education, the choices I made along the way and how I ended up where I did, teaching math and computer science. Now that the study is complete, I realize that it is just a pit stop, as there is so much more to explore.

Appendix A

Attitudes about Computers and Computer Science

Part I. Background Information:

1. What is your gender?
    a. Male
    b. Female
2. How old are you?
    a. 13
    b. 14
    c. 15
    d. 16
    e. 17
3. What grade did you just complete (2008-2009 school year)?
    a. 9
    b. 10
    c. 11
4. I am taking Introduction to Computer Science in summer school because that is the only way it will fit into my schedule.
    a. True
    b. False

For each question or statement below, please choose the answer which best characterizes your feelings using the following responses:

A: Strongly Agree
B: Agree
C: Disagree
D: Strongly Disagree
E: Non Applicable

Part II: High School Studies

5. I plan to take more Computer Science classes in high school after completing this Introduction course.
6. If there was room in my schedule, I would like to take more Computer Science classes in high school after completing this Introduction course.
7. I will use computer science in other high school classes after completing this Introduction course.

Part III: Computer Science Perceptions

8. I understand what computer science is.
9. I am looking forward to taking computer science.
10. My friends who have already taken Introduction to Computer Science enjoyed the class.
11. My friends who have already taken Introduction to Computer Science found the class helpful in other classes.

Part IV: Future with Computer Science

12. After this class, I will take more computer science classes while in college.
13. I am considering a career in computer science.
14. I know that I will most likely use computer science in my career.
15. My mother is encouraging me to do more with Computer Science.
16. My father is encouraging me to do more with Computer Science.
17. My teacher is encouraging me to do more with Computer Science.
18. My counselor is encouraging me to do more with Computer Science.
19. My friends are encouraging me to do more with Computer Science.

Part V: Computer Use

20. I use computers regularly outside of school.
21. I have programmed in a computer science language before this class.
22. My mother encourages me to work on the computer at home.
23. My father encourages me to work on the computer at home.
24. My mother uses computers regularly at home.
25. My father uses computers regularly at home.
26. My mother uses computers regularly at her job.
27. My father uses computers regularly at his job.
28. When I get stuck using the computer at home, my mother helps me fix the problem.
29. When I get stuck using the computer at home, my father helps me fix the problem.
30. When I get stuck using the computer at home, my sister helps me fix the problem.
31. When I get stuck using the computer at home, my brother helps me fix the problem.

Part VI: Computer Self Efficacy

32. I enjoy working with computers.

33. I am good at using computers.
34. I often help my friends or family in teaching them how to use a computer.
35. I enjoy programming in a computer science language.
36. I am good at programming.
37. I often help my friends or family in teaching them how to program using a computer science language.

Appendix B

Interview Guide for Girls in All Girls Computer Science Class

Interview Guide for use with female students who have completed all girls Introduction to Computer Science in Summer of 2009. The interviews will follow the guide below, realizing that respondent's answers will require additional follow up questions.

Guide for Interview with_____

Date_____

Location_____

1. Background information:
    a. Age_____ b. Grade:_____
2. How do you use the computer at home?
    a. Who encourages computer use at home?
3. When you began high school here at [school], what did you think about computer science?
    a. How have your views changed?
4. How many computer science courses did you think you would take during high school and college?
    a. Is that still the case?
5. Why did you choose to take Computer Science in Summer School?
6. Why did you choose to sign up for the All Girls Class?
    a. What did others think about your decision?
        i. Parents
        ii. Friends
        iii. Counselor
7. Looking back, are you happy you signed up for the All Girls Class?
8. Tell me about a time when you remember feeling that you were glad boys were not in the class.
9. Tell me about a time when you wish boys had been in the class.
10. Do you think that you enjoyed this class more because boys were not in the class? Why?
11. Do you think that you learned more because boys were not in the class? Why?
12. Do you think you are more likely than before to use computer science in other classes?
13. Do you think you will take any more computer science courses in high school?
    a. In college?

14. Would you consider a career that uses computer science?
    a. Do you think you would have answered that question the same way before taking this class?
15. Is there anything else about you, your computer science studies or your education in general that you want to share with me?

Appendix C

Recruitment Letter for All Girls' Section

High School for Science and Technology

PUBLIC SCHOOLS

May 24, 2009
Dear (Student Name),

You are receiving this letter because you have registered for Introduction to Computer Science this summer and are a female student. As you may be aware, we are trying something new this summer and will be offering an all girls section of the course. We have decided to do this because both at [school] and nationally, female representation in the computer science field is low. We want females to have a positive first experience with computer science and feel that this method may help to enable such an experience.

This is the first time an all-girls section is being offered at [school] and you have the opportunity to be a part of it. An all-girls engineering course has been offered at Chantilly High School for the past two years and students have thoroughly enjoyed the experience.

The all-girls section will be the same as the mixed-gender sections. The teacher of the all-girls section has been teaching the course for several years. The content will be the same and expectations will be the same. The time and location of the section will be the same as the mixed gender sections. The difference is that the environment will be all girls.

Enrollment in the all-girls section will be on a first-come, first-served basis. If you are interested in being in the all-girls section of computer science, please fill out the enclosed form and return it to the front office by Wednesday, June 3. You will be notified before the start of summer school about which section you will be in.

Thank you for considering being a part of this new class.

Sincerely,

Principal

PUBLIC SCHOOLS

Enrollment for All Girls Section of Introduction to Computer Science

I, _____ (enter your name), would like to be enrolled in the all girls section of Introduction to Computer Science during the summer of 2009 at High School for Science and Technology.

I understand that this section will be the same as the mixed gender sections and that the expectations of me as a student will also be the same.

I understand that enrollment in the all girls section is voluntary and I am choosing to be in the section.

I understand that enrollment is on a first-come, first served basis, and submitting this form does not guarantee me placement in the all girls section.

Name Signature Date

Parent's Name Parent's Signature Date

_____.

Student's Email Address

Appendix D

Letter to Students in All Girls' Section

High School for Science and Technology

PUBLIC SCHOOLS

June 5, 2009
Dear (Student Name) and Parent,

You have chosen to be part of something special at [school] – the first all girls Introduction to Computer Science class. It is sure to be an exciting experience for all involved.

What you may not know is that this class will be looked at as part of a research project to see if this could be a better way to teach computer science for some students. I, Ann Drobnis, will be teaching the class and conducting research for my doctoral dissertation at George Mason University.

The class will not be any different for you if you choose to participate in the research or not. All students in the class will take the pre and post class survey. All students in the class will write in their journal. During the class, I will not know who is participating in the research and who is not. At the end of the summer, after I have submitted final grades for all students, I will find out who is participating in the research. Only then will I read the journals of the students who participated to collect data. In addition, I will ask some of the students who are participating in the research for an interview so that I can better understand your experiences in the all girls class.

If you have more questions, please feel free to contact me or attend one of the information sessions, listed below. If you are willing to participate in the research, please submit the consent and assent forms included with this letter by returning them in the enclosed stamped envelope by June 30, 2009. You can also submit the forms at the information sessions or to the math office.

Thank you for considering helping me in my research.

Sincerely,

Ann Drobnis

For questions about research project, contact Ann Drobnis (adrobnis@xxx.edu) or 202-xxx-xxxx

For questions about participation, contact Debbie Bergeron (dberger3@xxx.edu). Mrs. Bergeron is not at all associated with the research project but will be collecting the research forms and will keep participants confidential from Mrs. Drobnis until after the course is completed. She is familiar with the project, specifically and can answer any questions you feel uncomfortable asking Mrs. Drobnis.

For additional information, feel free to attend either one of the information sessions:

Wednesday, June 17	Thursday, June 18
7:00-7:30	10:00-10:30
HSST	HSST

Appendix E

Consent and Assent Forms for Students in All Girls' Section

Ann Drobnis

(202)xxx-xxxx

adrobnis@xxx.edu

Girls in Computer Science: A Female Only Introduction Course in High School

PARENT INFORMED CONSENT FORM – ALL GIRLS CLASS

RESEARCH PROCEDURES

This research is being conducted to look at students attitudes and future intentions towards computer science. Your child is already enrolled in the all girls section of Introduction to Computer Science during the Summer of 2009, taught by a female teacher, who is also the researcher. The course will be exactly the same course as is taught to the rest of the students by a teacher who has been teaching the course for 5 years at High School for Science and Technology, both in summer school and during the school year. As part of the course, your daughter will be asked to respond to two surveys – one at the beginning of the computer science course, and the other at the end of the summer. These surveys will contain questions about her attitude towards computer science and her future intentions towards computer science. Each survey will take no more than 30 minutes and will be built into the school day. In addition, your daughter will be asked to write in a journal about her experiences throughout the course. The journal writing will take 5-15 minutes per entry. Students will be given class time to write in their journal every other day, but can write more on their own if they wish. If you choose to allow your daughter to participate in the study, the teacher / researcher will read her journal after the course is over as a data source for her research. In addition, your daughter may be interviewed about her experiences after the completion of the summer course. The interview is expected to take no more than an hour and will be at a time and location that is convenient for you and your daughter.

RISKS

There are no foreseeable risks for participating in this research.

BENEFITS
There are no benefits to your child as a participant, except to further research in computer science education.

CONFIDENTIALITY
The data in this study will be confidential. All information that could identify your child (including consent forms, survey results and student information) will be kept strictly confidential and in a locked office. Students will be assigned a study ID number that will replace their names and be used on all documents they fill out. Only the researcher will have access to the key which will link the ID number with Student Name. Only aggregated data will be presented. No individuals, districts or schools will ever be identified in reporting the findings.
When reporting data based on the writings and interviews, pseudonyms will be used and no personally identifiable information will be shared. The school and school district will never be referenced in any reporting. The surveys will be administered by Debbie Bergeron on the first and last day of summer school. She will maintain them in a locked cabinet at George Mason University until the course is completed and grades have been submitted, at which point, Ann Drobnis will work with the surveys and analyze the data.

PARTICIPATION
Your child's participation is voluntary, and you may withdraw your child from the study at any time and for any reason. If you or your child decide not to participate or if your child withdraws from the study, there is no penalty or loss of benefits to which you or your child are otherwise entitled. There are no costs to you, your child, or any other party. The surveys will be administered by Debbie Bergeron on the first and last day of summer school. She will maintain them in a locked cabinet at George Mason University until the course is completed and grades have been submitted, at which point, Ann Drobnis will work with the surveys and analyze the data.

CONTACT
This research is being conducted by Ann Drobnis through the Graduate School of Education at George Mason University. She may be reached at 202-xxx-xxxx for questions or to report a research-related problem. Her research is being supervised by Dr. Priscilla Norton who can be reached at 703-xxx-xxxx. You may also contact the George Mason University Office of Research Subject Protections at 703-xxx-xxxx if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to George Mason University procedures

governing your participation in this research.

CONSENT
I have read this form and agree to participate in this study.

Name Signature

Student's Name Date of Signature

Version date: February 11, 2009

Ann Drobnis

(202)xxx-xxxx

adrobnis@xxx.edu

Girls in Computer Science: A Female Only Introduction Course in High School

ASSENT FORM – ALL GIRLS CLASS

RESEARCH PROCEDURES

The reason for this research is to better understand students attitudes towards computer science. If you agree to take part in this study, you will be asked to fill out two questionnaires. Each questionnaire will take no more than 30 minutes and will be built into the school day. I will also ask you to write in a journal about your experiences during class. The journal writing will take 5-15 minutes per entry. You will be given class time to write in your journal every other day, but can write more on your own if you wish. I will not read your journal until the class has ended and grades have been submitted. In addition, I may want to interview you after the course has ended and grades have been submitted. The interview is expected to take no more than an hour and will be at a time and location that is convenient for you.

RISKS AND BENEFITS

You will not lose any of your rights by being in the study. There are no rewards or money paid for being in this study. However, the things I find out may help us create better computer science instruction in the future.

CONFIDENTIALITY

Your name will not be on the questionnaire that you fill out, only an ID number, which will be kept confidential. Only myself and a fellow researcher will read your journal and interview texts. No one will ever know that you participated or what you wrote about. I will not use your name or personal information when reporting data. I may use some of your words as supporting quotations for my research. The surveys will be administered by Debbie Bergeron on the first and last day of summer school. She will maintain them in a locked cabinet at George Mason University until the course is completed and grades have been submitted, at which point, Ann Drobnis will work with the surveys and analyze the data.

PARTICIPTION

You don't have to participate. If you change your mind after taking the first questionnaire or at any time during the course, you do not have to continue your participation. All prior material that you have worked on will be destroyed.

CONTACT

My name is Ann Drobnis, and I am studying to get a PhD in Education at George Mason University. You can call me at this phone number (202-xxx-xxxx) if you have any questions about this study. You can also call my Advisor, Priscilla Norton, a Professor at George Mason University, at this phone number 703-xxx-xxxx.

The George Mason University Office of Research Subject Protections knows all about my research and said that it was OK for me to do it. You can call them at 703-xxx-xxxx if you have any questions about being a part of this research.

CONSENT

I have read this form and I agree to be part of this study.

Signature **Date**

Name

Appendix F

Letter to All Computer Science Summer School Students except those in All Girls' Section

High School for Science and Technology

PUBLIC SCHOOLS

June 5, 2009

Dear (Student Name) and Parent,

As you may have heard, this summer, there is going to be an all girls class of Introduction to Computer Science at [school]. This is something we have always wanted to try and this summer it will be happening.

What you may not know be aware of is that this summer, I will be conducting research for my doctoral dissertation at George Mason University. For my research, I will be using the all girls computer science section as part of my study. However, part of my research also involves doing some comparisons with the mixed-gender sections.

As a student enrolled in summer school computer science, I hope you will consider being a part of my research. All students will be taking a survey on the first day and last day of class. For part of my research, I would like to include your survey results in my data set. The survey will be completed anonymously, and I will not know whether or not you are participating.

If you have more questions, please feel free to contact me or attend one of the information sessions, listed below. If you are willing to participate in the research, please submit the consent and assent forms included with this letter by returning them in the enclosed stamped envelope by June 30, 2009. You can also submit the forms at the information sessions or to the math office.

Thank you for considering helping me in my research.

Sincerely,

Ann Drobnis

For questions about research project, contact Ann Drobnis (adrobnis@xxx.edu) or 202-xxx-xxxx

For questions about participation, contact Debbie Bergeron (dberger3@xxx.edu). Mrs. Bergeron is not at all associated with the research project, but will be collecting the research forms and will keep participants confidential from Mrs. Drobnis until after the course is completed. She is familiar with the project, specifically and can answer any questions you feel uncomfortable asking Mrs. Drobnis.

For additional information, feel free to attend either one of the information sessions:

Wednesday, June 17	Thursday, June 18
7:00-7:30	10:00-10:30
HSST	HSST

Appendix G

Consent and Assent Forms for Students not in All Girls' Section

Ann Drobnis

(202)xxx-xxxx

adrobnis@xxx.edu

Girls in Computer Science: A Female Only Introduction Course in High School

PARENT INFORMED CONSENT FORM – ALL STUDENTS

RESEARCH PROCEDURES

This research is being conducted to look at students attitudes and future intentions towards computer science. If you agree for your child to take part in the study, your child will answer two surveys – one at the beginning of their computer science course, and the other at the end of the summer. These surveys will contain questions about their attitude towards computer science and their future intentions towards computer science. Each survey will take no more than 30 minutes and will be part of the school day.

RISKS

There are no foreseeable risks for participating in this research.

BENEFITS

There are no benefits to your child as a participant, except to further research in computer science education.

CONFIDENTIALITY

The data in this study will be confidential. All information that could identify your child (including consent forms, survey results and student information) will be kept strictly confidential and in a locked office. Students will be assigned a study ID number that will replace their names and be used on all documents they fill out. Only the researcher will have access to the key which will link the ID number with Student Name. Only aggregated data will be presented. No individuals, districts or schools will ever be identified in reporting the findings.

PARTICIPATION

Your child's participation is voluntary, and you may withdraw your child from the study

at any time and for any reason. If you or your child decide not to participate or if your child withdraws from the study, there is no penalty or loss of benefits to which you or your child are otherwise entitled. There are no costs to you, your child, or any other party.

CONTACT
This research is being conducted by Ann Drobnis through the Graduate School of Education at George Mason University. She may be reached at 202- xxx-xxxx for questions or to report a research-related problem. Her research is being supervised by Dr. Priscilla Norton who can be reached at 703- xxx-xxxx. You may also contact the George Mason University Office of Research Subject Protections at 703- xxx-xxxx if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to George Mason University procedures governing your participation in this research.

CONSENT
I have read this form and agree to participate in this study.

Name Signature

Student's Name Date of Signature

Version date: February 11, 2009

Ann Drobnis

(202)xxx-xxxx

adrobnis@xxx.edu

Girls in Computer Science: A Female Only Introduction Course in High School

ASSENT FORM – ALL STUDENTS

RESEARCH PROCEDURES

The reason for this research is to better understand students attitudes towards computer science. If you agree to take part in this study, you will be asked to fill out two questionnaires, during class. It will take no more than 30 minutes, each time.

RISKS AND BENEFITS

You will not lose any of your rights by being in the study. There are no rewards or money paid for being in this study. However, the things I find out may help us create better computer science instruction in the future.

CONFIDENTIALITY

Your name will not be on the questionnaire that you fill out, only an ID number, which will be kept confidential. No one will ever know that you participated or how you responded to the questionnaire.

PARTICIPTION

You don't have to participate. If you change your mind after taking the first questionnaire, you do not have to take the second questionnaire and your first questionnaire will be destroyed.

CONTACT

My name is Ann Drobnis, and I am studying to get a PhD in Education at George Mason University. You can call me at this phone number (202-xxx-xxxx) if you have any questions about this study. You can also call my Advisor, Priscilla Norton, a Professor at George Mason University, at this phone number 703- xxx-xxxx.

The George Mason University Office of Research Subject Protections knows all about my research and said that it was OK for me to do it. You can call them at 703- xxx-xxxx if you have any questions about being a part of this research.

CONSENT

I have read this form and I agree to be part of this study.

Signature **Date**

Name

Appendix F

Consent Form for Teaching Assistants

Ann Drobnis

(202)xxx-xxxx

adrobnis@xxx.edu

Girls in Computer Science: A Female Only Introduction Course in High School

INFORMED CONSENT FORM – TEACHING ASSISTANTS

RESEARCH PROCEDURES

This research is being conducted to look at students attitudes and future intentions towards computer science. You will be a teaching assistant for the all girls class of Introduction to Computer Science. As a teaching assistant, you will be asked to keep a journal of your experiences. It is hoped that you will write about how you felt as a girl in a mixed gender Introduction class a few years ago, compared to this class that you are now working with. The journal writing should take 5-15 minutes per entry. You will be encouraged to write in your journal at least every other day. You will have time during the work day to work on your journal while instruction is given. If you choose to participate in the study, the teacher / researcher will read your journal after the course is over as a data source for her research.

RISKS

There are no foreseeable risks for participating in this research.

BENEFITS

There are no benefits to you as a participant, except to further research in computer science education.

CONFIDENTIALITY

The data in this study will be confidential. All information that could identify you will be kept strictly confidential and in a locked office.

When reporting data based on the writings and interviews, pseudonyms will be used and no personally identifiable information will be shared. The school and school district will never be referenced in any reporting.

PARTICIPATION
Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.

CONTACT
This research is being conducted by Ann Drobnis through the Graduate School of Education at George Mason University. She may be reached at 202-xxx-xxxx for questions or to report a research-related problem. Her research is being supervised by Dr. Priscilla Norton who can be reached at 703-xxx-xxxx. You may also contact the George Mason University Office of Research Subject Protections at 703-xxx-xxxx if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to George Mason University procedures governing your participation in this research.

CONSENT
I have read this form and agree to participate in this study.

Name Signature

Date of Signature

Version date: February 11, 2009

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CURRICULUM VITAE

Ann W. Drobnis graduated from Hopkins School in New Haven, CT in 1996. She received her Bachelor of Science degree in Engineering from Cornell University in 2000. She received her Master in Education degree from the George Washington University in 2004. She has been employed as a teacher in Fairfax County Public Schools for seven years.