6-1-2008

High School Students' Perception of Technology and Its Influence on their Intent to Select a Technology College Major: A Study in Gender Differences

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High School Students' Perception of Technology and Its Influence on their Intent to Select a Technology College Major: A Study in Gender Differences

By

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Dissertation

Submitted to the College of Technology

Eastern Michigan University

In partial fulfillment of the requirement for the degree of

DOCTOR OF PHILOSOPHY

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June 2008

Ypsilanti, Michigan

"Math class is tough."

Electronic Barbie's first words, 1992

Acknowledgments

I have had the good fortune of getting tremendous support and guidance throughout my research and writing work. I am very grateful to Ms. Genevieve Bertsos, Ms. Lauretta Flowers, and Mr. Vaughn Price for letting me use their classrooms for administering the survey questionnaires for this research. I am also very thankful to Dr. Cinda-Sue Davis and Ms. Debbie Taylor for letting me use the engineering summer camp venue at their university for conducting my pilot studies.

I owe a tremendous debt of gratitude to Dr. Jacquelynne Eccles for graciously critiquing my work. Her work in this field is monumental and it was an honor to discuss my findings with her.

I would like to acknowledge the kind support of my dissertation committee. I am deeply indebted to Prof. Nelson Maylone from the College of Education for his helpful guidance and constant feedback. I would never have made it through a statistically intensive project without the guidance of Prof. Al Bellamy. He has been a tremendous asset in the analysis phase of this work. Neither would this work have seen the light of day without Prof. Ron Fulkert's invaluable help with formatting and writing style issues. I would like to acknowledge Prof. Ann Remp for her help early on in helping me shape my research problem in a rigorous and meaningful manner.

Most of all I wish to thank my committee Chair Prof. Mary Brake. I am very fortunate to have had her as my advisor for this work. Her deep involvement and concern made me feel as though I had an exclusive claim on her time. I want to acknowledge her for the countless little things she did to support my work. It is hard to list them all, but I am forever grateful for everything. She has been a mentor, a guide, and a very dear friend. I would also like to thank everyone in Mary's family: Bob, Charlie, Brian, and Andy for making me feel I was not alone in this work.

Finally I would like to thank Naresh, my dear husband and soul mate for his tremendous support, wise counsel, and ever-loving trust.

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June 12, 2008

ABSTRACT

The purpose of this research was to investigate technology perceptions of high school students and analyze the results by gender. The objective was to examine whether high school boys and girls differ in their technology perceptions and whether that difference is related to their intent to select a technology major in college.

The research employed survey analysis of 152 students from two high schools from suburban and rural locations in the Midwest. The sample included 72 boys and 80 girls. The students were surveyed to examine their confidence in working with technology products, their locus of control (or their perception of control over their life's outcomes), their confidence in math and science, the degree to which they considered technology work as *fun*, their opinions about people who might influence them - such as teachers and counselors at school and parents at home - and the degree to which their opinions conformed to the conventional wisdom that technology is best suited for boys. The final survey instrument used for this research was loosely based on an existing questionnaire formulated by the Assessing Women in Engineering Project. Three pilot studies were carried out to validate this instrument.

The data were analyzed using bivariate correlation. The study found statistically significant differences between the way boys and girls perceive technology. There was a statistically significant positive correlation for girls between their locus of control scores and their intent to choose a technology major in college. Locus of control also positively correlated with their confidence in math and science and with their opinion that technology work is *fun*. In the case of boys, their intent to choose a technology college

major was found to be statistically significantly positively correlated to their self-confidence in math and science, and with their opinion that technology work was *fun*. Girls with low locus of control scores generally felt that technology is boys' area. Students were found to have a limited knowledge of technology, where an overwhelming majority indicated that technology means computers.

This study demonstrates the need for intervention at the high school level, where perceptions about technology guide students' future major choices. It points to the need to build *technology* self-confidence in high school years. The study also finds the need to equate technology with "fun" for both boys and girls. It indicates a need to involve students in hands-on activities where they leave with a feeling of success and self-accomplishment. According to this study's findings, there is need for greater clarity in talking about technology choices to students. The study highlights the need to ensure zero gender bias and be cognizant of various gender differences in schools. Technology self-confidence and locus of control were found to be significant moderators of boys' and girls' intent to choose technology majors in college.

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Delimitations

The study is delimited to surveying boys and girls students in grades 9-12.

Assumptions

Each respondent will be able to interpret the instructions and questions to survey and answer the questions honestly.

The respondents will be able to provide accurate information to survey questions.

Functional Definitions

Variable definitions

CONF: Self-confidence in math and science

DIFF: Gender differences in opinions about technology (not better or worse)

FAM: Opinion that people in technology have no family life

GRAD: Confident of graduating from high school and entering college

GSS: Perceived messages from school that boys are better at technology than girls

GTP: Perception that boys are better at technology than girls

LOC: Perception of control over one's life's outcomes

PRNT: Perception that their parents' opinion about their future is important to students

SMET: Intent to choose a technology major in college

TECH: Confident of performing specific technology tasks

WORK: Opinion that technology work is fun

Acronyms

STEM: Science, Technology, Engineering and Math

STS: Science and Technology Studies

PATT: Pupils Attitudes toward Technology

NCES: National Center for Education Statistics

NCER: National Center for Education Research

NSF: National Science Foundation

EWEP: Extraordinary Women Engineering Project

AAUW: American Association of University Women

CHAPTER 1: INTRODUCTION

Over the past 20 years, more and more women in the United States have entered many male-dominated careers, but there is still a dearth of women in science, math, engineering, and technology careers (NCES 2007; NSF, 2004; Gibbons, 2006). There is extensive documentation suggesting that girls are less likely than boys to choose technology majors in college even though young women make up a slight majority of college students (AAUW, 1992; NSF, 2004; Gibbons, 2006). Figure 1 illustrates the fact that many more young men major in engineering, regardless of ethnicity. There have been many studies regarding this issue, but very few that have examined whether a student's understanding or lack of understanding of technology is a contributing factor in discouraging girls from majoring in technology (Nauta & Epperson, 2003). The Extraordinary Women Engineers Project (EWEP)[1] maintains that this is not about capacity, skill, or talent. According to EWEP, a national project designed to encourage engineering education and careers for girls:

> … girls are taking high school science and math courses at approximately the same rate as boys: 94% of girls and 91% of boys take biology, 64% of girls and 57% of boys take chemistry, 26% of girls and 32% of boys take physics, and 64% of girls and 60% of boys take algebra II. We believe that problem one of perception. Girls and the people who influence them – teachers, school counselors, parents, peers, and the media – do not

[1] EWEP is formed by American Association of Engineering Societies (AAES), the American Society of Civil Engineers (ASCE), and WGBH Educational foundation. See http://www.engineeringwomen.org/

understand what a career in engineering looks like and therefore don't consider it as a career option (2005, p. 3).

This research is based on the supposition that the lack of participation of girls in technology college majors is a function of their *perception* rather than any ability. This study investigated some key factors that might contribute to perceptions that may differ between boys and girls that may cause girls to be discouraged from technology careers. Numerous reasons have been cited in the literature for the lack of women in science, technology, engineering, and math (STEM) careers, including parental influence, educational bias, sibling and peer influence, and media biases (Eccles, Jacobs & Harold, 1990; Haynie, 2003; NSF, 2004; Kekelis, Ancheta, & Heber, 2005).

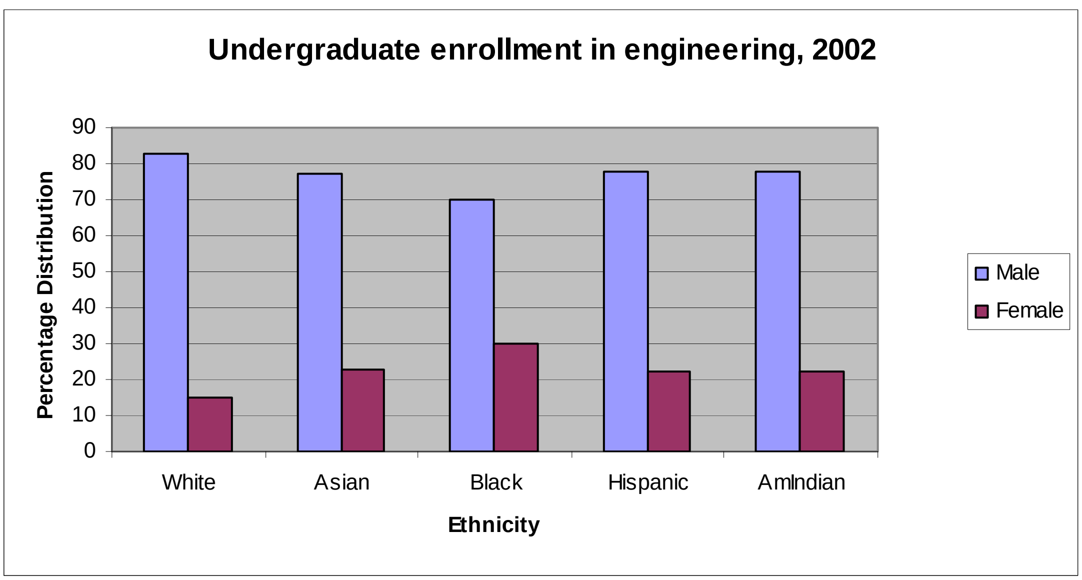


Figure 1. NSF data (2004) differential enrollment by gender

Recruitment and retention is another issue related to the low participation of women in technology majors. Colleges of Technology all across the country would like to increase enrollments in technology programs, particularly engineering technology. According to the National Center of Education Statistics (NCES), there are significant gender differences between the numbers of undergraduates and graduate students who study technology fields. For example, although females make up more than half of all undergraduate students, they make up fewer than half of graduate students in engineering schools (NCES, 2007). The relatively low participation of women in science and technological college majors, and technology careers in general, is a conundrum to higher education. The problem has a variety of societal consequences. Women do not have access to higher paying jobs that technology careers tend to garner, and just as important, the United States is losing the talent of a large group of our society. One reason as described by social constructivists for the low number of women participating in science and technological careers is that recruitment to STEM education and participation in STEM careers is a socially-mediated process (Cutcliffe & Mitcham, 2001). In other words, societal influences, such as conventional expectations from women in their jobs, home and family, affect the number of women going into STEM careers. Expectations and messages (stated or implied) of one's teachers at school affect students' perceptions. Moreover, the very fast advancements in technology in recent years further complicate the issue of how all students perceive technology and why they do or do not choose technology careers.

Technology versus Engineering

Before proceeding any further, it is necessary to state why this research focused on the broad area of technology rather than engineering specifically. In recent years there has been a sharp decline in the percentage of U.S. high school seniors and college freshmen who plan on majoring in engineering. From 8.6% in 1992, the numbers have plunged to 5.3% in 2003 (Boylan, 2006). If women do not make up this difference, the number of engineers in the U.S. will continue to decline. More than half of all undergraduates are women, and female high school seniors are more likely than their male counterparts to anticipate graduating from college (NCES, 2004). There have been many studies investigating why girls harbor negative feelings towards engineering and the physical sciences (DeHaven, & Wiest, 2003; Breakwell & Robertson, 2001; Eccles, 1994; Sadker & Sadker, 1994), but there have been very few studies that have examined what young people think about *technology*.

The term *technology*, although often used, is arguably ill-defined. One definition of technology is that it is an application of engineering, science, and math to consumer goods, manufacturing methods, medical advances, and research methods (Brake & Bhatnagar, 2008). This broad definition can be said to include a variety of applications, such as the use of engineering tools, machines, and hardware; it is also applicable to specific areas such as medical technology or construction technology. The term is also used to refer to devices, systems, methods of organization, and techniques (Cutcliffe & Mitcham, 2001).

The distinction between technology and engineering is not always clear. Engineering is the direct application of the scientific method to the natural world and deals with discovering the enduring principles that govern it. Technologies are usually not the exclusive products of science and the scientific method because they also satisfy functional requirements such as utility and safety (Kuhn, 1970).

From informal conversations with teachers and students, it appears that high school students - the teenagers of today - view technology as strictly electronic devices such as computers and everything related to microelectronics in their personal lives: mp3 players, cell phones, DVDs, and the Internet (Personal communication, Brake, Feb 18, 2008). But technology is much more than electronic devices. High school students do not understand how these devices are designed or manufactured, but this does not keep some of them from eventually majoring in engineering or engineering technology. Students have also mentioned (Personal communication, Brake, Nov 15, 2008) their enjoyment of "working with their hands" or hands-on project experiences in high school as having led to them wanting to pursue a career where they can use practical skills in technology related areas. However, the broader understanding of technology as a discipline is not clear to them; new technologies are based upon advances in science and engineering. The problem is that at the high school point in their education trajectory, engineering and the implementation of math and science to new technologies is still an abstract concept.

The definition of technology in the minds of young people has to be constantly changing because of the new advances in technology, the influence of TV, movies, print media, and the Internet, as well as the societal messages from school, community, and the family (Personal communication, Brake, Dec 11, 2007). The use of cell phones is ubiquitous to the point where, according to the authors of International Herald Tribune, "The average use of novice mobile phone users is dropping, reaching the age of 10 last year" (IHT, 2008, March7). Similarly Facebook, instant messaging, and mp3 players have all affected both usage and perception of technology (IHT, 2007, August 31). For example, students are using instant messaging shorthand such as LOL (laugh out loud) in school papers to the dismay of their teachers (IHT, 2008, Apr 24). Cell phones can record music and voice as well as take pictures. The huge advances in communication technology alone have arguably caused a generation gap in both usage and perceptions of technology between young people (age < 18 yrs) and their parents.

Due to the fluid nature of the definition of *technology* this researcher explored the *perceptions* of technology as defined by high school students and how these perceptions might be related to their decisions to consider or reject STEM majors in college. Most colleges offer majors in math, biology, physics, and so on, and many offer degrees in engineering (e.g. mechanical, electrical, chemical, etc.) and some in engineering technology (mechanical, electronics, computer). This research did not examine students' perceptions of math and science specifically because math and science perceptions have been studied extensively (Xie & Shauman, 2003; Eccles, Jacobs & Harold, 1990; Eccles, Adler & Meece,1984). However, emerging technologies are an outcome of research in math, science, and engineering. As mentioned previously, even though a lot of research has focused on why girls harbor negative feelings towards engineering and the physical sciences (DeHaven, & Wiest, 2003; Breakwell & Robertson, 2001; Eccles, 1994; Sadker & Sadker, 1994), very few studies have examined what young people think about *technology*. The few studies that have focused on technology in particular are discussed in Chapter 2 in the literature review on the subject.

Problem Statement

The problem of gender inequity in science and technology has been studied for many years, arguably starting with the Sadkers' seminal work "Failing at Fairness" (Sadker & Sadker, 1994). There are numerous levels at which this can and has been investigated in scholarly research.[2] The research questions range all the way from how and whether boys and girls learn math and science in different ways to why there are

[2] For a discussion of scholarly research on the subject, see Chapter 3

gender differences in career choices, particularly science and technology careers. This researcher focused on high school education and posed the question: What do high school students think about technology, and do these opinions result in gender differences in their intent to major in a technology area in college? This study attempted to glean insight into low enrollments of women in technology by examining high school students' perceptions about technology. In order to address the research question regarding technology perceptions of high school students in a meaningful manner, the first task was to determine the specific population for study. Although there appears to be a general consensus about male advantage in math and science, the *timing* of the emergence of gender differences is less clear. Both men and women go through a certain course of educational, career, and life stages, during which decisions to choose or reject a certain education and career path are made. The question of the gender differences in technology major choices is addressed within the framework of this trajectory of education and life-events.

Consider the education trajectory of an individual from early childhood to elementary, middle, high school, and college and onto a number of possible culmination points such as a career, marriage, a post-graduate degree, or any combination thereof. Each point in this trajectory is a critical phase with a set of external influences that affect the life course in unique ways. For example, early childhood is an important phase. Very strong parental influences shape individuals' likes and dislikes, opinions and interests during this phase. At the same time, a case can also be made for the junior-high stage as being the most critical to deciding one's career choice, where gender differences appear in math and science. However, high school is usually the last general educational experience before a student finds a specific educational path that leads to a career, so the research discussed in this thesis focused on high school. The broad set of influences that act upon an individual's life-course trajectory are represented in Figure 2. Each of these factors could help formulate students' perceptions about technology and thus affect their choices of college major. Education is just one of the factors that could influence a student's perceptions and choices. Their family and the omnipresent media are arguably the other two major influences that can influence their attitudes, opinions, and perceptions. This research focused on education because it is difficult to study *all* of the influences in a teenager's life. But education is one controlled aspect of their lives. All the teens surveyed in this research were in school. The variation in social status, parental education, and family life was too diverse and complex to be included.

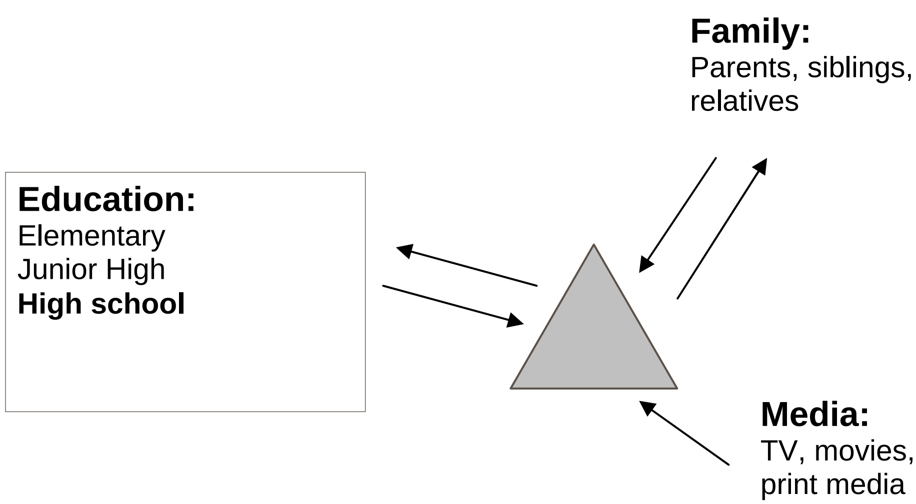


Figure 2. The three major sets of influences acting on an individual.

The following discussion offers a brief look at the literature that argues that grade school, middle school, and high school are the pivotal times when gender differences emerge in math and science literacy. This research chose high school because we assumed that older students (teenagers) would give more reliable and free opinions than younger students (grade school). Also the survey was more easily understood by older than younger students.

Consider the case of quantitative literacy, which is defined as students' efficacy in math. According to Eccles (1994), math ability is affected by gender-differentiated socialization, which may begin early in childhood with, for example, boys and girls receiving different feedback about their math efficacy, math performance, and the value of math. Early studies found that gender differences in math emerged in the elementary school years (Anastasi 1958; Maccoby 1966). Another research concluded, "…gender difference in mathematical problem solving is found as early as the first grade" (Geary, 1994, 228). Other research has found that students, teachers, and parents perceive that gender differences in math ability are evidently starting in junior high school (Eccles, Adler & Meece, 1984; Yee & Eccles 1988). Benbow (1988) found strong evidence for the existence of gender differences in math by age 12. However, others (Hyde, Fennema & Lamon 1990; Marshall 1984) have argued that gender differences in mathematical problem solving do not emerge until adolescence, i.e. high school.

More recent research seems to indicate that gender differences in quantitative ability begin in secondary school rather than in early childhood. According to Entwisle, Alexander, & Olson (1994), the gender gap is not evident in elementary school, where math test scores for both genders are equivalent. However, in secondary school there is a gender gap where boys receive higher math test scores. Leahey & Guo (2001) contend that although both boys and girls have the same initial skill level in math, boys acquire math skills at a faster rate than girls. Although it is unclear how much of an advantage boys have by the 12^{th} grade, there is a slight difference between boys' and girls' math scores. According to Leahey and Guo (2001), there is little difference between boys' and girls' mean math scores in grade school. Girls actually have higher average math scores in their coursework than boys until about age 11. At or around this age, the boys' mean math score surpasses the girls'. Leahey and Guo (2001) also found that although boys and girls had similar mean math scores, boys' scores had a greater variance. In other words, more boys may have had very high math scores but the average between boys and girls was close.

The results from the aforementioned study indicated that the overall gender difference in math scores for high school students is the greatest among high-scoring students, where boys obtain higher grades. So there is a slight, "late-emerging male advantage" in math among the general population of students (Leahey & Guo, 2001).

Next consider the case of achievement in science; researchers have found a slightly different pattern where even at young ages boys receive higher science scores than girls, and this gender gap appears to be consistent across grade levels (Xie & Shauman, 2003). The magnitude of the gender disparity in science achievement also varies with the subject matter of the sciences: achievement differences in biology and general science were found to be significantly smaller than those in physics (Becker, 1989; Lee, Burkam, & Smerdon, 1997). Interestingly, Xie & Shauman (2003)[3] found that the male advantage in science achievement is greater in magnitude than that observed for

[3] Xie & Shauman (2003) based their study on a set of national longitudinal data sources: The National Longitudinal Study (NLS), 1972, had a sample size of 15,485 students who had completed a 25-item cognitive test of mathematics achievement. The test consisted of items designed to assess basic competence in mathematics. Similarly High School and Beyond Senior and Sophomore Cohorts (HSBSr and HSBSo), 1980, with a sample size of 28,000, were given a 20-item science test designed to assess students' levels of basic science knowledge.

math achievement. They also found that for both math and science achievement scores, the variance of girls' achievement scores is on average about 20% less than the variance of the achievement scores of boys. It can be argued that gender disparities in the enrollment numbers for science and technology college majors may originate with gender differences in mean variances in math and science achievement among middle- and high-school students. There appear to be more boys at the extreme upper levels of performance. Even in the case of science achievement, the literature suggested high school age as the point when boys and girls advance at different rates. The reported gender differential between achievement rates supports the choice of high school as the point in the education trajectory to conduct the analysis for this research. As will be explained in the next chapter, boys' and girls' perception of their ability affects their post-graduation life. If some boys receive very high math scores, they may naturally consider careers that are math intensive compared to girls with average scores.

There is another way of choosing a specific point for investigation along an individual's education trajectory; this is to consider *consequences*. Along the education pathway of any individual there are arguably two broad stages: the formative stage and the resultant stage. During the formative stage, diverse influences have an impact on an individual's attitudes, opinions, and interests. The resultant phase follows largely as a consequence of these earlier influences. In the model used in this research, the high school period is pivotal. High school is where family, school, and society at large all have the largest impact in shaping a student's opinions and interests; but it is also the point at which critical individual choices are made. In high school the student makes decisions about his/her choice of courses, particularly Advanced Placement courses that often lead to career choices such as technology majors in college. Even such a fundamental decision as the choice to attend or not to attend college is usually made in high school. All these decisions have a direct impact on students' college education as well as the choice of career beyond their college years. The present research focused on secondary education as a point of analysis.

There are additional arguments for the choice of high school as a pivotal period. For example, indices of academic ability such as the SAT and ACT exam scores, as well as courses taken in high school, are used as selection criteria by college admission committees. Students who avoid science or math in high school are unlikely to be accepted into technology college programs (Betz, 1994). There is some empirical evidence supporting the importance of high school math and science course enrollments in students' choices of math and science college majors (NCER, 2007).

Our education system allows for few alterations once the course choices have been made in the junior and senior years of high school. For example, if a student did not choose Advanced Placement classes or higher level math classes, it is highly unlikely that he or she will be accepted in a technology intensive undergraduate program. Thus it can be argued that although parental, peer, and societal influences occur during K-12 education, high school forces a major decision. High school is also the time when there is a solidification of interests, opinions, and attitudes of students. Any parental suggestions or messages students may receive from their teachers, peers, or counselors at school are arguably likely to have great and lasting influence. Figure 3 illustrates high school as the focal point of this study, with a set of influences that tend to affect students' technology perceptions and their intent to choose a technology major in college.

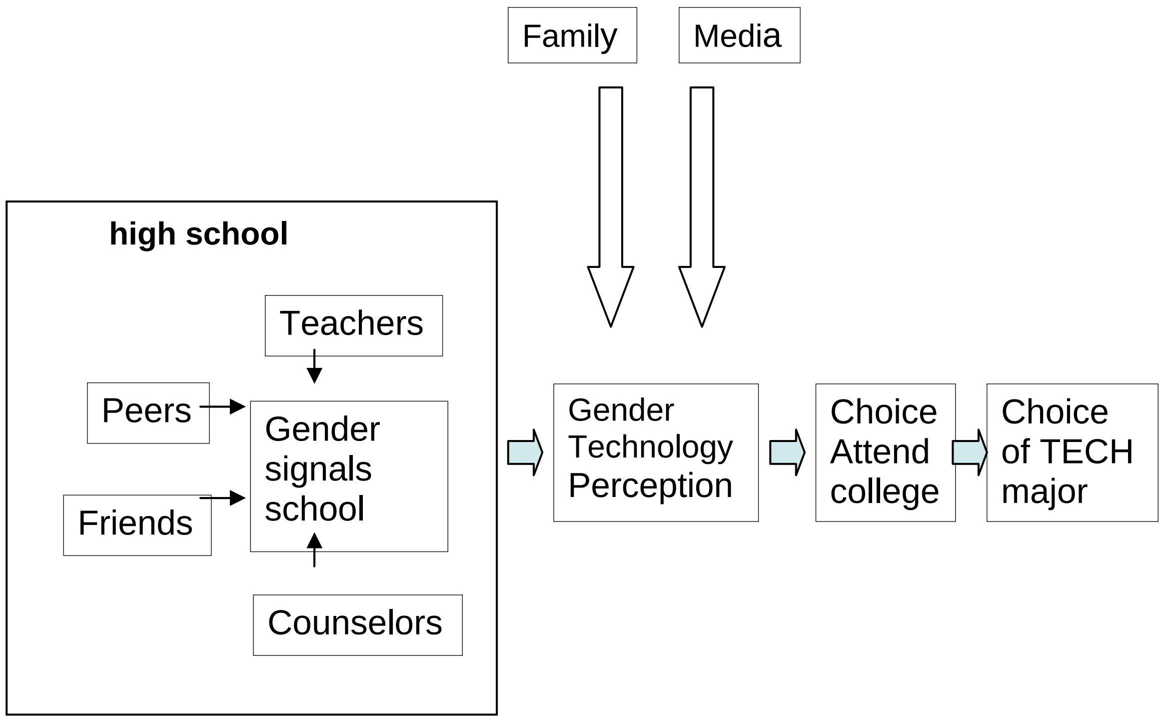


Figure 3. Factors that affect high school students' decision to pursue technology majors.

Prior research supports the concept that up until high school, the differences between boys' and girls' scores in math and science are not significant (NCES, 2005). Moreover, in high school the achievement gap widens (Xie & Shauman, 2003). This concept seems to support the hypothesis that parents or school are likely to be a strong influence in students' lives. There is also the element of greater personal choice for the student during high school years. These two arguments support the decision to select high school as the point of investigation for this study.

Figure 4 illustrates the focus of this research, the specific slice through an individual's life trajectory, which is being investigated. This is a cross-sectional model of inquiry, which investigates how opinions, influences, and perceptions about technology in high school affect students' intent to choose technology majors in college.

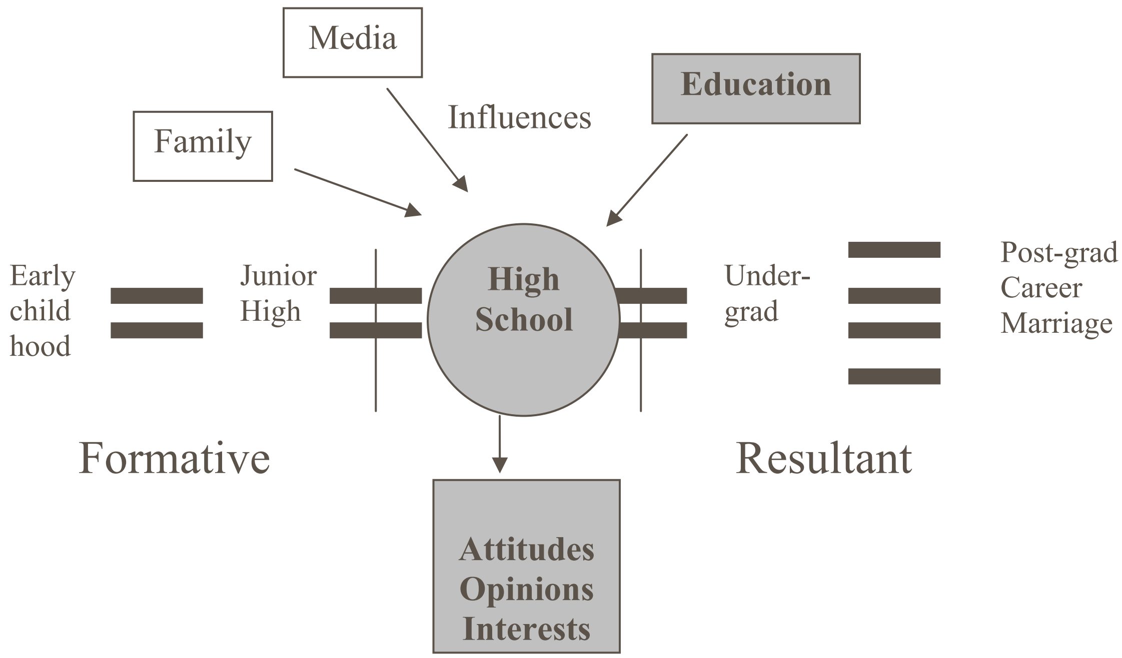


Figure 4. High school as the pivotal period along an individual's life trajectory

The purpose of this study was to explore the gender gap in high school students' choice of technology college majors. The research employed survey methodology to ask boys and girls for their opinions about technology and reasons for selecting or rejecting a technology major. During the analysis phase, the responses were coded for gender to examine if there were significant differences between boys and girls.

To reiterate, the problem question for this research was: What do high school students think about technology, and how are their perceptions related to their intent to choose a technology college major? This research question is broken down into more specific, researchable sub-questions for analysis. These are detailed in Chapter 3.

The overall organization of this research study is as follows. Chapter 2 contains a review of relevant literature, which describes the two different ways employed in literature to examine individuals' education trajectory: the pipeline approach and the life-course approach. A review of the literature on behavior and motivation follows. This is followed by examining previous studies on technology, in particular an old but large-scale project that examined high school students' views on technology. This section concludes by describing some recent national statistics on gender and technology education from the National Center of Education Statistics (NCES, 2007).

Purported in Chapter 3 is the theoretical framework for the study. Several theoretical arguments from a variety of disciplinary backgrounds are discussed. The theoretical framework is followed by an enumeration of the research questions for this study. The chapter concludes with the detailed design of composite research variables formulated using the theoretical constructs of research questions.

Described in Chapter 4 is the research design, selected sample, measurement techniques and statistical analysis methods used for this work. The two research methods used, namely survey research and correlation research, are briefly reviewed in the beginning. Sample description is followed by an outline of the measurement process and the statistical analysis techniques.

Note that in survey research we are gathering data on high school students' opinions. How well they represent reality is another issue. But, as will be discussed, perceptions play an important role in the decisions of high school students, particularly in how these opinions influence their choice of college major.

Reported in Chapter 5 are the results of the statistical analysis of the data obtained by having applied the method described in the previous chapter. Each of the research questions formulated in Chapter 3 is answered in this section. The results are illustrated and discussed in three parts to allow for greater clarity of analysis. Each of these parts is discussed in detail, using various forms of data interpretation including graphical, quantitative, and qualitative techniques. The different or similar ways each of the variables correlate to one another in the case of boys and/or girls is discussed. The quantitative analysis is followed by qualitative analysis of open-ended questions to identify common themes across and within genders. Finally, the obtained results are compared and contrasted with those obtained in previous scholarly research.

Discussed in Chapter 6 are the conclusions based upon the data analysis. Some ambiguous results are discussed and recommended for further research to reach a definite conclusion. The limitations inherent in this work are discussed, and a set of recommendations that can be pursued for future research are suggested.

Several appendices follow, which are used as supporting data files. Appendix A contains the final survey instrument used for this research. Appendix B contains individual data results from schools B and C, characterized in Chapter 4. Appendix C contains the PATT survey instrument, described in detail in Chapter 2. Appendix D describes all the pilot studies carried out in this work, including two engineering summer camps and high school A. Appendix E includes the survey used for pilot study 1. Appendix F includes the survey instrument used for pilot study 2. Appendix G contains scale development metrics used in formulating the instrument for the second pilot study. Appendix H contains the survey used for the third pilot study. Finally Appendix I includes suggested new variables for further research.

CHAPTER 2: REVIEW OF LITERATURE

There are several ways to examine gender differences in high school students' perception of technology. The following section reviews the work done on this subject. The question "What do high school students think about technology?" may lead to insights into possible causes for the gender disparity observed in technology majors. A large pool of scholarly work focuses on differential social and parental messaging that can affect boys and girls differently (Eccles & Jacobs, 1986; Eccles, Jacobs & Harold, 1990; Breakwell & Robertson, 2001). The following section discusses previous research using two very diverse ways of examining an individual's educational trajectory, namely the Pipeline (Leslie, McClure & Oaxaca, 1998; Berryman, 1983) and the Life-course approach (Xie & Shauman, 1997; Eccles, 1994). The scholarly literature in this area has traditionally followed one of these two approaches. The Life-course approach fits the research presented here better than the Pipeline approach.

The Pipeline Approach

The *pipeline* remains the most pervasive conceptual metaphor that is found in the literature today (Boylan, 2006; Freeman, 2004; Leslie, McClure & Oaxaca, 1998, Seymour & Hewitt, 1997; Berryman, 1983). The Pipeline approach assumes that girls become interested in science and math at an early age and proceed through the educational system until they reach careers in science, technology, engineering, or math (STEM). The pipeline *leaks* girls and young women until only a few women are left in STEM careers. Students don't leak back into the pipeline in this model. In other words, the pipeline approach refers to a set of educational and career stages through which an individual progresses (Xie & Shauman, 2003). The model is, as the name suggests, a rigid unidirectional straight-line path from point A to point B and eventually to point Z. The completion of a set of courses by a certain time in an individual's life, followed by a career in science/engineering, would constitute such a pipeline. As Xie and Shauman (2003) suggest, the pipeline metaphor is also amenable to the idea of *flow* and *leakage*, features that refer to the phenomenon of attrition that is often gender-based. Universities spend a lot of time and money to increase the pipe *flow* and to stop the *leaks*.

Although the Pipeline approach is an established paradigm to study the problem of gender imbalance, a number of problems with the pipeline model have been identified. According to Xie and Shauman (2003), the pipeline approach cannot uncover the dynamic processes underlying cross-sectional data. It is static in its conceptual framework and therefore fails to capture the complexity of a woman's education and career (Xie & Shauman, 2003). For example, a single mother, reentering college in her late 30s when her child is older, would not be counted in the pipeline model. Xie and Shauman (2003) also point out that there are often changes in enrollment status or time to degree during the course of an individual's educational experience. These changes are more likely to occur in the case of women, considering such life-course events as marriage and childbirth. Moreover, the pipeline model does not allow for women who leak back into the system. Those individuals who do not participate in a given course at a given academic level, at a specific time in their educational career, are not recognized as potential scientists according to this model (Xie & Shauman, 2003). The following excerpt from Turner, Bernt, & Pecora (2002) is an illustration of the way subsequent literature debates the pipeline model:

> Contrary to the oft-cited pipeline analogy a degree in computer science is not a prerequisite to a career in information technology. For many successful women, interest and talent in IT emerged gradually and developed over time, challenging the myth of the adolescent computer geek who masters the computer early in life. Rather than an "incredible shrinking pipeline" the field of information technology is a roadway with many on-ramps. In order to satisfy the growing need for information technology workers and expand women's participation in the field, it is important that we understand the experiences of those who enter the roadway at later points as well as those who enter through traditional academic paths (2002, p. 17).

Needless to say, the experience of women often requires a look at the alternate pathways of education trajectory. Thus evidently the Pipeline model has limitations and a somewhat restricted applicability.

The Life-Course Approach

The life-course model is a relatively new method of looking at the problem of gender equity or equitable participation in technology majors and/or careers of men and women. According to this approach, life trajectory is seen as a complex process that is influenced as much by social structures as by individual characteristics (O'Rand, 1996). The model proposes that individuals perceive their options through the matrix of social characteristics (Xie & Shauman, 1997). There is an interrelated web of social events and influences that run through the educational trajectory (Elder, 1977). Marriage, childbirth, child-rearing, relocation, and continuing education later in life are just some instances of social events that might significantly alter the course of the educational trajectory.

The life-course approach is much more inclusive in examining the problem of gender inequity. It is a constructivist point of view that allows room for social influences and social construction of gender identities (Cutcliffe & Mitcham, 2001). The life-course model describes how social influences could result in a perception of technology that differs between boys and girls. These influences may range from motivational and psychological to social as well as systemic.

Eccles (1994) suggests that occupational choices are not made in isolation of other life choices, such as the decision to marry and have children and the decision to balance one's occupational behaviors with one's other life roles. She goes on to suggest that many high-achieving girls and women have conflicting experiences between traditionally feminine values and demands of highly competitive activities that are traditionally male (Eccles, 1994). According to Xie & Shauman (2003), an important aspect of the life-course approach is the contention that the move towards engineering/technology careers is not isolated from the development of other aspects of the life-course model. As the responsibility for household and childcare labor falls primarily on women, an anticipated conflict between family and work roles can dissuade women from investing in time-intensive subjects such as math and science. As Eccles and Jacobs (1986) point out, the dual role of women in our society can be quite problematic. The numerous family responsibilities quite apart from their work life can result in considerable stress on the job and even affect women's rate of career advancement compared to their male counterparts. Moreover, there continues to be a lack of support services and employment policies that recognize women's dual role in our society.

The life-course model examines paths that start in early childhood and culminate in a career, and tries to isolate experiences that influence that path. In other words, as opposed to a rigid pipeline, this model includes a variety of social and familial influences that an individual encounters during the course of her lifetime. The life-course model is more flexible in explaining career choices. It addresses such factors as overt and indirect social messages, perceptions, attitudes, and opinions formed as a result of these messages. Only recently has research examined this problem, starting with the pioneering work "Failing in Fairness" (Sadker & Sadker, 1994). The Sadkers looked below the surface of pipeline numbers to systemic problems with the education system. For example, their work uncovered the presence of sexist attitudes among teachers, the differential teachers' feedback to boys and girls, the difference in teachers' call-outs, and the existence of two distinct tracks for boys and girls, where the boys learned *shop* and the girls did *home-economics*.

Attitudes towards technology and gender have been slow to change. A study that examined the change in attitudes towards science over a 10-year period (1988-1998) between boys and girls (aged 11-14) in the United Kingdom found that girls more than boys, reported disliking science taught in school. Girls were also found to have a more negative attitude towards science in general (Breakwell & Robertson, 2001). Breakwell and Robertson's study concluded by reiterating that no evidence was found to suggest that the gender gap in attitudes toward science is closing.

Kekelis et al. (2005) conducted "…in-depth interviews and focus groups with 126 girls and 34 of their parents/guardians" (p. 99). Their results indicated that "many girls have limited career options and lack the information and guidance to make informed academic and career plans" (Kekelis, Ancheta, & Heber, 2005, p. 107). Few of the girls interviewed were "…encouraged to consider a career in technology, and few understood what a career in technology might encompass" (2005, p. 107). Gender differences in technology use and technology access were found to be even more pronounced in the case of the Internet. About "one-half of the 'digital divide' between men and women on the Internet is fundamentally gender related" according to Bimber (2000, p. 1). Turner, Bernt, & Pecora., (2002, p. 15) report that a "significant number of respondents (women) cite male friends and colleagues as being powerful influences in their career decisions, and that intervention efforts must also be directed towards men, as students, faculty and co-workers, as well as towards women."

The Extraordinary Women Engineers Project (EWEP, 2005) mentioned in Chapter 1 offered some very interesting findings. It was reported that girls in general "…believe engineering is for people who love both math and science" (2005, p. 4). Most girls EWEP surveyed "…did not have an understanding of what engineering is, and did not show an interest in the field" (p. 4). EWEP also found that engineering is "…portrayed as challenging" (p. 4) and that students must already be gifted in math & science, but not much is said about the "…benefits and rewards of being an engineer" (p. 4). Moreover, "…high school girls react positively to personal and informational stories about engineering lifestyle" (p. 4). EWEP found some key career motivators for high school girls. For instance, they reported that "…professional interests for high school girls hinge upon relevance. Relevance incorporates the perception that a job is rewarding, and that it is for someone like them. Girls want their jobs to be enjoyable, have a good working environment, make a difference, offer a good salary, and be flexible" (p. 3).

Perceived ability in science and technology emerges as one of the major factors in low enrollments of women in science and technology careers. Perceived ability is related to confidence. Chan, Stafford, Klawe, & Chen (2000) found that among high school students in Vancouver, "…men were almost twice as likely as women to cite 'being good at mathematics and/or science in high school' as a reason for choosing a science/math/engineering major. The fact that young men may or may not be better prepared or skilled than women was not the issue. What matters is that many more young men than young women felt confident in their readiness to undertake higher level science and mathematics" (2000, p. 7).

DeHaven & Wiest (2003) have focused on ways to boost the confidence of girls to promote technology careers among girls. In one study, DeHaven & Wiest investigated the impact of an all-female, non-school based mathematics program on middle school girls' attitudes towards mathematics. They reported "…a significant increase in confidence scores, although the perceived usefulness of mathematics, and perceived teachers' attitudes towards girls in mathematics did not increase significantly" (2003, p. 1).

On the opposite end of the research spectrum, qualitative, ethnographic interviews on technology education provide interesting findings. Haynie (2003) reported that even though "…women are generally well accepted and comfortable in technology careers, there are some problems that make them feel isolated, patronized, minimized, conspicuous or otherwise uncomfortable" (2003, p. 28). Haynie suggested that "…problems will be eliminated if more women are encouraged to enter the profession and are advanced to positions of leadership so that they may serve as role models" (p. 28). The study also noted the "lack of well-established networks for women, unlike that for men" (p. 22).

Studies report a general perception that technical areas are "…not well suited to women" (Hellens, Nielsen & Trauth, 2001, p. 118). For example, a female professor in Information Technology suggested that the reason women students drop out of programming subjects and technical areas is that "they couldn't find other girls to work with and to relate to" (2001, p. 118). Hellens also suggested that the educational system did not encourage young women and often actively discouraged them from studying technical subjects "she wouldn't be able to because of the math" (p. 118).

Attendance at an all-girls' school and having supporting parents (with one or more parents working in a technical area) tend to boost confidence and are reported as being key factors in enabling the girls to break into male-dominated fields (Hellens, Nielsen, & Trauth, 2001; Eccles, Jacobs, & Harold, 1990). Girls are also consistently reported as underestimating their technical abilities, while boys tend to overestimate them (Sherman, 1983; Chan, Stafford, Klawe, & Chen, 2000). Perceived ability relates to their perceptions about themselves and not their true abilities.

The Women, Minorities, and Technology project currently being carried out in the Institute of Social Research at the University of Michigan, as part of the Gender Achievement Research Program, has addressed the question of the underrepresentation of women and minorities in the Information Technology labor force. Based on three longitudinal data sets from 1987, this project assesses the utility of Eccles expectancy theory framework (Eccles et al., 1983; Eccles, Jacobs, & Harold, 1990) as applied to the problem of lack of women in technical fields. This project is still underway, and the longitudinal data sets are being analyzed. Results to date indicate that “both mothers’ and fathers’ socialization of children’s activities was positively associated with children’s engagement in math, science and computer activities during the elementary school.” The results did suggest that “gender differences in children’s activities may result from different aspects of parental socialization, such as provision of toys and materials related to information-technology activities.” This research also finds that “gender differences may emerge from the differential influence of parental socialization on children’s confidence and self-esteem in these areas.” Another interesting finding concerns the difference between math grades and math interest scores across genders. It was found that girls had higher math grades than boys in elementary school but by the time they reach junior and high school, math grades for both genders declined (WMTP, 2008). Boys, on the other hand, had a higher interest in math than girls. This is related to Eccles’ expectancy theory. Girls tended to underestimate their math ability, even after obtaining higher grades than boys in elementary school.

School and the education system in general have been shown to be a significant influence in providing encouragement or discouragement to women in technology fields (Eccles, 1994; Haynie et al., 2003). An Ohio University study presented at the Annual Meeting of the American Educational Research Association reported that many women (whom they studied) who had successful careers “were first introduced to computers in school, and that they took seriously the encouragement or discouragement of their teachers" (Turner, Bernt & Pecora, 2002, p. 15). The study showed that women who directly entered into technology programs as undergraduates and those who switched to a computer science major later were most influenced by their parents and teachers. The young women cited in this study mentioned that elementary, high school, and college teachers helped persuade them to pursue technical careers. Most of their teachers taught math, science, or computer science. Interestingly, the study noted that women cited teachers as being the most influential, whether as providing encouragement or being discouraging. "Women cited teachers as the most discouraging (influence) as well. School experiences were an important influence on women, suggesting that school and teachers can be a target for effective intervention programs" (Turner, Bernt, & Pecora, 2002, 14, 15). This supports the use of school as an important mediating influence and helps to validate the line of inquiry described in this thesis.

As this section on life-course approach has illustrated, the education trajectory of any individual is shaped in large part by external factors. These can range from parents, peers, and family to influences at work, at school, and from the media. The question of technology opinions and technology choices cannot be viewed in isolation of the life-course context. Several detours along an individual's life-course can affect women disproportionately. Marriage and childbirth are perhaps the most common detours. But societal expectations and lack of expectations can have a substantial cumulative negative effect.

Behavioral and Motivational Approach

Gender debate cannot be undertaken without addressing behavior and motivation. The previous section examined the various scholarly studies that addressed possible external influences, such as parents, school, and so on. Expectancy theory is a framework that can explain differences in individual behavior based on differential motivation.

As described previously, expectancy-value theory is a cognitive approach to the study of achievement behavior. The basic assumption of expectancy-value theory is that an individual’s motivation is governed by his/her expectation of achieving a specific goal and the value that particular individual places on that goal (Sullins, Hernandez, Fuller, & Tashiro, 1995; Vroom, 1964; Atkinson, 1957). Expectancy-value models have been successfully applied to a wide range of behaviors. Eccles uses this approach in her research on gender differences in mathematics achievement, arguing that academic choices are determined by the joint effects of a student’s expectation of success in specific courses and occupation and the subjective value placed on such achievement (Eccles, et al., 1983). It has been pointed by Eccles and others that the expectations for success and the confidence in one’s ability to succeed are important mediators of one’s behavioral choice (Eccles, 1994, Weiner, 1985). Numerous studies have demonstrated the link between expectations for success and a variety of achievement related behaviors, including educational and vocational choices (Bandura, 1997; Weiner, 1985; Eccles & Wigfield, 2002).

It is possible to argue that the question of major choices for boys and girls might in part be influenced by their expectations for success at various academic subjects and in various occupations. It has been reported, for example, that highly motivated gifted girls have lower self-confidence than equally highly motivated gifted boys (Eccles, 1994). Eccles also reported finding that gifted girls were more likely to underestimate their intellectual skills and their relative class standing, whereas gifted boys were more likely to overestimate theirs. A consistent evidence of gender differences was found in boys' and girls' expectancies for success and confidence in their mathematics ability (Eccles, 1994).

Girls were less likely than boys to enroll in advanced mathematics, primarily because they felt that math was less important, less useful, and less enjoyable than boys did. Studies found clear evidence of gender differences in the *value* attached to various school subjects and activities (Meece, Glienke, & Burg, 2006; Eccles, 1994). Another study found that even though there was no gender difference in expectations for success in mathematics, girls reported disliking math more than did boys. The girls also rated math as less useful than did boys (Gilbert, 1996). The literature supports the idea of selecting or rejecting a course based on its perceived usefulness or likeability. For example, "Gifted girls were less likely than gifted boys to take advanced mathematics, in part because they liked language-related courses more than they liked mathematics courses" (Dweck & Elliot, 2007, 118). They reported a substantial evidence of gender differences in the valuing of various educational and occupational options.

The framework outlined by Eccles (1994) forms an important benchmark in understanding the differences in motivation and subsequent behavior as related to technology choices. Eccles's thesis is as follows:

> We assume the following: (a) individuals seek to confirm their possession of those characteristics central to their self-image, (b) various tasks

> provide differential opportunities for such confirmation, (c) individuals place more value on those tasks that either provide the opportunity to fulfill their self-image or are consistent with their self-image and long-range goals, and (d) individuals are more likely to select tasks with higher subjective value than tasks with lower subjective value. To the extent that women and men have different self-images, various activities will come to have different subjective value for women and men. And, to the extent that women and men place differential subjective value on various educational and vocational characteristics, they should also differ in their educational and vocational choices (1994, p. 597).

Moreover Eccles also stated that, "Numerous factors influence the development of expectancies and values related to particular types of achievement. The cultural context in which children are raised conveys information about gender stereotypes. The beliefs and values held by parents, teachers, and other socializing agents are transmitted to children both directly and indirectly" (1994, p. 594). It has been reported that along with a child's actual aptitudes, children also develop self-perceptions of their own abilities, as well as absorb perceptions of what others think about them. The value children place upon a particular outcome, as well as their expectation of success in attaining that outcome, are a result of external and internal perceptions (Sullins & Hernandez, 1995).

During the past decade, research (Eccles & Wigfield, 2000, 2002) has consistently found the expectancy-value model to be a better predictor of female achievement than other popular theories. In particular, "Factors associated with self-perceptions of ability, gender-role socialization, and beliefs about specific task requirements have been shown to be crucial influences on women's expectations and values whereas subjective value appears to be an even more important factor in female's achievement than in the achievement of males" (Sullins & Hernandez, 1995, 106).

Studies (McMahan, 1973; Eccles, Jacobs & Harold, 1990; Li, & Adamson, 1995) indicate that women are more likely to exhibit what has been labeled as a low-expectancy attribution pattern, and their achievement behavior has been found to suffer as a consequence. Specifically, it was found that men attributed their successes to ability, whereas women attributed their failures, but not their successes, to the lack of ability (Meece, Glienke, & Burg, 2006). Lack of success related to a self-perception of lack of ability and was found to be particularly influential in mathematics where girls were found to be less likely than boys to attribute their success to ability. Girls tended to attribute their success to hard work, which may undermine their expectations for success as math courses increase in level of difficulty (Meece, Glienke, & Burg, 2006). In other words, girls are discouraged when considering higher level math courses because girls think that the work will be so difficult they won't be able to keep up. Boys, on the other hand, assume they have an innate ability to succeed even for time-intensive, difficult math courses.

Picking a technology major is likely to be affected by the self-perceptions of ability of boys and girls. The low-expectancy pattern of girls is an important factor in this research, and presents an interesting facet for analysis. The motivational aspect has been addressed in this research using locus of control scores for boys and girls. Locus of control provides a measure of their self-confidence and self-esteem.

Two distinct theoretical strands have been discussed so far in this literature review: the education trajectory as a set of external influences that might affect students' choice of college major, and the self-perception of ability among students, each of which may or may not differ by gender.

Technology and Behavior

Although literature abounds on women in science and engineering (Sadker & Sadker, 1994; Eccles, Jacobs, & Harold, 1990; Eccles & Wigfield, 2002; Haynie, 2003), studies focusing on technology and gender are rare. One of the very few papers that attempted to correlate technology to the pursuit of technology careers is the longitudinal study carried out by Nauta and Epperson (2003). Nauta and Epperson defined variables as "technical interest" and "science interest," each of which was shown to be correlated to the choice of science, math, or engineering majors in college. However, the paper did not define *technology*. The reason this paper is worth mentioning is that it was one of the very few studies that considered "technology" as distinct from science and engineering in its analysis. Nauta and Epperson did not investigate gender as a variable.

The definitive study on the subject of technology perceptions by students that also looked at gender as one of its variables was the 1986 Netherlands study conducted at the Eindhoven Institute of Technology: Pupils' Attitude Towards Technology (PATT, 1986). The PATT study was one of the largest research projects that addressed students' technology perceptions. Even though it is more than 20 years old, it is relevant to this research because it specifically dealt with technology as opposed to science, engineering, or math. Also, the scope of the PATT study was large as it was initially offered to 2,600 thirteen-year-old students in the Netherlands. This was later expanded to include 11 countries round the world[4]. This study formulated an elaborate definition of technology, which was broad enough to be applicable today. Two sections in particular make it strikingly similar to this study. The PATT study defined technology as "…a specifically human activity, the implications being that technology is for women as well as for men" (1986, p. 29). Further, it defined the technology skill set as constituting "…designing, practical-technical skills and handling technical products" (1986, p. 29). The research being reported here also considered the knowledge of technology as consisting of technical skills and knowledge of technology products and processes. Furthermore, the current research looked at gender differences in students' perceptions about technology, thus making the PATT study a very similar conceptual model.

Undoubtedly the one major change in technology since 1986 is the ubiquitous presence of computers in all levels of our society and the education system. Therefore, the knowledge and the comfort level of working with the computers becomes a major aspect of defining technology. This research addressed this change by including questions in the survey that dealt with computers. This was one major difference compared to the PATT study. The largest difference, however, was the fact that technology has changed so much in 20 years.

The PATT study reported the following attitudes and impressions of students regarding technology:

> Boys are interested in technology, girls are rather neutral; Pupils (girls more than boys) think that girls are apt for technology; Pupils (boys more than girls) are aware of the diversity of technology; Pupils (boys more than girls and pupils with a technical father and/or mother more

[4] Australia, Belgium, Canada, France, Hungary, Kenya, Nigeria, Poland, Sweden, UK and USA.

> than other pupils) think that technology is important; Pupils are not very acquainted with technical appliances; girls are less acquainted with these appliances than boys are; In general pupils are not aware of the role of creativity and designing in technology; Pupils think they do not hear much about technology at school; Pupils (pupils with a technical father and/or mother more than other pupils) do think technology is too difficult for them; It is hard for pupils to give a description of what technology is; the relation between physics and technology is not clear to them (1986, p. 29).

For a study that was conducted more than twenty years ago, these results are remarkably similar to those of the present day. The survey questionnaire used in the PATT study is included in Appendix C. It is noteworthy that even the questions used by the PATT study are quite similar to the present one. The definition of technology used by PATT was entirely internal. In other words, no explanation was offered to the survey respondents about what was meant by *technology*. The same principle was followed in this research as well, where *technology* was not defined for the participants. The PATT study found that a fundamental gender difference existed in students' perceptions and attitudes about technology. As will be discussed, gender differences in students' perceptions about technology were found in this research as well.

Math, Science and Reading Scores

Math, science, and reading scores of middle and high school students nationwide compiled by the National Center of Education Statistics for 2007 (NCES, 2007) will be discussed in this section to illustrate gender differences in these technology-related subjects. The U.S. national average of boys' and girls' performance in Grades 4th, 8th, and 12th for reading, math, and science give an idea of the nature and extent of gender differences in performance.

Several significant gender differences were reported by NCES 2007. Interestingly, many of these show that girls are outperforming boys. For example, it is reported that "…girls outperform boys on reading and writing assessments at fourth-, eighth- and twelfth- grades…More girls than boys take Advanced Placement examinations" (2007, p. 36), except for physics. "Since 1990, more girls in their senior year of high school are likely to plan to graduate from college than boys. Girls have generally been more likely than boys to enroll in college immediately following high school. In 2001, boys were more likely than girls to have dropped out of school." The report also states that "…the employment rates for women have increased across all levels of educational attainment since the 1970s" (NCES 2007).

On the other hand, the NCES 2007 reports "…a significant wage gap, where among young adults with bachelor's or higher degrees, women earn about 78 percent of what their male counterparts earn. The labor force participation for women is lower than for men at every education level in selected large industrialized countries (Canada, France, Germany, Italy, United Kingdom, United States)."

The results reported in NCES 2007 focus on the high-school-to-college-bound graduates in science, math, engineering, and technology (SMET) majors. The first result-set reports the elementary and middle school test results for boys and girls. The results of reading skills were found to vary by gender. For example, "girls outperformed boys in each grade in 2005." Girls were more likely than boys to show mastery in four of the five reading skills[5] (no measurable difference was found for evaluating nonfiction); however, "boys were more likely than girls to demonstrate mastery in mathematics skills."

According to the NCES 2007 report, girls consistently outperformed boys in each of the reading measures. The average test scores in reading for 1992 and 2005 (for grades 4th, 8th, and 12th) increased slightly as students reached higher grades, and girls slightly outperformed boys at each grade level. The math scores of 12th graders were slightly higher for boys. However, the overall distribution was approximately the same for both boys and girls. The NCES 2007 report also found that, unlike in 1998 and 2000, "…2004 female graduates were more likely than male graduates to have completed some advanced mathematics courses (e.g. trigonometry, pre-calculus, or calculus)." Similar to math, boys also outperformed girls in science but barely so.

Girls scored higher than boys on a number of metrics, according to NCES, 2007. For example, girls reported spending more time on homework than boys. In 2002, 41 percent of girls compared with 33 percent of boys reported spending more than 10 hours per week on homework. That same year, 19 percent of girls compared with 26 percent of boys reported spending 3 hours or less per week on homework (2007, p. 52).

Girls also scored higher on academic preparedness. Student academic preparedness was defined by the NCES study as "…a demonstration of the extent to which students are actively engaged in education and is crucial to the learning process" and was measured by "…looking at how often high school students came to school without books; without paper, pen, or pencil; and without their homework" (2007, p. 53). The study looked at the years 1980, 1990, and 2002. Across all three years, boys reported

[5] Reading Skills: 1. Understanding words in context, 2. Making literal inference, 3. Deriving meaning from text, 4. Interpreting beyond text, 5. Evaluating non-fiction.

coming to school unprepared more often than girls. For example, in 2002 about 30 percent of boys came to school usually or often without their homework, compared with 21 percent of girls. Similar patterns held for the two other indicators, forgetting books and leaving pencils and paper at home.

In the young adults (age 16 or older) category, girls scored higher than boys on prose, defined as the "…knowledge and skills needed to perform prose tasks, i.e., to search, comprehend, and use information from continuous texts, such as paragraphs from stories" (2007, p. 45). Girls also scored higher than boys on document literacy, defined as the "knowledge and skills needed to perform document tasks - i.e., to search, comprehend and use information from non-continuous texts in various formats, such as bills or prescription labels" (2007, p. 45). Boys outperformed girls on quantitative literacy, defined as the "knowledge and skills required to perform quantitative tasks i.e., to identify and perform computations, either alone or sequentially, using numbers embedded in printed materials" (2007, p. 45) in 1992 and 2003. "The boys' scores declined in prose and document literacy from 1992 to 2003, while girls' scores increased in document and quantitative literacy" (2007, p. 45).

Thus boys scored marginally higher in quantitative scores thru 4th, 8th, and 12th grades, as well as among young adults age 16 or older. Boys as a group also scored marginally higher than girls in science thru 4th, 8th, and 12th grades (2007, p. 38). However, the differences are extremely minor and not statistically significant. On a number of metrics, girls scored higher. For example, in 2004 (unlike in previous years), girls were more likely than boys to have completed courses like trigonometry, pre-calculus, or calculus, i.e. advanced math classes. They were also more likely than boys to complete some advanced science courses. Girls also reported spending more time on homework than boys (2007, p. 53).

The gender disparity observed at the high school level is also reflected in the amount and nature of terminal degrees obtained by each gender. The following charts[6] illustrate the disparity among men and women at Bachelor's, Master's, and Doctoral degrees. From the available NCES data (2007, p. 177), four sets were selected to represent SMET majors: "Math and Statistics, Physical Sciences and Science and Technology, Computer and Information Science, and Engineering and Engineering Technology." Within these, the fraction of degrees earned by women versus men was compiled for each level. In no category have the women earned more than 40% of higher education degrees. In areas such as Engineering and Computer and Information Science, that fraction drops to 20%. See Figure 5 for an illustration.

[6] All charts in this chapter have been drawn using the data provided in the NCES 2007 report. The corresponding page number where the data occurs in the report is included in the chart's parenthetical reference.

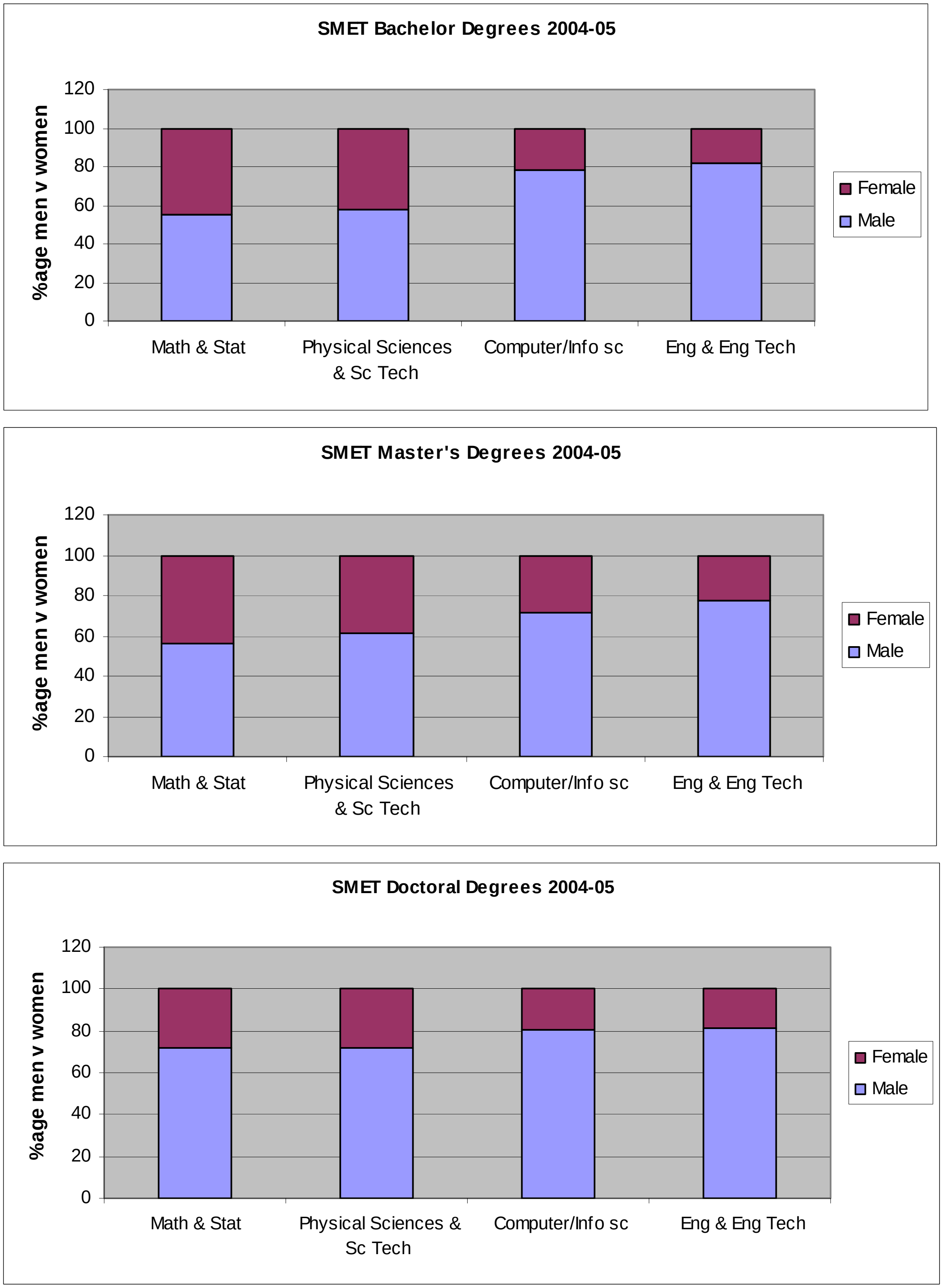


Figure 5. Percentage of Bachelor's, Master's and Doctoral degrees earned by men and women in SMET fields of study in 2004-05 (NCES, 2007, 177)

The patterns for the Bachelor's and the Master's degrees are strikingly similar among the two genders. The same trend can be seen to continue at the doctoral level as well. Women earned less than 30 percent of the doctoral degrees awarded in 2004-05 in math and engineering technologies (NCES, 2007).

In summary, boys and girls consistently show different skill levels formed during their school years, and the difference results in fewer women in STEM careers. There is a significant and consistent difference between the degrees obtained by men and women. According to the Condition of Education (2007) report, "Women earn a greater number and proportion of Bachelor's, Master's and Doctoral degrees than they did 25 years ago." The percentage of degrees awarded in particular fields of study has varied: Less than a quarter of Bachelor's and Master's degrees were awarded in the fields of Computer/Information Sciences and Engineering Technologies to women according to the Condition of Education 2007 report. There is a consistent pattern wherein men are found to outperform women in quantitative literacy. Men are also found to earn Bachelor's, Master's, and Doctoral degrees in STEM majors with greater frequency than women.

The question remains: Why so? With an otherwise greater participation than men in the education system at both the high school and college levels, why do women fall behind in science and technology areas? Why does the gender gap continue to persist to this day, with a significant difference between the genders in their choice of technology majors in college? What accounts for the consistently low numbers of enrollments and degrees earned in science, math, engineering, and technology fields for women? This research tried to answer these questions by looking at technology perceptions of boys and girls from high school and relating these perceptions to their intent to choose a technology major in college. The review of literature is followed by a brief survey of the theoretical framework for this work, which in turn leads to specific research questions addressed by this work.

CHAPTER 3: THEORETICAL FRAMEWORK & RESEARCH QUESTIONS

The problem question of this research: "What do high school students think about technology and do these opinions affect their intent to major in a technology area in college?" cannot be investigated without considering the theoretical bases of existing work in a number of disciplines: Education, Gender studies, Motivation Studies, and Science, Technology, and Society (STS) studies. Each of these areas must be used to provide the theoretical framework.

The research question investigated motivation and gender as well as technology perceptions and education experiences. Any investigation that examines behavior within a societal framework must include *social constructivism*. The theoretical framework formed by the combination of each of these disciplines is represented diagrammatically in Figure 6.

Note that the inclusion of these disciplines is an acknowledgement of the highly interrelated nature of the constructs involved in this research problem, which cannot be answered in isolation of the social and behavioral matrix surrounding it. Each of these elements needs to be individually addressed in order to form the final research design. As Figure 6 illustrates, this research is situated at the confluence of a wide variety of theories. The discussion can perhaps best be started with an examination of the field of STS. An interdisciplinary field, STS examines the ways in which society influences the creation of scientific knowledge and technological development. STS studies how social, political, and cultural values affect scientific research and technological innovation, and how these in turn affect society, politics, and culture (Cutcliffe & Mitcham, 2001).

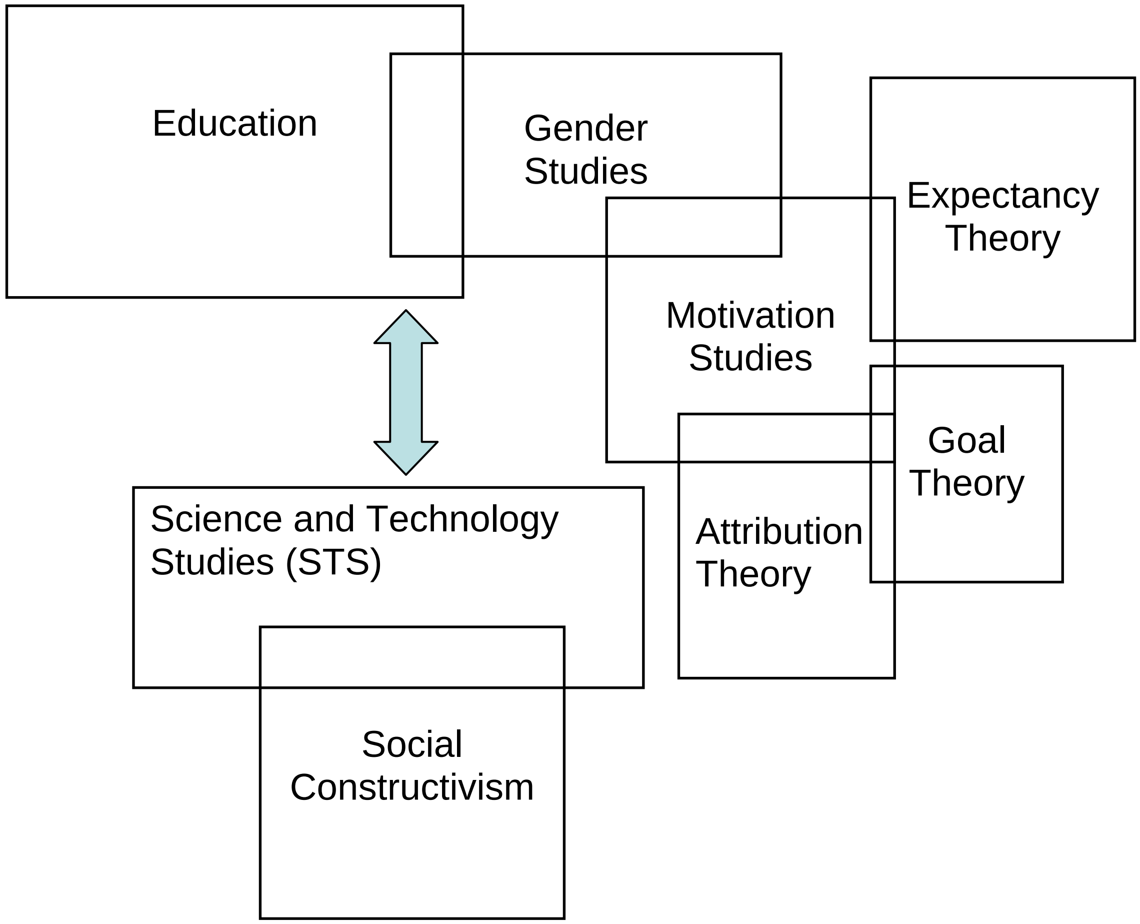


Figure 6. Theoretical framework for this research

The relevance of STS to this study arises from the assumption that science and technology are embedded in society. This forms the premise of social constructivism, an approach widely applied by science and technology studies. Social constructivism can be summarized as the theory of social construction of gender identities. In other words, boys and girls are products of differential socialization. Just as STS is based on the premise that human understanding of nature, science, and technology is socially mediated, the argument is extended to the understanding of gender. Social mediation and differential socialization are ways of explaining the existing gender gap in science and technology majors. Social constructivism is grounded in the idea of societal contextualization of science and technology (Berger & Luckmann, 1966; Kuhn, 1970). It is interesting to note that literature in STS points to gender as a missing factor that has not been sufficiently taken into consideration in science and technology studies (Sedano, 2001). This work, therefore, also attempts to add to the limited body of research in STS by extending the constructivist argument to gender issues in science and technology.

A constructivist viewpoint assumes that both gender and ethnic identities are socially constructed, and that the society assigns certain characteristics and expectations to each (Lorber & Farrell, 1990). In other words, one's gender does not pre-determine one's interests or scholastic capabilities. Instead, both of these are attributes developed by societal influences.

The research question addressed by this study goes to the heart of the constructivist theory. The reasons behind high school students' intent to choose technology majors in college may be related to their perceptions of technology, their influences at school and home, their confidence level and self-esteem, their understanding of technologists' work, their own expectations from a job, and their opinions about technology jobs. Each of these is a construction of or is affected by the society in which the students live. This research looks at gender differences among the various factors noted above, and thus is based upon a constructivist argument: Boys and girls are socialized differently; their opinions, interests, perceptions, and the messages they receive from their schools and family are significantly different when it comes to the choice of technology majors.

Confidence and sense of self-esteem form another set of factors that can differ significantly across genders in relation to boys' and girls' intent to select a technology major in college. According to a social-constructivist framework, both self-confidence and self-esteem levels across genders are based not on individual capacity, but on societal approbation and societal expectations (Cutcliffe & Mitcham, 2001).

While discussing the constructivist framework, it is important to point out that this study did not undertake to investigate all possible influences and factors that might affect high school students' intent to choose a technology major in college. The study largely focused on influences, suggestions, and inputs that high school students might receive from various influence groups within their school. Media, although arguably a huge set of highly potent influences, was not included due to the limited scope of this study. As will be discussed, peers were found to be of little influence in the pilot studies, so their influence was not investigated further. The role of the students' families was explored in a limited way, while the focus remained on their schools as the mediating attribute.

Expectancy Theory of Motivation

Behavioral and motivation studies form another critical theoretical support for this research. Arguably, behavior is largely caused by motivation. The expectancy theory of motivation has become a commonly accepted theory for explaining how individuals make decisions regarding various behavioral alternatives (Vroom, 1964). Expectancy theory views motivation as the result of three different types of beliefs:

1. Expectancy – this is the expectation that effort will affect performance.
2. Instrumentality – this is the expectation that performance will be rewarded.
3. Valence – this is the perceived value of the rewards that are expected.

Expectancy relates to the degree to which efforts are seen to affect performance. Certain tasks, for example, might seem more rewarding and hence worthy of inputting a lot of effort, but others might not be perceived to be that rewarding. In other words, an individual might have a very low *expectancy* that his efforts will result in high levels of performance. If that is the case, it is unlikely that that person will continue to exercise more effort (Furnham, 2005). For instance, if an individual is operating a faulty piece of equipment, he may have a low level of expectancy about the level of outcome. On the other hand, if he is working on a brand new state-of-the-art piece of equipment, he might have a high level of expectancy regarding the outcome.

Instrumentality is the next key element in this theory. Even if an individual performs at a high level, his or her motivation may suffer if that performance is not appropriately rewarded – that is, if the performance is not perceived as *instrumental* in bringing about the rewards.

Valence indicates the value or desirability of the rewards for a certain level of performance for that individual. With a highly diverse workforce, for example, all employees would not be equally attracted to the same rewards. Expectancy theory focuses on people's *perception* of reality (Vroom, 1964).

According to this theory, the motivational force (MF) for a behavior or action is the product of the above three factors: MF = Expectancy x Instrumentality x Valence. Note that since the motivational force is defined as the product of these three factors, if any one of their values is zero, the net motivation equals zero.

Scholars have found that boys and girls tend to assign very different values to different subjects studied in school such as math and science (Eccles et al., 1983). There is also difference in instrumentality – the students' belief that their efforts will be rewarded. Thus it can be demonstrated that expectancy theory is operating in the case of observed gender differences regarding math and science courses. Eccles and her colleagues have formulated a model of expectancy theory as applied to girls' lower participation in math and sciences (Eccles et al., 1983; Eccles & Wigfield, 2000). According to Eccles, girls' lower self-concept of their ability to do math and lower importance assigned to the value of being good in math are the primary factors that affect their future math course choices. The model designed by Eccles to describe gender related behavioral variations is illustrated in Figure 7 below.

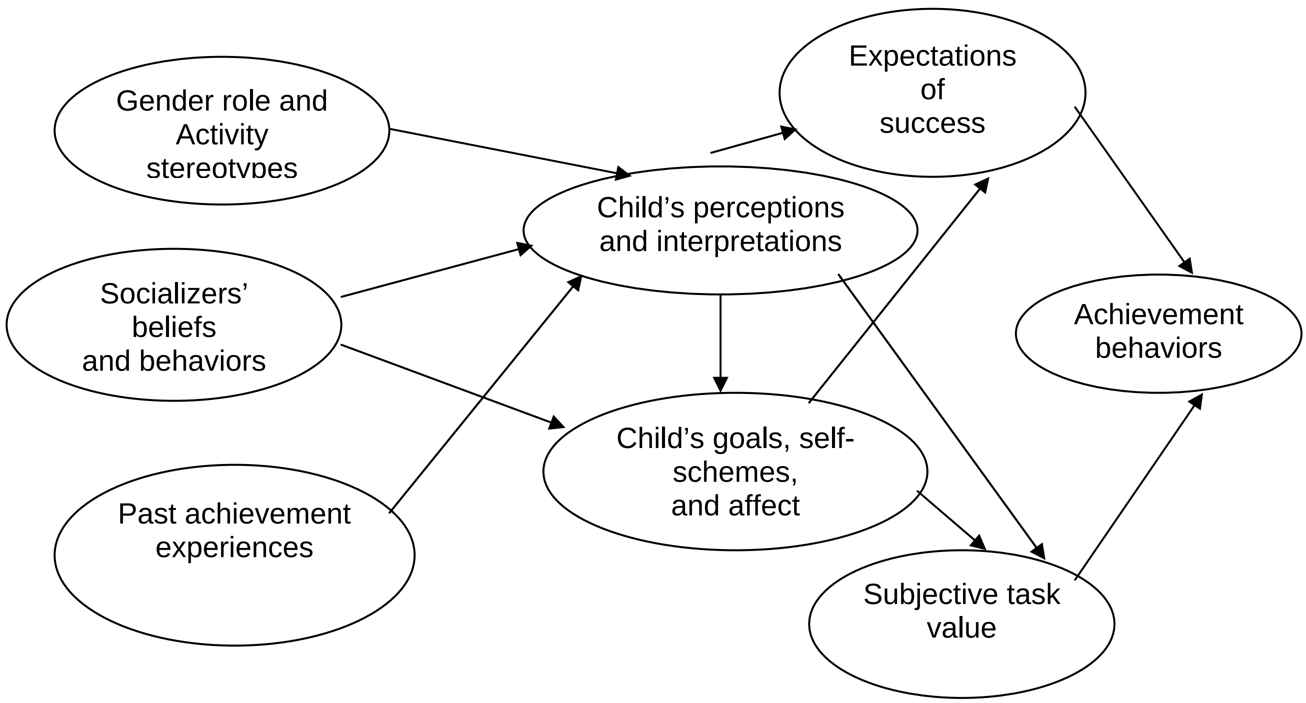


Figure 7. Eccles' expectancy value model of activity choices (Eccles et al., 1983)

According to this model, the differential socialization among boys and girls is seen as the basis of differential achievement behaviors. Thus the expectancy theory, as applied to technology and gender, tends to support and reinforce the notion of social constructivism or, in other words, the social construction of gender identities in science and technology.

Attribution Theory of Motivation

The attribution theory of motivation is another way to understand gender differences in achievement motivation. Weiner (1985) proposed that people attribute the perception of their success or failure to two factors, ability and effort. Research using an attribution theory framework identified gender differences in the different ways that boys and girls interpret their successes and failures (McMahan, 1973). Studies indicated that women were more likely to exhibit a low-expectancy attribution pattern, and their achievement behavior was found to suffer as a result (Gilbert, 1996; Eccles & Jacobs, 1986). Men attributed their successes to ability, whereas women attributed their failures and not successes to their ability (or lack of). The study on gender and motivation by Meece, Glienke, & Burg (2006) reported that in mathematics, girls are less likely than boys to attribute their successes to ability. Research concurs that girls attribute their successes to effort and hard work, which may undermine their expectations for success as mathematics increases in difficulty (Eccles et al., 1983; Parsons, Meece, Adler, & Kaczala, 1982). Similar differences in causal attribution patterns have also been noted for successes and failures in science courses (Li & Adamson, 1995; Meece, Glienke & Burg, 2006). According to Weiner (1985), causal attribution patterns were related to expectations for success and to the benefits associated with achievement. Meece, Glienke, & Burg, 2006, suggest that causal attributions of ability versus effort are the strongest motivations for achievement behavior.

Another pertinent area of attribution research is the study of learned helplessness. According to Meece, Glienke, & Burg (2006), learned helplessness occurs when someone attributes failure to a lack of ability and gives up easily. Their study reported that learned helpless children underestimated their performances, discounted their successes, and believed others performed better than they did. In contrast, children who do not experience learned helplessness continued to perform a task even after experiencing failure because they attributed failure to a lack of effort or task difficulty. Due to gender differences in attribution patterns, Meece et al. suggest that girls may be more prone to learned helplessness than boys, especially with regard to math and science domains.

Thus based on attribution theory, boys are likely to have higher motivation in science and math, and girls are likely to have higher motivation in reading and writing, because both groups have adopted stereotypical roles that they are supposed to excel in according to their gender (Wigfield & Battle, 2002).

Goal Theory of Motivation

The goal theory of motivation focuses on a person's *reasons* for engaging in a specific activity. Two types of goal theories have been used to explain behavior in academic settings. Different standards are used to judge achievement for a particular goal. Meece, Glienke, & Burg (2006) define a *learning or mastery* goal orientation as "…a desire to develop one's competencies, to master a task, or to improve intellectually, whereas they define a *performance* goal orientation as demonstrating high ability relative to others, competing for grades, or gaining recognition for ability" (p. 3). Differences in goals that individuals set for themselves may result in very different behaviors. For example, girls are found to be more learning focused and less performance focused in science than boys (Meece, Glienke & Burg, 2006).

Reviewing Figure 6 at the beginning of this section, we can now see how the various theories of motivation and social constructivism together constitute a substantial theoretical framework for this research. This discussion is followed by the specific research questions addressed by this study. These questions were based on the various theoretical constructs discussed earlier, such as social constructivism, gender and motivation, self-confidence, and self-esteem.

Research Questions

Following are the specific research questions that this research looked to answer by conducting bivariate correlational analysis on the collected data:

a. What is the correlation between the students' opinion that "technology work is fun" and their intent to choose a technology major in college, and is this correlation moderated by gender?
b. What is the correlation between the students' confidence in math and science and their intent to choose a technology major in college, and is this correlation moderated by gender?
c. What is the correlation between the students' confidence in performing specific technology tasks and their intent to choose a technology major in college, and is this correlation moderated by gender?
d. What is the correlation between the students' perception of control over their life's outcomes and their intent to choose a technology major in college, and is this correlation moderated by gender?
e. What is the correlation between the students' perception of control over their life's outcomes and their confidence in performing specific technology tasks, and is this correlation moderated by gender?
f. What is the correlation between students' considering technology work as fun and their confidence in performing specific technology tasks, and is this correlation moderated by gender?

g. What is the correlation between the students' considering technology work as fun and their self-confidence in math and science, and is this correlation moderated by gender?

h. What is the correlation between the students' considering technology work as fun and their perception of control over their lives' outcomes, and is this correlation moderated by gender?

i. What is the correlation between the students' perception of control over their lives' outcomes and their self-confidence in math and science, and is this correlation moderated by gender?

j. What is the correlation between the students' confidence in performing specific technology tasks and their self-confidence in math and science, and is this correlation moderated by gender?

k. What is the correlation between the students' opinion that "people in technology have no family life," and their intent to choose a technology major in college, and is this correlation moderated by gender?

l. What is the correlation between the students' considering technology work as fun and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

m. What is the correlation between the students' considering technology work as fun and their perception that boys are better at technology than girls, and is this correlation moderated by gender?

n. What is the correlation between the students' perception of control over their lives' outcomes and their perception that boys are better at technology than girls, and is this correlation moderated by gender?

o. What is the correlation between the students' perception of control over their lives' outcomes and the messages the students report receiving at school that boys are better at technology than girls, and is this correlation moderated by gender?

p. What is the correlation between the students' considering technology work as fun and the messages they report receiving at school that boys are better at technology than girls, and is this correlation moderated by gender?

q. What is the correlation between the students' confidence of graduating from high school and then attending college and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

r. What is the correlation between the students' intent to select a technology major in college and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

s. What is the correlation between the students' perception that boys are better at technology than girls and their confidence in math and science, and is this correlation moderated by gender?

t. What is the correlation between the messages the students report receiving at school that boys are better at technology than girls and their own stated perception that boys are better at technology than girls, and is this correlation moderated by gender?

u. What is the correlation between the students' opinion that "people in technology have no family life," and their confidence in their abilities in math and science, and is this correlation moderated by gender?

v. What is the correlation between the students' stated importance of their parents' opinions about their future and their confidence in math and science, and is this correlation moderated by gender?

w. What is the correlation between the messages the students report receiving at school that boys are better at technology than girls and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

x. What is the correlation between the students' perception of control over their lives' outcomes and the opinion that "people in technology have no family life," and is this correlation moderated by gender?

y. What is the correlation between the students' perception of control over their lives' outcomes and their perception of parents' opinion about their future as important to them, and is this correlation moderated by gender?

The results of the statistical analysis of the research questions are discussed in Chapter 6. The analysis of Research Question "a" thru "j" are presented in Part 1, "k" thru "r" are presented in Part 2, and "s" thru "y" in Part 3. The research questions were divided into three parts based upon the similarities in the questions. The three divisions will be discussed in detail in Chapter 5.

The analysis also included comparing different variables for the two genders by conducting t-tests. The specific research questions for these comparisons were as follows:

a. Is there a difference between girls' and boys' level of confidence in performing specific technology tasks?
b. Is there a difference between girls' and boys' opinions that technology work is "fun"?
c. Is there a difference between girls' and boys' level of confidence in math and science at school?
d. Is there a difference between girls' and boys' opinion that technology work is more suitable for boys?
e. Is there a difference between girls' and boys' intent to major in technology in college?
f. Is there a difference between girls' and boys' perception that their parents' opinion about their future is important to them?
g. Is there a difference between girls' and boys' sense of self-esteem?

In addition to the quantitative part, the research framed questions about the respondents' opinions about technology. Specifically, five sets of opinion questions were analyzed: The students were asked to indicate the level of their agreement or disagreement with the following opinions:

- Technology has no place for imagination.
- Technology has improved most people's lives.
- Technology isolates you from spending time with friends, as in seeing them in person.
- Technology has done more bad for the environment than good.
- Technology is mainly concerned with computers.

The final research question was open-ended and required the respondents to provide their own image/impressions about technology by answering the question: “What are the first three things that come to mind when you think about ‘technology’?”

The survey instrument was based on these research questions. The study variables were designed to address the theoretical constructs posed by these questions. The instrument is fully described in the following chapter.

CHAPTER 4: RESEARCH METHODS

Research Design

The study was carried out using a survey research design. The data for analysis was collected from a set of surveys. These data were subsequently analyzed using bivariate correlational technique in SPSS statistical software. The survey instrument also included an open-ended question that was analyzed qualitatively. A brief overview of each research method used in this study follows.

Survey Research

Survey research essentially consists of asking a series of questions about a particular topic of interest from a large number of people. This group of people is selected from a larger population and is ideally its most representative sample. A survey instrument, usually in the form of a questionnaire, is designed to find out how people feel or think about a particular topic. Depending on the research question, surveys can be cross-sectional or longitudinal. A cross-sectional survey collects information at a single point in time, while a longitudinal survey is used to collect information at different points in time in order to study changes over time (Fraenkel & Wallen, 2003).

The present study uses survey research to gather the opinions of high school students regarding technology in general and the intent to choose a technology major specifically. The choice of high school students as the most suitable group for the purpose of this research was discussed in Chapter 1. The design of a survey instrument becomes critical for such research and must be validated before it can be used in a study. The importance of instrument design cannot be overstated because ultimately the data are only as good as the instrument used to obtain them. This significance is especially true in the case of the present study because the surveyed sample consisted of high school teenagers. It was important to ensure that the survey questions were properly understood, so that the respondents were in fact giving as accurate an opinion as possible. The design and development of the survey instrument used in this research was carried out in a series of three pilot studies. These were conducted in two engineering summer camps over the course of one year, and in high school A. Each of these is discussed in detail in Appendix D. However, survey research formed only part of the research methodology of this study. Subsequent to the data gathering, data analysis was carried out using correlational analysis.

Correlational Research.

Correlational research is associational in nature. In other words, relationships between two or more variables are studied without any manipulation or treatment. A correlational study describes the degree to which two or more quantitative variables are related (Fraenkel & Wallen, 2003). A correlation coefficient describes this degree of association. The correlation coefficient can be either positive or negative. When high scores of one variable are associated with high scores of the other, then the two variables are said to be positively correlated. A negative correlation, on the other hand, implies that high scores on one variable are associated with low scores on the other. To draw conclusions from the correlations, however, requires that the two variables be correlated to a certain degree of statistical significance.

It is important to clarify that correlational research does not imply causation. Two variables under study might be found associated positively or negatively with one another. However, that does not mean that one is causing the other. Both variables might be affected by an extraneous third factor.

This research investigates gender differences among high school students' opinions about technology and their intent to choose technology majors in college. Since it is an exercise in gathering data on opinions about a certain issue, survey research presented itself as the most suitable method. Correlational analysis was performed on the data gathered through various surveys such that associations and relationships among the data could be determined. Specifically, bivariate correlational analysis was performed to investigate the relationships among the variables.

Qualitative Research

The method for carrying out qualitative analysis is markedly different from quantitative research. "Research studies that investigate the quality of relationships, activities, situations, or materials are referred to as qualitative research" (Fraenkel & Wallen, 2003, p. 430). Qualitative work is rich in descriptive detail and requires content analysis. One of the key characteristics of qualitative data is that these are usually in the form of words or pictures rather than numbers. In this study, the open-ended question in the survey instrument invited the respondents to write in their impressions of the word *technology*. The responses were widely varied and were categorized into themes for the purpose of analysis. It must be pointed out that the categorization was subjective and influenced by the researcher. Unlike quantitative research, qualitative studies are influenced by those who carry them out. The researcher is inseparable from the research question and contributes to it in unique ways (Fraenkel & Wallen, 2003). Given the nature of qualitative research, the findings of a particular study cannot be generalized in the same way that quantitative findings can be. Instead, qualitative research sheds light on the specific study sample and cannot be justifiably extended to a larger population.

Study Sample

The final sample for this study was selected from two Midwest high schools. The ethnic composition of each school and each sample set is given below.

School B: Ethnic composition

School B is a comprehensive four-year high school, grades 9-12, with a total enrollment for the 2005-2006 academic year of 2092.

Table 1
Ethnic composition of School B

Total Number: 2092	Male	Female	Total	Percentage of total
Caucasian	695	603	1298	62.0
African American	163	198	361	17.3
Hispanic	41	45	86	4.1
Asian	174	165	339	16.2
American Indian	3	5	8	0.4

Total free and reduced price lunch eligible students: 210 (10% of total)

Sample characteristics: Suburban; lower, middle, and upper middle class

N = 81: 50 girls, 31 boys (mostly sophomores and juniors)

Caucasian: 51; African American: 6; Latino/Hispanic: 8; Asian: 11; Multiethnic: 5

The survey was carried out in one argumentation and four theater classes. All students must take argumentation and theater (or speech, which this teacher did not teach the semester the survey was given) to graduate. There was no self-selection in the sample and the subject was unrelated to technology and therefore assumed not to affect students' responses.

School C: Ethnic composition

School C is a comprehensive four year high school, grades 9-12, with a total enrollment for the 2005-2006 academic year of 744.

Table 2
Ethnic composition of School C

Total No: 744	Male	Female	Total	%age of total
Caucasian	345	321	666	89.5
African American	31	17	48	6.5
Hispanic	11	10	21	2.8
Asian	2	2	4	0.5
American Indian	3	2	5	0.7

Total free and reduced price lunch eligible students: 72 (9.7% of total)

Sample characteristics: Suburban/rural, largely Caucasian, middle class

n = 71: 30 girls, 41 boys (mostly juniors)

Caucasian: 57; African American: 7; Latino/Hispanic: 0; Asian: 1; Multiethnic: 6

The survey was carried out in a global studies class that was mandatory for graduation. There was no self-selection in the sample and the subject was unrelated to technology, and again we assumed that classroom or subject would not affect students' responses. The fully developed survey instrument, as well as a copy of the letters to the schools' principals and parents asking permission to survey their children, was duly approved through the Eastern Michigan University's Graduate School's Human Subject

Review process. The total sample size was 152 students, including 80 girls and 72 boys. A copy of the final survey used for this research is included in Appendix A.

Measurement

The survey instrument allowed for quantitative measurements and empirical correlations between the various variables as defined previously. The final instrument used a 5-anchor point Likert scale that included the option to pick *neutral.* Each variable under study was a composite score of a set of questions previously tested for reliability and statistically significant correlation. From pilot study 2 (included in Appendix D), students appeared to stay on task when filling out the survey for only about 10-15 minutes. Hence the questionnaire was edited for length and duplication. Ambiguous questions were also removed, and as far as possible, they were checked for clarity of interpretation. Moreover, it was found in pilot study 2 that very few students cited peers or friends as possible influences in technology major choice. The following section describes the specific questions used in the survey.

Variable Design

The research questions outlined previously were explored by formulating specific variables in the survey questionnaire. Variables such as “student’s confidence in math and science” or “student’s opinion about considering technology work as fun” were formed as composites from a cumulative score of several similar questions in the survey instrument. Three pilot studies were carried out to validate the instrument and to obtain scale reliability and strong internal correlation for each scale. Those questions that reduced the reliability score for the composite variable or did not correlate strongly with others in the set were removed. Following is an enumeration of each composite variable used in the study.

Variable1: Gender Signals School (GSS)

Variable Definition: This is all the messages/signals a student might get from his or her school that imply a superiority of boys at math and science when compared to girls. The following statements tested high on internal correlation and reliability score for the scale for this variable: (Note that the numbers are not serial, as variables with lower reliability scores were removed in the process of validation)

(GSS1: MoreApp) 1. The teachers in my school give the impression that technology courses are more appropriate for boys than girls.

(GSS2: TechCareerEn) 2. The counselors in my school encourage boys more than girls to pursue engineering/ technology careers.

(GSS3: APEncourage) 3. The teachers in my school encourage boys more than girls to take Advanced Placement courses in math and science.

(GSS5: CallMore) 7. Teachers in my school call on boys more than on girls in math and science classes.

Cronbach’s Alpha Reliability score: 0.755

Range of scores: 4 - 20

Variable2: Self-Confidence in Math and Science (CONF)

Variable Definition: This variable measures their feeling of self-confidence in math and science. The following statements tested high on internal correlation and reliability score for the scale for this variable:

(CONF1: NotGoodMSc) 4. I feel like I don't really belong in math and science classes because I am not very good at these subjects.

(CONF2: GoodMSc) 5. I am good at math and science.

Cronbach's Alpha Reliability score: 0.636

Range of scores: 2-10

The following question was retained as a separate item (PRNT) and not part of any composite variable:

"My parents' opinion of what I plan to do after high school is very important to me."

Variable 3: Gender Technology Perception (GTP)

Variable Definition: This is their level of gender bias in viewing boys as being more suitable for technology and technology jobs than girls. The following statements tested high on internal correlation and reliability score for the scale for this variable:

(GTP1: BoysBetter) 11. I feel that boys are better at math and science than girls.

(GTP3: MenTechworkers) 13. Most of the adults I know who work in technology are men.

(GTP4: FNontechjobs) 14. I feel that women are better at non-technical jobs, particularly ones that deal directly with people, such as a psychologist or social worker.

(GTP5: MTechjobs) 15. I feel that men are better at technical jobs like engineering compared to women.

(GTP6: BoysMScEasy) 16. Subjects such as science, math, engineering, technology and computers are easier for boys.

(GTP7: GirlsArtSoScEasy) 17. Subjects such as art, literature and social studies are easier for girls.

Cronbach's Alpha Reliability score: 0.781

Range of scores: 6 - 30

Variable 4: Intent to choose engineering/ technology major in college (SMET)

Variable Definition: This is the likelihood of students choosing engineering/ technology majors in college. The following statements tested high on internal correlation and reliability score for the scale for this variable:

(SMET1: EngMajorChoice) 18: I am interested in engineering or technology as a possible college major choice.

(SMET2: majoring) 40: I am confident that I will major in a technology field such as engineering.

Cronbach's Alpha Reliability score: 0.854

Range of scores: 2-10

Question #19 was retained as a separate item and not part of any composite variable: "I am interested in or have taken advanced placement courses in math and science."

Variable 5: Locus of Control (LOC)

Variable Definition: These questions measure the perception of how much control the respondents think that they have over their lives. It is an indication of their self-esteem. The following statements tested high on internal correlation and reliability score for the scale for this variable:

(LOC1: inControl) 20. I am in control of my career goals and choices.

(LOC2: workNoLuck) 21. Becoming a success is a matter of hard work; luck has little or nothing to do with it.

(LOC3: studyDoWell) 23. If I study hard, I am confident I will be able to do very well in science and math.

(LOC4: gradeNotLuck) 25. In my case getting what I want (like good grades) has little or nothing to do with luck.

(LOC5: noControl) 27. Sometimes I feel that I don’t have enough control over the direction my life is taking.

Cronbach’s Alpha Reliability score: 0.772

Range of scores: 5 - 25

Variable 6: Confidence in one’s ability to perform specific technology tasks (TECH)

Variable Definition: These questions measure their confidence in tackling specific technology tasks. The following statements tested high on internal correlation and reliability score for the scale for this variable.

(TECH2: cookRecipe) 31. I am confident that I can prepare a delicious beef stroganoff dinner from a recipe.

(TECH3: repairItems) 32: I am confident I can fix a non-working object like a bike, roller-blades or a skateboard.

(TECH4: changeTire) 33. I am confident that I can change the tire on a car.

(TECH5:collectCall) 34: I am confident that I can make a collect phone call from a payphone.

(TECH6: assembleBike) 35. I am confident I can put together a new bike by following the assembly instructions.

(TECH7: webpage) 37. I am confident that I can create a web page.

(TECH8: ripCD) 38. I am confident that I can “rip” a CD and turn music into mp3 or WAV files.

Cronbach’s Alpha Reliability score: 0.743

Range of scores: 7 - 35

Question #39 was retained as a separate item, and not part of any composite variable: “I am confident that I will graduate from high school and attend college.”

As mentioned earlier, the term “technology” was not defined for the respondents. However, at the end of the Likert series of questions, they were given a chance to provide their own definitions and/or impressions about what they thought about technology. The question asked them to “name three things that come to mind when you think of *technology*.” Since this was left completely open to their interpretation, their responses included technology devices such as “computers” and “cell-phones,” processes and systems such as “communication” and “transportation,” and sensory reactions/impressions such as “new,” “advanced,” “boring,” or “difficult.” These data were qualitatively analyzed for themes and trends across genders (See Chapter 5).

Survey Administration

A consistent process of survey administration was followed in all schools. The surveys were administered at the beginning of the classes. The teachers were given parental notification letters a week before the day of the actual survey. Most parents gave permission for their children to be surveyed. It is interesting to note here that on a brief investigation of the permission letters, it was found that most refusals were from mothers who did not want their daughters to participate. Since the purpose of this survey had been made clear in the letter to the parents[7] it was surprising to note that some mothers were less open to such an exercise for their daughters. Further investigation of this occurrence is, however, out of the scope of the present research.

On the day of the survey, the students were given a short talk by their teacher about the technology survey being conducted by Eastern Michigan University, and this researcher was introduced. This was followed by a short talk by this researcher to the students about the purpose of the survey. A brief transcript of this talk follows.

“Thank you for taking the time to fill out this survey. This is a study conducted by Eastern Michigan University. We are interested in finding out what high school students think about technology. We would like to know your opinions. Please do not think a great deal before any one question; instead put down your first thought. There are no right or wrong answers. Please do not write your names. This information will be kept completely anonymous. Thank you for helping us out with our study.” The theme of the survey as being gender-based was intentionally not mentioned. It was thought that the students would respond best in the absence of any pre-defined agenda.

In most instances the students took about 15-20 minutes to fill out the entire survey. Several sections of the same course were surveyed in each school. This required the survey to be administered over the course of 2 to 3 days. The students were not individually identifiable. The results were analyzed as aggregates based on the variable of interest, gender in this case. The results of these surveys are summarized and statistically analyzed in the following chapter.

[7] The letter to the parents and the principal is included in Appendix C.

Statistical Analysis

Two statistical techniques were performed on the collected data: Correlation and t-tests. Correlation constituted the bulk of the data processing. In specific, bivariate correlation was performed for each of the constructs defined previously. The use of bivariate correlation allowed for an analysis of inter-relationships between the various constructs. Several statistically significant correlations were obtained for boys and/or girls for each set of correlations.

Conducting t-tests allowed for comparing mean scores for boys and girls, for each construct. It was possible to check if there were statistically significant differences in mean scores for these for boys and girls.

The results of the statistical analysis are discussed in the following chapter.

CHAPTER 5: RESULTS – DATA AND DISCUSSION

This section reports and discusses the results of each of the research questions outlined previously. The results of individual schools' correlations have been included in Appendix B. The results reported here are based on combined data from the two schools B and C, with total sample size of 152 students. See Table 3 for the Pearson Correlation Matrix for the entire sample (boys and girls).

The analysis of the research questions outlined in Chapter 3 is discussed below. As mentioned earlier, the research questions relating to correlation were divided into three parts. Each of these parts is discussed in the following section. Each part shows varying relationships between its set of composite variables. Certain themes emerge in each part.

Part 1: Research questions "a" thru "j"

a. What is the correlation between the students' opinion that "technology work is fun" and their intent to choose a technology major in college, and is this correlation moderated by gender?

A statistically significant positive correlation was found between intending to select technology majors (SMET) and considering technology work as fun (WORK) for both boys (0.579**) and girls (0.655**) at alpha level of <0.01. In other words, students who reported considering majoring in technology also reported that they thought that technology work was fun.

Table 3. *Pearson Correlation Matrix for each variable for the entire sample*

N=152		*1:SMET*	*2:WORK*	*3:CONF*	*4:FAM*	*5:LOC*	*6:TECH*	*7:GRAD*	*8:GTP*	*9:GSS*	*10:DIFF*	*11:PRNT*
1	**SMET**	**----**										
2	**WORK**	**0.637****	**---**									
3	**CONF**	**0.255****	**0.454****	**----**								
4	**FAM**	**-0.191***	**-0.370****	**-0.319****	**----**							
5	**LOC**	**0.159***	**0.266****	**0.430****	**-0.222****	**----**						
6	**TECH**	**0.254****	**0.339****	**0.145**	**-0.093**	**0.444****	**----**					
7	**GRAD**	**0.000**	**0.048**	**0.167***	**-0.219****	**0.381****	**0.144**	**----**				
8	**GTP**	**0.091**	**-0.087**	**-0.190***	**0.174***	**-0.236****	**0.034**	**-0.170***	**----**			
9	**GSS**	**-0.015**	**-0.207***	**-0.196***	**0.306****	**-0.274****	**0.006**	**-0.232****	**0.601****	**----**		
10	**DIFF**	**0.012**	**0.005**	**-0.087**	**0.025**	**0.005**	**0.045**	**-0.001**	**0.194***	**0.022**	**----**	
11	**PRNT**	**0.112**	**-0.028**	**0.064**	**-0.030**	**0.213****	**-0.158**	**0.231****	**-0.141**	**-0.311****	**0.088**	**----**

b. What is the correlation between the students' confidence in math and science and their intent to choose a technology major in college, and is this correlation moderated by gender?

A statistically significant positive correlation was found between intending to select technology majors (SMET) and the sense of confidence in math and science (CONF), but only for boys (0.306**) at alpha level of <0.01. This is an interesting finding in that the girls' confidence level did not factor into their reported intent to choose a technology majors in college.

c. What is the correlation between the students' confidence in performing specific technology tasks and their intent to choose a technology major in college, and is this correlation moderated by gender?

A statistically significant positive correlation was found between the intent to select a technology major in college (SMET) and confidence in their ability to perform specific technology tasks (TECH), but only for girls (0.294**) at alpha level of <0.01. Thus confidence in their ability to perform specific technology tasks tended to correspond with girls' intent to choose a SMET major when they went to college. There was no correlation for boys.

d. What is the correlation between the students' perception of control over their life's outcomes and their intent to choose a technology major in college, and is this correlation moderated by gender?

No statistically significant positive or negative correlation was found between intending to choose a technology major (SMET) and students' perception of control over their lives' outcomes (LOC) for either gender.

e. What is the correlation between the students' perception of control over their life's outcomes and their confidence in performing specific technology tasks, and is this correlation moderated by gender?

A statistically significant positive correlation was found between locus of control (LOC) and confidence in their ability to perform specific technology tasks (TECH) for both boys (0.472**) and girls (0.456**) at the alpha level of <0.01. Thus a high locus of control score correlated to a high score in their confidence in their ability to perform specific technology tasks.

f. What is the correlation between students' considering technology work as fun and their confidence in performing specific technology tasks, and is this correlation moderated by gender?

For girls, a statistically significant positive correlation was found between the confidence in their ability to perform specific technology tasks (TECH) and considering technology work as fun (WORK), (0.361**) at the alpha level of <0.01. Thus for girls there was a strong correlation between their confidence in performing technology tasks and their opinion that technology work would be fun.

g. What is the correlation between the students' considering technology work as fun and their self-confidence in math and science, and is this correlation moderated by gender?

A statistically significant positive correlation was found between considering technology work as fun (WORK) and self-confidence in math and science (CONF) for both boys (0.377**) and girls (0.555**) at the alpha level of <0.01. Thus a high score on considering technology as fun correlated with a high score for students' self-confidence to perform well in math and science for both genders.

h. What is the correlation between the students' considering technology work as fun and their perception of control over their lives' outcomes, and is this correlation moderated by gender?

A statistically significant positive correlation was found between locus of control (LOC) and considering technology work as fun (WORK), but only for girls (0.319**) at the alpha level of <0.01. Thus for girls, the higher their locus of control, the greater the chance they considered technology work as fun.

i. What is the correlation between the students' perception of control over their lives' outcomes and their self-confidence in math and science, and is this correlation moderated by gender?

A statistically significant positive correlation was found between locus of control (LOC) and self-confidence in math and science (CONF) for both boys (0.411**) and girls (0.445**) at the alpha level of <0.01. Thus a high locus of control or sense of self-esteem correlated with a high score on self-confidence in math and science for both genders.

j. What is the correlation between the students' confidence in performing specific technology tasks and their self-confidence in math and science, and is this correlation moderated by gender?

A statistically significant positive correlation was found between the confidence in their ability to perform specific technology tasks (TECH) and self-confidence in math and science (CONF), but only for boys (0.259*) at the alpha level of <0.05. The correlation was weak for boys, but there was no correlation between TECH and CONF for girls. This is interesting because for girls, having high confidence levels in math and science did not necessarily correlate with confidence that they could successfully perform specific technology tasks.

Figure 8 illustrates all the correlations discussed above:

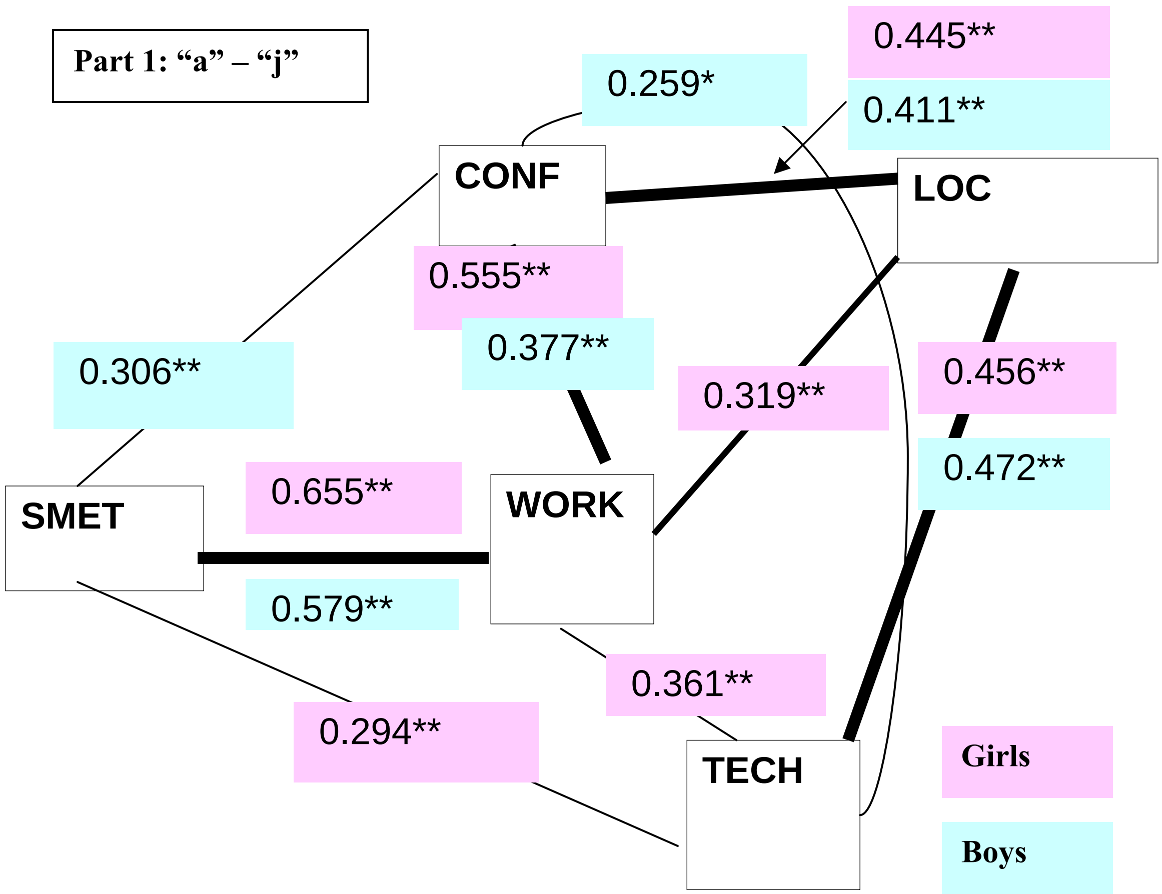
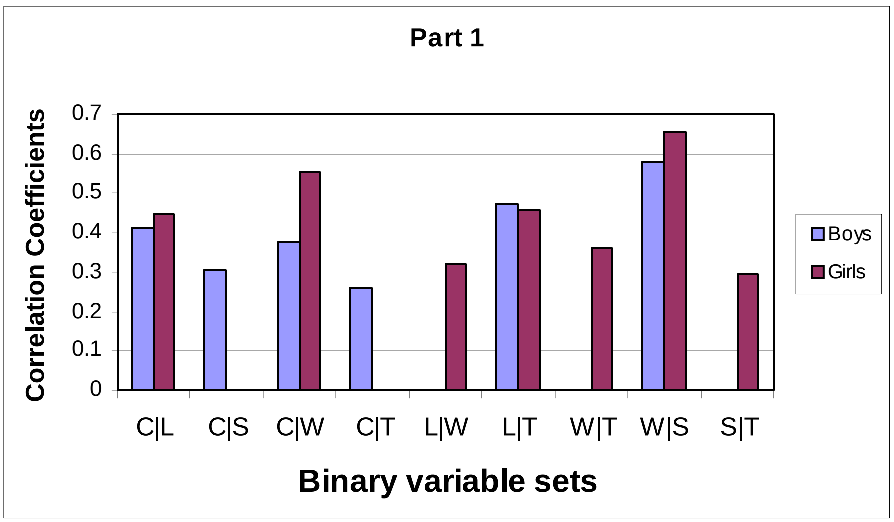


Figure 8. Statistically significant correlations found for research questions “a” thru “j” for boys and girls

The following discussion examines this set of variables further. The gender distinctions found for this set are illustrated in Figure 9. The varying relationships observed in the case of girls and boys are discussed separately. Some variables are found to be more strongly correlated to others in the case of one gender when compared to the other. In some cases division by gender clearly demonstrates the influence of certain variable pairs that statistically correlate only in the case of either boys or girls. Figure 9 shows the statistically significant correlations for boys and girls. Non-statistically significant data are not shown.



Binary Variables	
CONF|LOC	C|L
CONF|SMET	C|S
CONF|WORK	C|W
CONF|TECH	C|T
LOC|WORK	L|W
LOC|TECH	L|T
WORK|TECH	W|T
WORK|SMET	W|S
SMET|TECH	S|T

Figure 9. Variable correlations for Part 1

Girls: Part 1

In the case of girls, the variable LOC emerged as a significant factor that correlated with all other variables in this cluster. A high locus of control or self-esteem score correlated strongly with confidence in their ability to perform technology tasks, with considering technology work as fun, and with having confidence in math and science. At the same time, the intent to select a technology college major also statistically correlated to their confidence in their ability to perform specific technology tasks. Their intent to select a technology major also statistically correlated with their opinion that technology is fun.

In summary the statistically significant set of variables are as follows.

<u>LOC correlations:</u>

High LOC (score) – statistically correlates with – high WORK

High WORK – statistically correlates with – high SMET

High LOC – statistically correlates with – high CONF

High CONF – statistically correlates with – high WORK

High LOC – statistically correlates with – high TECH

High TECH – statistically correlates with – high SMET

A strong locus of control is common to each of these correlations. Although no causality is being suggested, a strong locus of control statistically correlated with each of the technology variables - WORK, CONF, and TECH - in the case of girls.

Boys: Part 1

When comparing the same variables for boys, it was their self-confidence in math and science that correlated statistically with considering technology work as fun (WORK). Note that for girls it was a sense of self-esteem (LOC) that correlated strongly with their considering technology work as fun (WORK). In either case, WORK correlated strongly with their intent to choose a technology major (SMET). The following sets of statistically significant correlations illustrate that self-confidence is an important variable for boys.

<u>CONF correlations for boys:</u>

High CONF – statistically correlates with – high SMET

High CONF – statistically correlates with – high LOC

High CONF – statistically correlates with – high WORK

High WORK – statistically correlates with – high SMET

In each case, the CONF correlation coefficient is statistically significantly related to 3 major variables. Although no causality is suggested, a strong self-confidence in math and science correlated statistically significantly with each of the technology variables, WORK, LOC, and SMET for boys.

Based on this data set, instilling a sense of fun when doing technology projects at school and promoting girls' sense of self-esteem and boys' self-confidence in math and science can promote the chance that boys and girls may choose technology majors in college.

Part 2: Research questions "k" thru "r"

k. What is the correlation between the students' opinion that "people in technology have no family life," and their intent to choose a technology major in college, and is this correlation moderated by gender?

A statistically significant negative correlation was found between the "intent to choose a technology major in college" (SMET) and the opinion that "people in technology have no family life" (FAM), but only in the case of boys (-0.395**) at the alpha level of <0.01. In other words, those boys who report that they may select a technology major in college *do not* think that technology will interfere with their family life. No significant correlation was observed for girls, either positively or negatively. No correlation was found in the case of girls in either positive or negative direction.

l. What is the correlation between the students' perception that technology work is fun and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

A statistically significant negative correlation was found between the opinion that people in technology have no family life (FAM) and the perception that working in technology is fun (WORK) for both boys (-0.460**) and girls (-0.350**), each at alpha level of <0.01. This is an interesting finding as the correlation is negative for both genders. In the case of both boys and girls, those who consider people in technology to have no family life are also less likely to think of technology work as fun.

m. What is the correlation between the students' perception that technology work is fun and their perception that boys are better at technology than girls, and is this correlation moderated by gender?

A statistically significant negative correlation was found between the perception that boys are better at technology than girls (GTP) and the perception that working in technology is fun (WORK), only among girls (-0.399**) at the alpha level of <0.01. Thus girls with the perception that boys are better than girls at technology were less likely to think of working in technology as fun.

n. What is the correlation between the students' perception of control over their lives' outcomes and their perception that boys are better at technology than girls, and is this correlation moderated by gender?

A statistically significant negative correlation was found between the perception that boys are better at technology than girls (GTP) and their locus of control (LOC), only in the case of girls (-0.405**) at the alpha level of <0.01. The opinion that boys are better than girls at technology was correlated to low scores on self-esteem, but in the case of girls only. This result underscores the significance of the nature of societal messages that are reaching girls.

o. What is the correlation between the students' perception of control over their lives' outcomes and the messages the students report receiving at school about boys being better at technology than girls, and is this correlation moderated by gender?

A statistically significant negative correlation was found between messages from school about technology being more suitable for boys (GSS), as perceived by the students, and their locus of control (LOC), but only in the case of girls (-0.389**) at alpha level of <0.01. Thus the perception of messages about girls' lack of ability in technology correlated with low scores on self-esteem, in the case of girls. This is similar to the preceding finding and underscores the significance of negative messages perceived by girls.

p. What is the correlation between the students' considering technology work as fun and the messages they report receiving at school about boys being better at technology than girls, and is this correlation moderated by gender?

A statistically significant negative correlation was found between reporting receiving negative messages from teachers and counselors about girls' ability in technology (GSS) and the perception that working in technology is fun (WORK) only among girls (-0.328**) at the alpha level of <0.01. If girls perceive that schools (teachers and counselors) feel that boys are better at technology than girls, they will be less likely to consider technology work as fun.

q. What is the correlation between the students' confidence of graduating from high school and then attending college and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

A statistically significant negative correlation was found for girls (-0.428**) between the opinion that people in technology have no family life (FAM) and their reported likelihood of graduating from high school and going to college (GRAD) at the alpha level of <0.01. (N=3).

r. What is the correlation between the students' intent to select a technology major in college and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

A statistically significant negative correlation was found between the "intent to choose a technology major in college" (SMET) and the opinion that "people in technology have no family life" (FAM), but only in the case of boys (-0.395**) at the alpha level of <0.01. In other words, those boys who intend to select a technology major *do not* think that technology will interfere with their family life. No significant correlation was observed for girls either positively or negatively. No correlation was found in the case of girls in either positive or negative direction. Figure 10 shows the interrelationship between the correlation coefficients discussed.

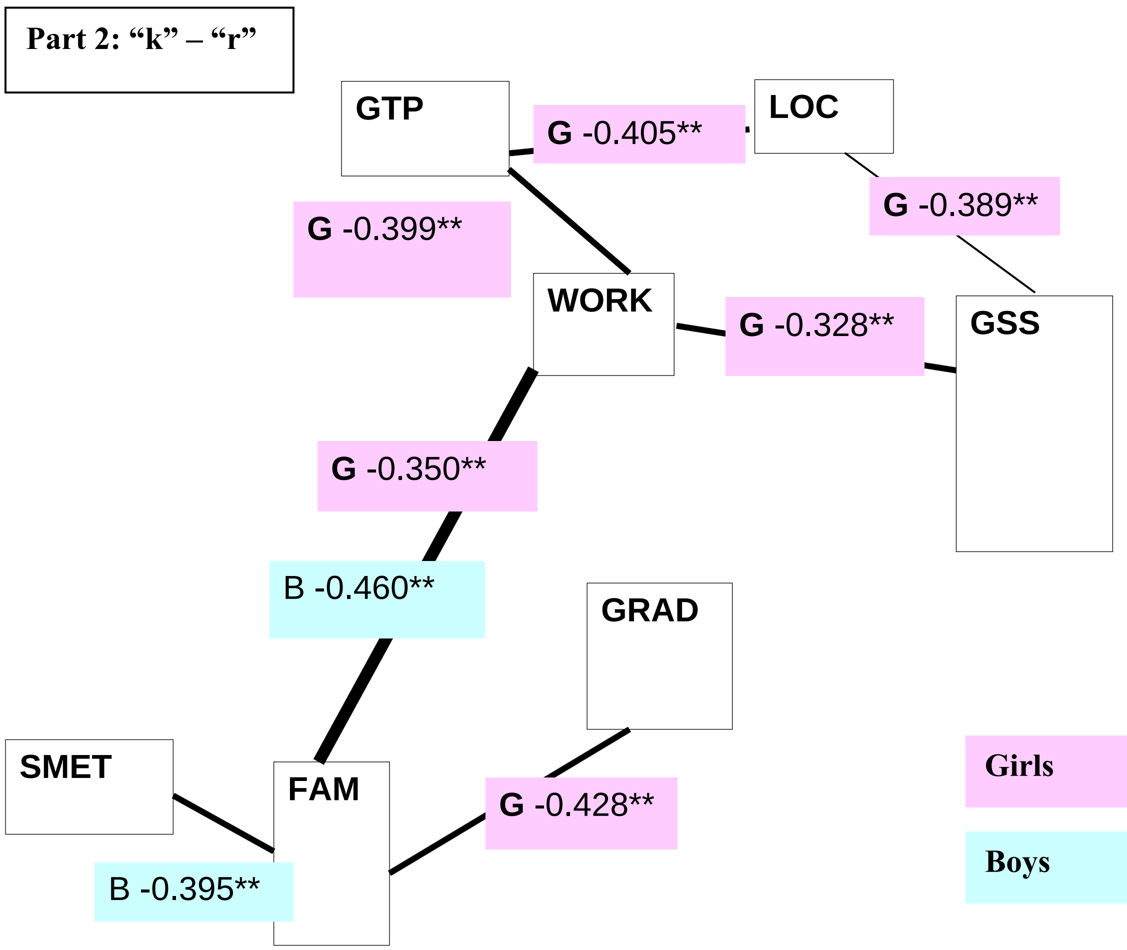
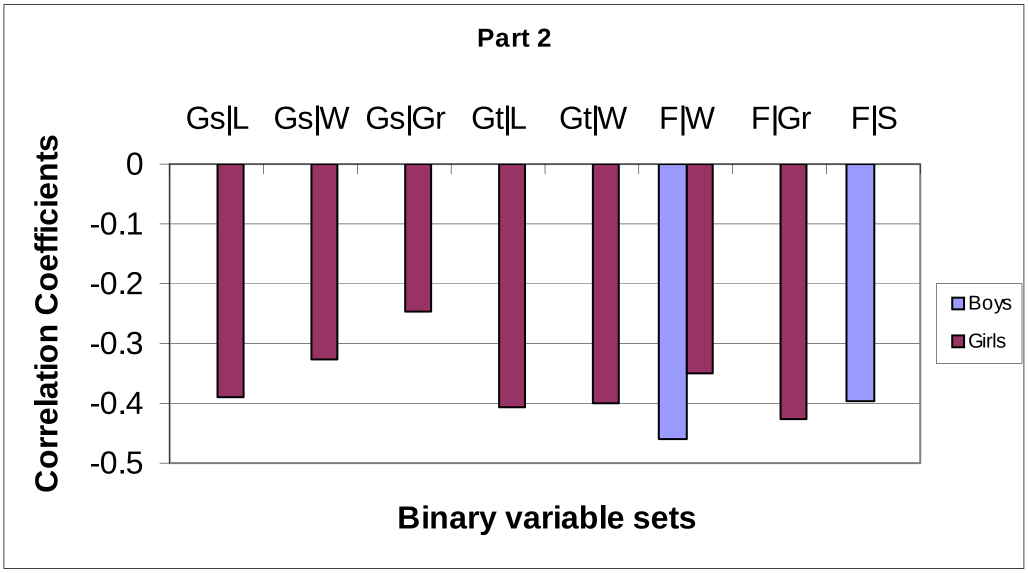


Figure 10. Statistically significant correlations found for research questions "k" thru "r" for boys and girls



Binary Variables	
GSS|LOC	Gs|L
GSS|WORK	Gs|W
GSS|GRAD	Gs|Gr
GTP|LOC	Gt|L
GTP|WORK	Gt|W
FAM|WORK	F|W
FAM|GRAD	F|Gr
FAM|SMET	F|S

Figure 11. Variable correlations for Part 2

In Part 2 certain variables are more strongly correlated in the case of one gender than the other.

Girls: Part 2

This part is interesting because of its predominantly negative correlations. Girls' negative opinions about their technology ability correlated to low self-esteem or, in other words, low locus of control scores. Negative messages perceived by girls regarding their ability to work with technology was also inversely correlated to their considering technology as fun. In other words, they are less likely to think of technology work as fun with all the negative messages they perceive from their school. The following correlations can be observed in the case of girls:

<u>LOC correlations:</u>

Low LOC – correlates with – High GTP

Low LOC – correlates with – High GSS

Low LOC – correlates with – High FAM

<u>WORK correlations:</u>

Low WORK – correlates with – High GTP

Low WORK – correlates with – High GSS

Low WORK – correlates with – High FAM

Boys: Part 2

Note that the correlation between GTP & GSS is not significant for boys. The correlation between the opinion that people in technology have no family life (FAM) was inversely correlated to the boys' intent to major in technology and also inversely correlated to their considering technology work as fun.

Part 3: Research questions "s" thru "y"

s. What is the correlation between the students' perception that boys are better at technology than girls and their confidence in math and science, and is this correlation moderated by gender?

A statistically significant negative correlation was found between the opinion that "boys are more suitable for technology than girls" (GTP) and reporting self-confidence in math and science (CONF) but only among girls (-0.326**) at alpha level of <0.01. Thus girls who thought boys were better at technology than girls were less likely to have self-confidence in math and science.

t. What is the correlation between the messages the students report receiving at school about boys being better at technology than girls and their own stated perception that boys are better at technology than girls, and is this correlation moderated by gender?

A statistically significant positive correlation was found between perceived messages from school that technology is more suitable for boys (GSS) and the perception that boys are better at technology than girls (GTP) for both boys (0.645**) and girls (0.545**), each at alpha level of <0.01. This was one of the strongest correlations found (i.e. both boys and girls had high correlation coefficients compared to rest of the results). The strong positive correlation for both genders shows the way these two constructs are intertwined. GTP is the larger construct of negative opinions about girls in technology, whereas GSS forms a subset of negative messages that students report receiving from their school. The higher their score on GTP, the more likely they are to report high on GSS as well. So if, for example, a teacher knowingly or unknowingly conveys the message that boys are better than girls at technology, then this perception is strongly correlated to the opinion that boys are better than girls by both genders.

u. What is the correlation between the students' opinion that "people in technology have no family life," and their confidence in math and science, and is this correlation moderated by gender?

A statistically significant negative correlation was found between reporting self-confidence in math and science (CONF) and the opinion that "people in technology have no family life" (FAM), but only among girls (-0.441**) at alpha level of <0.01. Thus those girls who reported being self-confident in math and science indicated the opinion that a career in technology would also include a family life. Note that no correlation was found in the case of boys. Girls appear to have thought about a family, or at least they had an opinion, whereas boys did not. No empirical assertions can be made, however, without further research.

v. What is the correlation between the students' stated importance of their parents' opinions about their future and their confidence in math and science, and is this correlation moderated by gender?

There was no statistical correlation between confidence in math and science and students' perceptions about their parents' opinions about their future for either gender.

w. What is the correlation between the messages the students report receiving at school that boys are better at technology than girls and their opinion that "people in technology have no family life," and is this correlation moderated by gender?

A statistically significant positive correlation was found between reporting messages from school that technology is more suitable for boys (GSS) and the opinion that "people in technology have no family life' (FAM), but only among girls (0.420**) at alpha level of <0.01. Thus those girls who scored high on reporting receiving messages from school that boys are better at technology were also likely to think that people in technology had no family life.

x. What is the correlation between the students' perception of control over their lives' outcomes and the opinion that "people in technology have no family life," and is this correlation moderated by gender?

A statistically significant negative correlation was found between girls' sense of self-esteem or the locus of control (LOC) and the opinion that "people in technology have no family life" (FAM) (-0.329**) at alpha level of <0.01. In other words, in the case of girls alone, those with a high sense of control over their lives felt that they could work in a technology area and have a family life at the same time.

y. What is the correlation between the students' perception of control over their lives' outcomes and their perception that parents' opinion about their future was important to them, and is this correlation moderated by gender?

A statistically significant positive correlation was found between boys' sense of self-esteem or the locus of control (LOC) and the perception that "my parents' opinion about my future is important to me" (PRNT), (0.252*) at alpha level of <0.05. As this question occurred in a survey about technology and at the end of the survey, it can be assumed that the students were most likely answering it with reference to technology even though the question specifically did not mention technology. No correlation was observed between girls who considered their parents' opinions to be important (regarding technology careers, we assume) and the sense of self-esteem among girls. Underscoring that this does not in any way imply causation, this still *might* say something about parents' opinion about their daughters' future as not bolstering girls' sense of self-esteem. In other words, this is a comment on the *nature* of opinions parents hold for their daughters and sons. In the case of sons, their opinions appeared to boost self-confidence, and in the case of their daughters they did not. Note, however, that literature suggests that girls care more about what their parents think (in general) than boys do (Hannu, 2002; Yee, 1988). That makes this finding even more unfortunate, as in spite of the daughters valuing their parents' opinions more, those opinions do not tend to reinforce their sense of self-esteem. An interesting point of future research would be to investigate the exact messages or lack of messages given by parents specifically regarding technology skills and advice on technology majors.

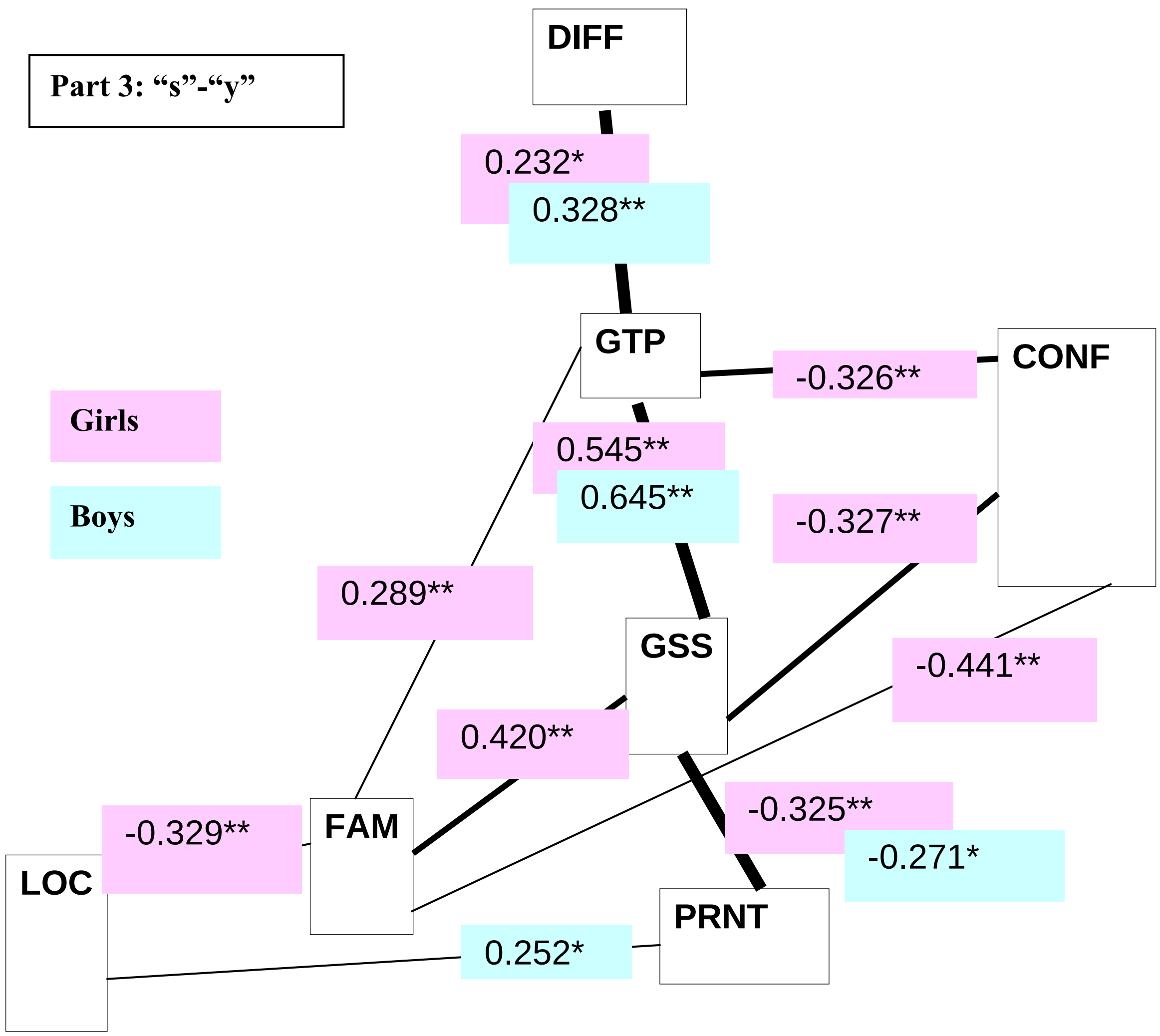
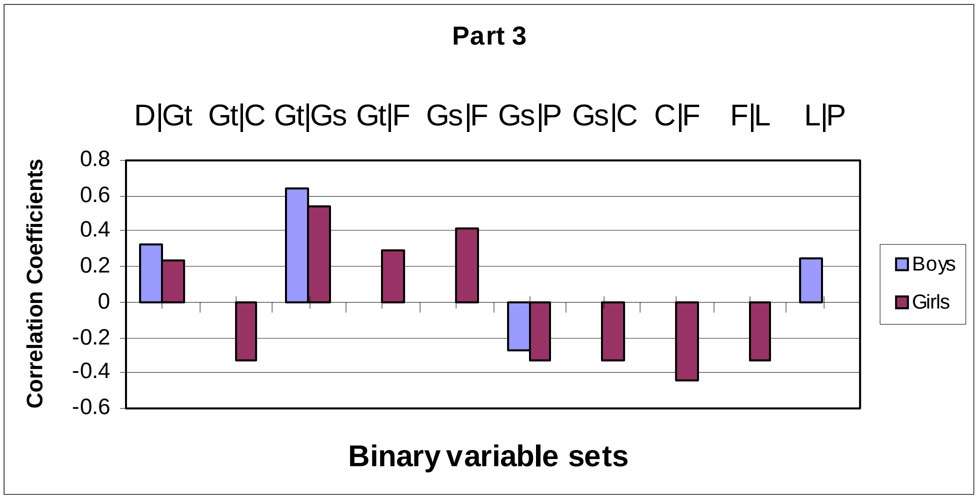


Figure 12. Statistically significant correlations found for research questions "s" thru "y" for boys and girls



Binary Variables	
DIFF|GTP	D|Gt
GTP|CONF	Gt|C
GTP|GSS	Gt|Gs
GTP|FAM	Gt|F
GSS|FAM	Gs|F
GSS|PRNT	Gs|P
GSS|CONF	Gs|C
CONF|FAM	C|F
FAM|LOC	F|L
LOC|PRNT	L|P

Figure 13. Variable correlations for Part 3

Girls: Part 3

Note that this part, just as the previous one, shows how girls' high self-confidence in math and science correlates with their ability to work with technology and higher likelihood of thinking that people in technology do have a family life. Note also that all of these variables factor in the case of girls' opinions. So for example, in the case of girls, the following relations hold:

<u>GTP correlations:</u>

High GTP – correlates with – low CONF

High GTP – correlates with – high GSS

High GTP – correlates with – high FAM

<u>FAM correlation:</u>

High FAM – correlates with – low CONF

<u>GSS correlations:</u>

High GSS – correlates with – low CONF

High GSS – correlates with – high FAM

High GSS – correlates with – low PRNT

Boys: Part 3

There are no results in this cluster that exclusively pertain to boys. Two results, however, apply to both boys and girls:

High GTP – correlates with – high GSS

High GSS – correlates with – low PRNT

The second of the two is notable as it underscores how the reporting that boys are better at technology is inversely related to the importance of their parents' opinions in the case of boys as well.

Discussion

Taken together, the results show two different sets of variables at work. The outputs from Parts 2 and 3 are largely negative for girls, while those from Part 1 are all positive for both genders. The variables in Part 1 are SMET, CONF, LOC, WORK, and TECH and tend to correlate with each other; high score on CONF correlates with high scores on LOC, TECH, and WORK. This is the most gender-neutral set of the results. It also gives some very valuable pointers on how to approach technology education. The strongest correlation was observed between SMET (intend to choose technology majors) and WORK (considering technology work as fun) for both genders. This is definitely a point of intervention in technology education. CONF is the other significant point that correlates to WORK. In the case of both genders, the greater their self-confidence in math and science, the more likely students are to consider technology work as *fun*, and the more they are likely to consider technology work as *fun*, the more likely they are to choose technology majors. The locus of control or their sense of self-esteem (LOC) positively correlated to CONF for both genders. So the greater their perception of control over their life's outcomes, the greater their self-confidence in math and science is likely to be.

The last piece of Part 1 is TECH, or their confidence in their ability to perform specific technology tasks. The higher their score on TECH, the higher their LOC scores were likely to be, in the case of both genders. This is interesting when taken apart:

TECH ←→ LOC ←→ CONF ←→ WORK ←→ SMET

This trend appears for both boys and girls. More specific relationships emerge when examining boys and girls separately. In the case of girls as a group, a positive correlation was observed between TECH and WORK. In other words, the higher their confidence in their ability to perform specific technology tasks, the more likely they were to think of technology work as *fun*. They were also more likely to have the intent to choose a technology major if they had higher confidence in their ability to perform specific technology tasks. So considering girls as a group, the following relationships were observed:

TECH ←→ SMET

TECH ←→ WORK ←→ SMET

TECH ←→ LOC ←→ WORK ←→ SMET

TECH ←→ LOC ←→ CONF ←→ WORK ←→ SMET

In the case of boys as a group, the observed correlations were slightly different. A positive correlation was found between TECH and CONF. So the boys who expressed higher confidence in their ability to perform specific technology tasks were likely to have higher self-confidence in math and science and were also more likely to intend to choose a technology major.

TECH ←→ CONF ←→ SMET

It is interesting to note that there was no correlation observed between CONF and SMET in the case of girls. In other words, higher self-confidence in math and science did not correlate with a greater intent to choose a technology major for girls. However, a greater degree of confidence in their ability to perform specific technology tasks (such as "I am confident I can put together a new bike by following the assembly instructions"; or "I am confident that I can 'rip' a CD and turn music into mp3 files") *did* coexist with a greater intent to choose a technology major in college.

When comparing the two genders, boys had higher mean values for the variables CONF, SMET, TECH, SMET, and WORK. As a group they displayed higher confidence in doing technology tasks, showed more knowledge of technology, were more likely to consider technology work as fun, and were more likely to consider technology majors for college than girls. However, the boys also scored a higher mean on the variable GTP, indicating that they were more likely to think that technology was more suitable for boys than girls. This relates to the analysis of the next two parts.

The findings for both Parts 2 and 3 are quite different from the results of Part 1. In the latter two parts, the inclusion of the variables GTP, GSS, FAM, and PRNT introduces a new set of conditions. “Self-confidence in math and science” is seen moderated by broader factors that include messages from and opinions about family, school, and parents. These variables are affecting girls and boys very differently.

In Part 2 every correlation is negative. Note the correlations with GSS and GTP variables in the case of girls as a group: Each of these (GSS and GTP) is negatively correlated to LOC and WORK in the case of girls. The variable FAM is also negatively correlated to WORK for girls:

LOC correlations:

Low LOC – correlates with – high GSS

Low LOC – correlates with – high GTP

WORK correlations:

Low WORK – correlates with – high GSS

Low WORK – correlates with – high GTP

Low WORK – correlates with – high FAM

In Part 3, note how once again most correlations are in the negative direction. In the case of girls, their self-confidence in math and science (CONF) is negatively correlated to both GSS and GTP. Their confidence is also negatively correlated to FAM or the opinion that people in technology have no family life. No such correlation is found in the case of boys. Higher score on GTP is also likely to coexist with higher score on FAM in the case of girls. Those girls who report that people in technology do have a family life, are also less likely to report the perception that boys are better at technology than girls.

<u>CONF correlations:</u>

High CONF – correlates with – low GSS

High CONF – correlates with – low GTP

High CONF – correlates with – low FAM

An interesting result in this part is the negative correlation observed between the variables GSS and PRNT for both boys and girls. Thus those boys and girls, who reported receiving more messages from their schools about technology being more suitable for boys, were also less likely to think that their parents' opinions were important to them. This is interesting as at one level it sets up a contrast between the messages they receive from their parents and the messages they receive from their schools. Further research needs to be carried out.

Another interesting correlation was observed in this part in the case of girls only between the variables FAM and LOC. Those girls who were of the opinion that people in technology had a family life were also likely to have high LOC or self-esteem scores. No correlation was found in the case of boys. There was instead a positive correlation between the variables PRNT and LOC for boys. Thus the boys who considered their parents' opinions as important to them were likely to have a high score on LOC or self-esteem. However, caution needs to be underscored, as no causal effect between boys' parents' opinions about their future and boys' sense of self-esteem is being suggested. Nonetheless, this is an interesting finding and needs to be investigated further.

<u>LOC correlations:</u>

Low LOC – correlates with – high FAM (for girls only)

High LOC – correlates with – high PRNT (for boys only)

In the final analysis the results of the bivariate correlational analysis indicated some very interesting findings for both boys and girls. Considering technology work as *fun*, having a strong locus of control, and being confident in their ability to perform technology tasks all emerged as positively correlated to their intent to choose a technology major in college. It was also found that a high LOC score is likely to coexist with a high likelihood of attending college, but a high LOC does not correlate with the intent to choose a technology major. On the other hand, those who reported receiving negative messages or had a negative perception about girls and their ability to work with technology tended to score low on their intent to choose technology majors in college.

Parents appeared to have a stronger positive influence in boys' decisions to select technology majors than girls. Both boys and girls indicated that their schools were giving somewhat gender-biased messages in providing more support to boys for technology majors, but this is much less than has been reported in the last decade (AAUW, 1992; Sadker & Sadker, 1994).

A rigorous survey analysis has resulted in empirical findings that point to possible high school activities to alleviate the problem of low enrollment of girls in technology majors. These are discussed in Chapter 6.

The next set of research questions addressed mean comparisons for boys and girls for each of the variable constructs. The results of the t-tests are given in Table 4 and Table 5. The interpretation of results follows for each research question posed previously.

a. Is there a difference between girls' and boys' level of confidence in performing specific technology tasks? (TECH)

The relevant t-statistic (from Table 5) is 4.468 with p=.000, which is highly significant. It can therefore be concluded that there is indeed a statistically significant difference between girls' and boys' level of confidence in performing specific technology tasks. Boys' mean score was higher than girls' mean score for this variable.

b. Is there a difference between girls' and boys' opinions about considering technology work as "fun"? (WORK)

The relevant t-statistic is 2.897 with p=.004, which is highly significant. It can therefore be concluded that there is indeed a statistically significant difference between girls' and boys' opinions about considering technology work as *fun*. Boys' mean score was higher than girls' mean score for this variable.

c. Is there a difference between girls' and boys' level of confidence in math and science at school? (CONF)

The relevant t-statistic is 0.336 with p=0.738, which is not significant. It can therefore be concluded that there is no statistically significant difference between girls' and boys' level of confidence in math and science at school.

d. Is there a difference between girls' and boys' opinion about technology work being more suitable for boys? (GTP)

The relevant t-statistic is 4.162 with p=0.000, which is highly significant. It can therefore be concluded that there is indeed a statistically significant difference between girls' and boys' opinion about technology work being more suitable for boys. Boys' mean score was higher than girls' mean score for this variable.

e. Is there a difference between girls' and boys' intent to major in technology in college? (SMET)

The relevant t-statistic is 3.677 with p=0.000, which is highly significant. It can therefore be concluded that there is indeed a statistically significant difference between girls' and boys' intent to choose a technology college major. Boys' mean score was higher than girls' mean score for this variable.

f. Is there a difference between girls' and boys' regarding their parents' opinions about their future being important to them? (PRNT)

The relevant t-statistic is -2.072 with p=0.040, which is significant. It can therefore be concluded that there is indeed a statistically significant difference between girls and boys regarding their parents' opinion about their future being important to them. Girls' mean score was higher than boys' mean score for this variable.

g. Is there a difference between girls' and boys' sense of self-esteem? (LOC)

The relevant t-statistic is 0.414 with p=0.679, which is not significant. It can therefore be concluded that there is no statistically significant difference between girls' and boys' sense of self-esteem.

Table 4
Mean statistics for boys and girls

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
CONF	male	72	13.50	2.742	.323
	female	80	13.35	2.761	.309
SMET	male	72	5.96	2.492	.294
	female	80	4.58	2.145	.240
LOC	male	72	23.82	3.441	.406
	female	80	23.59	3.456	.386
GTP	male	72	19.14	5.562	.656
	female	80	15.36	5.606	.627
WORK	male	72	7.14	2.016	.238
	female	80	6.26	1.674	.187
TECH	male	72	21.25	2.915	.344
	female	80	18.90	3.503	.392
Parent	male	72	3.60	1.329	.157
	female	80	4.01	1.119	.125

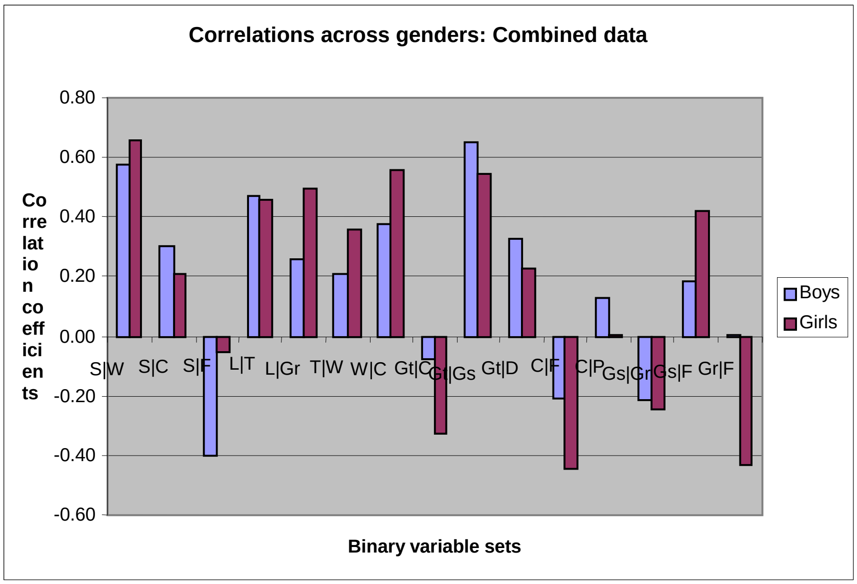
Table 5

Comparison of Means between boys and girls for variables CONF, SMET, LOC, GTP, WORK, TECH, PRNT

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CONF	Equal variances assumed	.161	.689	.336	150	.738	.150	.447	-.733	1.033
	Equal variances not assumed			.336	148.532	.738	.150	.447	-.733	1.033
SMET	Equal variances assumed	2.175	.142	3.677	150	.000	1.383	.376	.640	2.127
	Equal variances not assumed			3.648	140.946	.000	1.383	.379	.634	2.133
LOC	Equal variances assumed	1.945	.165	.414	150	.679	.232	.560	-.875	1.339
	Equal variances not assumed			.414	148.460	.679	.232	.560	-.875	1.339
GTP	Equal variances assumed	.012	.912	4.162	150	.000	3.776	.907	1.984	5.569
	Equal variances not assumed			4.164	148.563	.000	3.776	.907	1.984	5.569
WORK	Equal variances assumed	4.536	.035	2.926	150	.004	.876	.300	.284	1.468
	Equal variances not assumed			2.897	138.530	.004	.876	.302	.278	1.474
TECH	Equal variances assumed	1.576	.211	4.468	150	.000	2.350	.526	1.311	3.389
	Equal variances not assumed			4.511	149.120	.000	2.350	.521	1.321	3.379
Parent	Equal variances assumed	4.685	.032	-2.091	150	.038	-.415	.199	-.808	-.023
	Equal variances not assumed			-2.072	139.521	.040	-.415	.200	-.812	-.019

The overall correlation numbers for the combined data follow. Some broad trends can be seen below. A correlation matrix (Table 3) was drawn for the entire sample of 152 students. The results as divided by gender can be seen in Table 5.



Binary Variables	
S|W	SMET|WORK
S|C	SMET|CONF
S|F	SMET|FAM
L|T	LOC|TECH
L|Gr	LOC|GRAD
T|W	TECH|WORK
W|C	WORK|CONF
Gt|C	GTP|CONF

Binary Variables	
Gt|Gs	GTP|GSS
Gt|D	GTP|DIFF
C|F	CONF|FAM
C|P	CONF|PRNT
Gs|Gr	GSS|GRAD
Gs|F	GSS|FAM
Gr|F	GRAD|FAM

Figure 14. Correlation coefficients across genders for the entire sample (N=152)

Table 6

Correlation results between variables by gender for the entire sample

Variable 1	**Variable 2**	**Boys N=72**	**Girls N=80**	**Total N=152**	**Variable definitions**	
SMET	WORK	0.579**	0.655**	0.637**		
SMET	CONF	0.306**	0.209	0.255**	SMET	Intent to choose a technology major in college
SMET	FAM	-0.395**	-0.048	-0.191*	WORK	Opinion that working in technology is fun
LOC	TECH	0.472**	0.456**	0.444**	CONF	Self-confidence in math and science
LOC	GRAD	0.256*	0.492**	0.381**	FAM	Opinion that people in technology have practically no family life
TECH	WORK	0.210	0.361**	0.339**	LOC	Perception of control over one's life's outcomes
WORK	CONF	0.377**	0.555**	0.454**	TECH	Confident of performing specific technology tasks
GTP	CONF	-0.078	-0.326**	-0.190*	GRAD	Confident of graduating from high school and entering college
GTP	GSS	0.645**	0.545**	0.601**	GTP	Perception that boys are better at technology than girls
GTP	DIFF	0.328**	0.232*	0.194*	GSS	Messages they received from school that technology as an area is more suitable for boys.
CONF	FAM	-0.208	-0.441**	-0.319**	DIFF	Gender differences (not better or worse) in opinions about technology
CONF	PRNT	0.129	0.007	0.064	PRNT	Opinion that: my parents' opinion about my future is important to me.
GSS	GRAD	-.0215	-0.245*	-0.232**		
GSS	FAM	0.185	0.420**	0.306**	*** $\rho \le 0.05$ ** $\rho \le 0.01$**	
GRAD	FAM	0.005	-0.428**	-0.219**		

Qualitative Data Analysis

The next set of research questions was addressed through qualitative data analysis. Five questions were framed to find out respondents' opinions about technology, and each addressed a different facet of technology perception. The questions addressed such opinions as technology has no place for imagination, technology isolates you from friends, and technology is mainly about computers. Since these were individual themes about their opinions on technology, no composite variables were formed. The results were cross-tabulated across genders, for each item individually. In each case, the respondents were asked to give their opinions on a Likert scale that ranged from "strongly agree" to "strongly disagree". A brief tabulation of these results follows.

Surprisingly uniform results were obtained for the following two sets of opinions across both genders:

"Technology has no place for imagination."

Table 7
Frequency count by gender for the variable 'noImagination' (Technology has no place for imagination)

Gender * noImagination Crosstabulation

Count

		noImagination					Total
		strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree	
Gender	male	38	20	8	3	3	72
	female	36	28	10	2	4	80
Total		74	48	18	5	7	152

“Technology has improved most people’s lives.”

Table 8
Frequency count by gender for the variable ‘impLives’ (Technology has improved most people’s lives)

Gender * impLives Crosstabulation

Count

		impLives				
		strongly disagree	neutral	somewhat agree	strongly agree	Total
Gender	male	1	4	24	43	72
	female	2	6	28	44	80
Total		3	10	52	87	152

In each case there was no significant difference in the way boys and girls responded. Both groups tended to disagree or strongly disagree that technology has no place for imagination. Both groups also agreed or strongly agreed that technology has improved most people’s lives. They appear to have a positive opinion of technology.

The next question asked them about perceiving technology as an isolating influence. It also yielded quite similar responses. Boys and girls were fairly evenly divided in their opinions. Girls tended to disagree a bit more, but not significantly so. “Technology isolates you from spending time with friends, as in seeing them in person.”

Table 9
Frequency count by gender for the variable ‘isolatePeople’ (Technology isolates you from spending time with friends, as in seeing them in person)

Gender * isolatePeople Crosstabulation

Count

		isolatePeople					
		strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree	Total
Gender	male	18	17	19	14	4	72
	female	15	26	21	14	4	80
Total		33	43	40	28	8	152

"Technology has done more bad for the environment, than good."

Table 10.
Frequency count by gender for the variable 'moreBad' (Technology has done more bad for the environment than good)

Gender * moreBad Crosstabulation

Count

		moreBad					Total
		strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree	
Gender	male	20	22	17	10	3	72
	female	10	26	25	16	3	80
Total		30	48	42	26	6	152

Girls as a group gave the opinion "strongly disagree" less than boys and "agree" more than boys.

"Technology is mainly concerned with computers."

Table 11.
Frequency count by gender for the variable 'techComputers' (Technology is mainly concerned with computers)

Gender * techComputers Crosstabulation

		techComputers					Total
		strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree	strongly disagree
Gender	male	4	12	14	27	15	72
	female	1	14	18	38	9	80
Total		5	26	32	65	24	152

This was interesting in that even though the general trend remained similar, both boys and girls tended to be neutral or somewhat agreed with the statement.

The final research question was addressed using an open-ended item in the questionnaire. The respondents were asked to note the "first three things that came to mind when you think about technology." These data were analyzed qualitatively. Several themes emerged out of the students' responses. The data were also explored for the gender distribution. For this purpose, the raw open-ended inputs from the respondents were converted into a set of themes. The following table indicates the raw inputs, the assigned theme for those inputs, and the frequency of the occurrence of this theme by gender. Figure 15 summarizes these results in the form of a histogram.

Table 12.
Raw open-ended inputs converted to themes: Occurrence by gender

Raw inputs from questionnaire	**Occurrence 152**	**Boys 72**	**Girls 80**	**Theme**
Computers, computer work, monitor	124	59	65	**Computers**
New, up-to-date, modern, lots of $, FUN! Smart, intelligent, future, sophistication, improvement, easier way of life, futuristic things, new ways of testing things, innovations, inventions, different, advanced, research, challenging, following plan/guidelines	36	16	20	**Positive perceptions**
Cellphones, phones, telephone, connecting to people/things in other places	32	12	20	**Phones**
ipods, mp3 players, music	29	6	23	**Digital music**
Cars, vehicles, planes, car air bags, automobiles, wheel speed censors	26	16	10	**Vehicles**
Engineers, engineering, C++, programming, HTML, software, file storage, compression	25	24	1	**Engineering**
Internet, myspace, internet access	15	7	8	**Internet**
TV, dvd, music system, speakers, tivo, camera, radio	15	6	9	**Entertainment**
Science, scientists	13	6	7	**Science**
Hard, boring, environment unfriendly, sitting in an office all day, no human/animal interaction, confusing, hard work, nerds, confusion, things that I don't know about	13	2	11	**Negative perceptions**
Math, numbers	12	3	9	**Math**

Video games, Playstation, games, toys, World of Warcraft	12	10	2	**Videogame**
Electronics	11	5	6	**Electronics**
Electricity, electrical, wires, batteries, lights, power, light bulbs	11	5	6	**Power**
Machines, factories, machinery, putting machines together, tools	9	5	4	**Machines**
Robots	8	5	3	**Robots**
Weapons, destruction	2	2	0	**Weapons**
Microsoft, Apple	2	2	0	**Companies**
Helping people	1	0	1	**Helping people**
Medical service, medicines, medical stuff in surgery, AIDS research, healthcare, hospital equipment, energy alternatives, energy manipulation and generation, space propulsion, outer space, new physics, nanotechnology, satellites, graphic design, design, animation, AutoCAD, construction, communication, transportation, industrial, manufacturing, lasers, DNA processing, export/import, globalization, future planning, automotive design, heating/cooling, the wheel, the pencil	37	25	12	**Specialty**

Overall, students' first thoughts about technology brought about opinions of what could arguably be considered positive technologies.

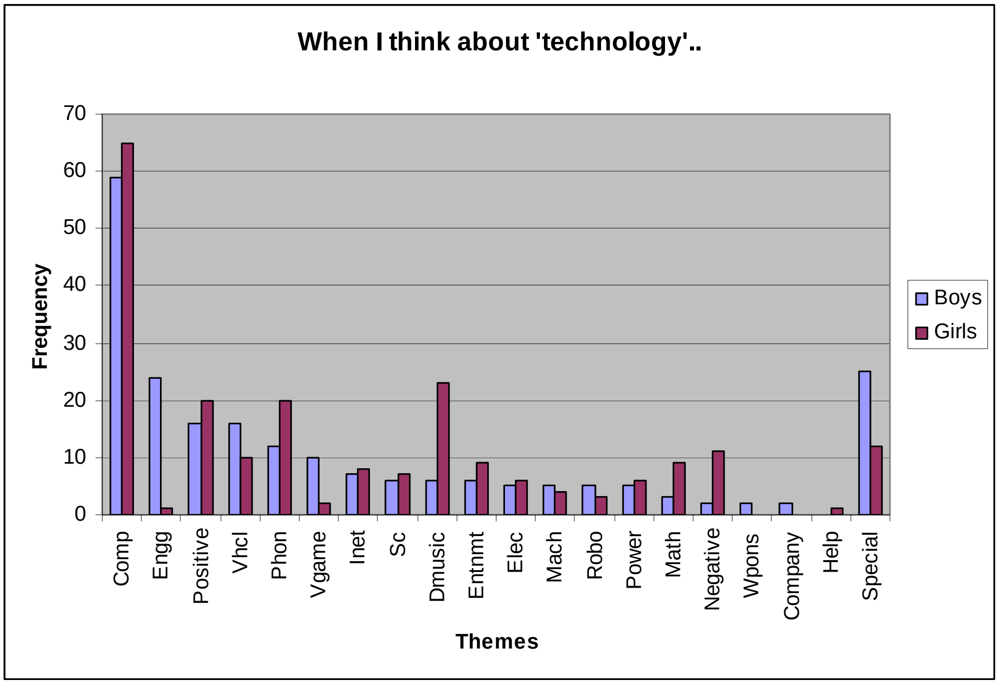


Figure 15. Distribution of technology themes by gender

Note that the tallest spike for both genders is the theme “computers.” Most boys and girls agreed that when they thought about *technology* one of the things that came to mind was “computers.” But there are some interesting gender differences. For example, technology as “engineering” was mainly reported by boys. On the other hand, technology as phones/music/entertainment was the choice of more girls than boys. Predictably many more boys than girls chose “videogames.” An interesting comment can be made on the “specialty” theme. This included different types of technology such as new physics, graphic design, nanotechnology, lasers, and medical research, to name a few. This theme was chosen by twice as many boys as girls. An underlying message might be the lack of information and/or awareness regarding technological advances among girls. Although positive perceptions about technology (new, up-to-date, modern, lots of money, fun, smart, intelligent, future, sophistication, improvement, easier way of life, futuristic things, new ways of testing things, innovations) were expressed almost equally by both girls and boys, a substantially larger number of girls than boys (but overall low numbers) had negative perceptions (hard, boring, environment unfriendly, sitting in an office all day, no human/animal interaction, confusing, hard work, nerds, confusion, things that I don't know about) about technology. In terms of perceptions, this is a telling result.

Noteworthy results

This section highlights the most salient points of the results described previously. These are key findings that are arguably quite significant. This research addressed perceptions, as opposed to categorical factual inputs. These perceptions and opinions were converted into empirical pieces of data through an elaborate process of survey research design. A total of 34 statistically significant correlations were obtained among the various variables investigated. A very large number of these (29) were found to be statistically significant at the confidence level of alpha < 0.01. The results can be essentially summarized into two points.

It was empirically found that certain perceptions and attitudes regarding technology tended to relate positively to girls' and boys' intent to select a technology college major. These included the students' considering technology work as *fun*, their self-confidence in math and science, and their confidence in their ability to perform technology tasks. Their sense of self-esteem did not correlate with their intent to select a technology college major; however, it correlated positively to all other technology variables for one or both genders.

The research also found that certain perceptions and attitudes regarding technology tended to correlate negatively to girls' intent to select a technology college major. Messages from school that technology was more suitable for boys were empirically found to correlate with low self-esteem, low confidence in math and science, and low confidence in their ability to perform technology tasks, in the case of girls. Messages from school that technology was more suitable for boys also correlated positively with students' own opinions about technology being more suitable for boys. This result demonstrates how any subtle messages that students perceive coming from their teachers or counselors at school tend to reinforce a gender bias of their own.

Comparative Analysis of Results

The results obtained as a result of this study can be viewed in the context of other findings from similar work. One of the most important comparisons that needs to be made is between these results and the PATT study (PATT, 1986) outlined in Chapter 2. This comparison is relevant because the focus of the two studies is strikingly similar, with each looking at *technology* and *gender*. Since neither PATT nor this study attempted to define technology for the respondents, the respondents used their own judgment and opinions, in answering these questions. Both studies investigated students' opinions about technology, and both studies examined differences by gender. The two studies resulted in differing conclusions. For example, according to the PATT study, in general students were *not* aware of the role of creativity and design in technology. In this study a majority of respondents (58 boys and 64 girls) strongly or somewhat *disagreed* with the statement that "technology had no place for imagination." In other words, both boys and girls today are generally aware of the role of imagination and creativity in technology.

The current study used TECH variable to look at students' confidence in performing various technology tasks. A high mean score for this variable was found for both boys and girls (21.25 for boys and 18.90 for girls out of a possible maximum score of 25). Girls had a marginally lower mean score than boys, but within statistical limits. In some ways, though, the results are similar to PATT. For example, the PATT study found that more boys than girls were aware of the diversity of technology. The current study found similar results in its qualitative analysis, which was based on the result of the open-ended question: "Name the first three things that come to mind when you think of 'technology.'". The students' responses were qualitatively analyzed for various themes and categories. It was found that boys had a lot more diversity in their responses than girls. Moreover, there was still a very slight gender bias found where boys, more than girls, thought that technology career choice is suitable for boys. This was similar to the PATT finding where "pupils (girls more than boys) think that girls are apt for technology" (PATT, 1986, 29). PATT had also found that it was hard for pupils to give a description of what technology is. This was echoed in the way students in this study tended to think of technology as mainly computers and digital technology.

The more recent work on gender gap in technology is interesting for numerous reasons. The word *technology*, though, has not been used very often in previous research, as has been discussed in the literature review section. However, while using a variety of measures for gender gap in science, math, and engineering, current research finds very similar themes. For example, Crombie et al. (2005) reported that there was a direct path from "competency beliefs" to "enrollment intentions" for girls. For boys it was not competency beliefs but rather prior grades that led to enrollment intentions. This echoes the findings of this research. Locus of control or the LOC was the construct used in this work, which points to and is related to competency beliefs. The locus of control scores for girls were found to be positively correlated with key technology variables: TECH (confidence in their ability to perform specific technology tasks), WORK (opinion that technology work is fun) and CONF (self-confidence in math and science). Research on gender and motivation (Eccles & Wigfield, 2002) also points to the issue of confidence and locus of control. According to Eccles & Wigfield, there are gender differences in locus of control, where girls tended to have higher scores for both positive and negative achievement events that, in turn, result in girls accepting more blame for negative events than boys. As discussed previously, this greater tendency for girls to take personal responsibility for their failure, combined with their more frequent attribution of failure to lack of ability, shows greater learned helplessness in females.

The other aspect of gender research links to the notion of valuation. Research has found that children's and adolescents' value of different activities relates strongly to their choice of whether or not to continue to pursue that activity (Eccles et al., 1983; Eccles & Wigfield, 2002). Thus the extent to which boys and girls value technology affects their decision to select or reject a technology major in college.

Without question a lot of work has been done to include girls in science and technology. In fact, much of recent gender research laments that there is a crisis with boys' education (Sax, 2007). But by the time boys become men, they are still more successful than women. For example, ninety percent of the world's billionaires are men. Men continue to dominate the highest paying jobs in such leading edge industries such as engineering, investment banking, and high tech. The pay gap is still 78 cents to the dollar, and the proverbial glass ceiling continues to exist for most women (Gibbons, 2006). This differential climate of achievement for boys and girls has formed the grounds for this research.

The following chapter concludes this discussion, but not the debate, by underscoring the results, as well as highlighting some interesting findings that point to the need for further research.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

The reasons for gender disparities in education and workplace have been the subject of long standing debate. In particular, the education of boys versus girls has been scrutinized by many researchers. Compared to findings fifteen years ago (Sadker & Sadker, 1994), this study highlights some of the changes in gender disparities that have become the norm. Both girls and boys exhibit a reasonable understanding of technology work and its rewarding nature. In the past, girls had been thought to dismiss technology based careers because these careers did not "help people", did not require "creativity and imagination" or "social interaction" (Farmer, Wardrop, & Rotella, 1999; Sherman, 1983). The lack of these attributes was attached to a negative career image. However, this survey supports the findings that girls no longer harbor these misconceptions about technology work and technology education, although it appears that parents still encourage their sons more often than their daughters to consider technology careers.

A significant point of this study is the importance of self-confidence and a sense of having control over one's life's outcomes (LOC). Girls do display a positive level of confidence related to knowledge of technology, but it is slightly lower than that of boys. There is a correlation between self-confidence and the importance of parental opinion regarding technology ability for boys but not girls. On average students no longer lack knowledge regarding technology and technology careers. So lack of information by itself is not the barrier to the pursuit of technology careers. However, confidence in one's ability and the accumulation of even small signals of gender discrimination appear to affect the confidence level of girls more than boys. As discussed previously, this research found that the more girls thought that boys are better at technology than girls, as measured by GTP, the lower was their confidence as measured by CONF, at $\alpha<0.05$ level. This leads to the issue of recruitment and retention of students, particularly girls, into technology majors.

Several results warrant further research. These are outlined here to underscore the need for future in-depth analysis. It was found, for example, in the case of both boys and girls, that those who considered people in technology as having family life were also more likely to think of technology work as fun (WORK). Moreover, those girls who were of the opinion that people in technology had no family life were less likely to report confidence working with technology (CONF). However, no correlation was found in the case of boys. This result seems to point to the idea of “family life” being important to girls and not considered by boys. No empirical assertions are being made at this point, though this does point to the need for further research.

Another interesting result was the negative correlation observed between messages from school about technology being more suitable for boys (GSS) and the opinion that their parents’ opinion about their future was important to them (PRNT) for both boys and girls. Thus in the case of both boys and girls, those who reported receiving messages from their school that technology was more suitable for boys were also less likely to think that their parents’ opinions were important to them. This is interesting as, at one level, it sets up a contrast between the messages they reported receiving from their parents and those from their schools. It would be instructive to look more pointedly at the varying messages that students are receiving from their parents and from their schools, and whether the two conflict with each other. Similar to the previous example, though, this too needs more empirical data for further analysis.

A very interesting result was obtained in the correlation of the variables PRNT and LOC. Only boys who considered their parents' opinions about their future as being important to them were likely to score high on LOC or self-esteem scores. No correlation, either negative or positive, was obtained in the case of girls. In other words, those boys who said they valued their parents' opinion about their future also tended to have high self-esteem. Valuing parents' opinion in the case of girls did not coexist with high LOC scores. Although correlation by definition does not imply causation, the fact that these two variables correlated strongly only in the case of boys is an interesting finding. This may or may not point to a tendency for parents to treat their sons differently from their daughters, and needs further investigation.

From a social-constructivist viewpoint, it is interesting to note that girls' sense of self-esteem as measured by LOC strongly correlated with girls' choice to attend college, but not so with the boys. Also math/science classes did not appear to encourage girls to study technology fields. More boys than girls were found to be encouraged to pursue technology fields by their teachers. This is an indication of the larger social framework in which schools and teachers construct their narratives of gender disparity. Since our schools are very influential in building interest, nurturing confidence, and developing expectations, there is need for technology teachers and the technology curriculum to be more inclusive of girls.

This study supports the need not only for greater clarity in communicating technology and technology choices to the students but also illustrates that there is a significant issue of girls' confidence that must be addressed. There are subtle and probably unintentional messages that teachers and parents seem to be conveying to this highly impressionable age group that affect girls' and boys' decisions about intended college majors. The choice that students make, girls or boys, must be based upon a realistic assessment of their abilities and interests and not influenced by adult-biased messages that could undermine their self-confidence.

This study highlights the need for a greater understanding of technology perceptions and the way these relate to students' self-confidence, their knowledge about technology, and the messages, both direct and subconscious, that they receive at school about technology. As a matter of fact, the results of this study provide some thought-provoking pointers for recruitment to technology majors.

High school serves as a threshold to college and adult life, where students make life choices based primarily on their perceptions, however inaccurate or biased. Therefore, it is very important for educators to ensure that there is zero gender bias in the way *technology* is being communicated to students if we want more students to consider technology careers. If colleges of technology would like to recruit more students, both boys and girls, then they should pay more attention to finding ways to build technology self-confidence in the high school years. This could be achieved with campus visits with fun hands-on activities that allow students to engage in projects where they leave with a feeling of success and self-accomplishment. Teachers can also work on boosting the students' self-confidence by presenting technology as a *fun* activity rather than a difficult one. They can also work on providing information about the available job options for a technology major, so that the students are not left with the stereotypical image of a computer *nerd*. According to this research, students report subtle and small gender biases still present in their teachers and counselors at school. One possible alternative to counter this could be to experiment with a few single-sex class sessions. This process could allow teachers to work on the confidence issue with girls and help to draw them out more in conversation. They could talk more freely about their opinions and perceptions about technology and what they do and don't like about it. However, a full investigation of the various ways to instill and nurture self-confidence in technology is a subject for future work.

The results of this research must be seen in context of certain limitations. These were mostly attributable to the limited scope of the study, necessitated by time, and financial and logistical constraints of a student project. The study was based on a relatively small sample size. Although all efforts were made to remove self-selection, the sample was still non-random. The study is limited in its results and can only be generalized to the specific populations surveyed. Thus there is little external validity for such work. An additional limitation was the use of newly developed survey instrument, although this was duly validated in a series of pilot studies and tested for reliability against a well-established scale.

Future research in this area can specifically target the questions raised previously. Random samples with a large sample size can be used to validate the results obtained in this work. Moreover, there are a few significant points of extension for this work: Technology perceptions can be tested at different times along the education trajectory, such as junior high or in freshman year of college; this will provide interesting complementary results for the same survey. Another way to approach this study would be to test for other influences, such as to focus the instrument on family or the media, to find out how these affect students' technology perceptions and influence their college major choices. Each of the above suggests a cross-sectional study; however, a longitudinal study of a cohort over a longer period is another possibility for future work. A longitudinal study has the potential to track changes of perceptions, attitudes, and opinions over time. It would be, for example, extremely instructive to pick a cohort in junior high and track them all the way to college. Undoubtedly such a study will have many more external factors to study, most or all of which cannot be controlled, yet it is likely to yield some significant findings about the way boys' and girls' opinions and perceptions about technology are formed and altered over time and how these are related to their ultimate choice of college major. It is important to note that this entire line of questioning does not take into account the choice of technology jobs or technology career. This research has primarily addressed education and does not extend to the arena of jobs and careers. This can therefore easily be extended to look at the gender differences in career choices, given the same academic background. Another direction for future work is looking at the way LOC or self-esteem measures are affected by external influences. For example, a study could investigate how media in its various forms is affecting LOC and look at gender differences.

Future work can also extend this research to more variables so that a wider variety of correlations could be examined. For example, emotional intelligence (EQ) is a related construct to LOC. EQ is defined as the ability to perceive and manage emotions, both personal and those of other people, and includes such concepts as empathy, self-awareness, and managing relationships (Goleman, 1995). Examining how high EQ scores correlate with confidence in technology and intent to major in technology could form an instructive addition to this work. Some preliminary questions to measure EQ are included in Appendix I.

The subject of technology can be further explored by adding more questions to the survey instrument. The issue of women in science and technology has been, for example, also investigated from the point of view of women learning and performing science differently than men (Xie & Shauman, 2003). That is a different perspective than examining external influences. Some questions have been included in Appendix I as examples of this approach. Thus it is evident that this research can be fruitfully extended in numerous different directions.

This research has highlighted the significance of teachers and their influence on their students' perceptions of technology. One of the reasons why students do not pick technology careers is that they are not given enough information about technology career options to be able to do so. They work with computers everyday, and the surveys conducted during this research pointed to an overwhelming response that students consider technology to be synonymous with computers and all things digital. However, such items as contact lenses, textiles, or bullet-proof vests were less well identified with *technology*. The students therefore were found to have a limited understanding of technology, partially based on information they received at school. They did not learn how everyday things are manufactured and the role of technology in almost every part of their daily life. Thus the results point to the need for teachers to talk about technology in their classrooms in a more inclusive and real-world manner.

The work undertaken in this dissertation has been publicly disseminated at a number of stages in the process. The results from the pilot studies 1 and 2 were presented at the Annual ITEA conference in Baltimore (Bhatnagar & Brake, 2006). Results from pilot study 3 were presented at the Research on Women in Education (RWE) convention sponsored by Wayne University in Detroit in October 2006. The paper compiled from some of this research was accepted for publication in "Advancing Women in Leadership", the summer 2007 issue of the Special RWE journal (Bhatnagar et al., 2007). The analysis of results from School B was presented at the Annual NAIT convention held in Panama Beach, Florida, in

October 2007. This was also presented at and accepted for publication in the proceedings of the American Society of Engineering Education (ASEE) conference, June 22-25, 2008, in Pittsburgh, PA (Brake & Bhatnagar, 2008). Each of these venues contributed substantial feedback to the research, which was duly incorporated in the final work.

In conclusion, it is important to underscore that even when we are near the close of the first decade of the 21st century, the issue of gender inequity in technology remains yet to be resolved. According to a Business Week article, "Ninety percent of the world's billionaires are men…(and) men continue to dominate the highest paying jobs in leading edge industries" (Businessweek.com, 2003). Women still face considerable obstacles in the form of pay gap and the ever-present struggle to juggle family and work. The proverbial glass ceiling is still very much in place.

Ultimately the best way to achieve equity or at least provide a level playing field is through education. Choice of technology majors in college forms an important component of this larger narrative. The results of this work point to high school and the educational system as a significant influence on technology perceptions of boys and girls, as well as their intent to choose or reject a technology major in college. There are often subliminal ways in which the idea of *technology* is perceived by the young people. Perceptions have the power to shape future goals and aspirations, and, more importantly, negative perceptions can limit these options and even prevent students from considering technology majors. If our schools and the education system are in any way reinforcing a negative perception of technology among their students, then remedial measures become necessary. It is especially important to explore these trends in the light of the gender gap that exists to this day in the engineering and technology professions.

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APPENDICES

Appendix A - Final Survey: Schools B and C

EMU - Technology Perceptions Survey

For the purpose of this survey technology means science, math, engineering and technology.

Gender	Ethnicity (Check a maximum of two)
[] Female	[] Caucasian
[] Male	[] African American
	[] Latino/Hispanic
	[] Asian
	[] Native American

Please CIRCLE the option that best matches your opinion:

1. The teachers in my school give the impression that technology courses are more appropriate for boys than girls.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

2. I don't raise my hand in class because I am afraid to be wrong.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

3. My parent's opinion about my future is important to me.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

4. I am confident that I will major in a technology field such as engineering.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

5. When I make plans I am almost certain I can make them work.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

6. People in technology jobs have no family life.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

7. Technology has no place for imagination.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

8. The counselors in my school encourage boys more than girls to pursue technology careers.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

9. Boys are better at math and science than girls.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

10. Working in technology would be fun.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

11. If I study hard, I am confident I will be able to do very well in science and math.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

12. Women are likely to have a different perspective on technology because women have different viewpoints than men.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

13. Boys know more about technology than girls do.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

14. The teachers in my school encourage boys more than girls to take Advanced Placement courses in math and science.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

15. Technology is hard.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

16. Women are better at non-technical jobs, particularly ones that deal directly with people such as a psychologist or social worker.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

17. Boys are more interested in technology than girls.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

18. Most jobs in technology are monotonous and boring.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

19. In my case getting what I want (like good grades) has little or nothing to do with luck.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

20. I am confident I can put together a new bike by following the assembly instructions.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

21. Technology has improved most people's lives.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

22. Math and Science teachers in my school call on boys more than on girls.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

23. Technology is only for smart people.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

24. Men are better at technical jobs like engineering compared to women.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

25. Technology isolates you from spending time with friends, as in seeing them in person.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

26. Sometimes I feel that I don't have enough control over the direction my life is taking.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

27. I am confident that I can create a web page.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

28. Technology has done more bad for the environment, than good.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

29. Subjects such as science, math, engineering, technology and computer science are easier for boys.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

30. I am in control of my career goals and choices.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

31. I am confident that I can prepare a delicious beef stroganoff dinner from a recipe.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

32. I am confident that I can take music from a CD and put it on an MP3 or iPod.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

33. Technology is mainly concerned with computers.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

34. I am good at math and science.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

35. Subjects such as art, literature and social studies are easier for girls.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

36. I am interested in technology as a possible college major.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

37. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

38. I am confident I can fix a broken object like a bike, roller-blades or a skateboard.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

39. I am confident that I will graduate from high school and attend college.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

40. Name THREE things that come to mind when you think of ‘technology’:

1. ________________________________

2. ________________________________

3. ________________________________

Letter of consent to parents

April 26, 2007

Dear Parent(s)/ Guardian(s),

The College of Technology at Eastern Michigan University is conducting research as part of its doctoral program of technology, entitled 'Perceptions of Technology'. The objective of this research is to explore students' perceptions of technology and their plans to study technology majors. We hope that this data will provide valuable information on why students select or reject technology majors during the course of their education.

We are surveying a sample of students from several high schools in the region. Milan High School is one of the selected schools for this study. We would like to obtain your permission to survey your daughter/son at the Milan (/Huron) High School. The survey will ask them such questions as their sources of information about technology, their plans about selecting technology majors, and their impressions about technology in general. It will take about 10 – 15 minutes of their time.

The identity and the responses of each student will remain completely confidential. The students' participation in this survey will be completely voluntary. They will be free to withdraw their participation at any time during the survey. We intend to compile the results of this study in student doctoral research about technology. You may receive a copy of the compiled research upon request.

This research has been approved by the EMU Human Subjects Review Committee. If you have any questions about the approval process, you may contact Dr. Deb deLaski Smith at 734-487-0042 or Deb.deLaski-Smith@emich.edu. In case of any questions concerning the research, please feel free to contact the project team personnel:
Project Director: Professor Mary Brake at (734) 487-2326: mbrake@emich.edu
Co-investigator: Kaninika Bhatnagar at (734) 717-3910: kbhatnag@emich.edu

Please provide the parent/guardian and student signature on the following page.
Thank you very much for your participation!

Professor Mary Brake
Research Director

Consent form for "Perceptions of Technology" Survey

Student's name: ____

__ My daughter/son may take the survey.

__ I do not want my daughter/son to participate in the survey.

Parent/Guardian's Signature: ____

Student Signature: ____

Date: ____

Appendix B: Data from Schools B and C

In this section, the individual results from each of the two schools are compared and contrasted. The correlation values for boys and girls for each school are given in Figures B1 and B1. Note that some variables correlate in the negative direction. That is, if the score on one is high, the score on the other tends to be low. However, both genders tend to give similar results. The difference lies in the magnitude of correlation coefficients as well as in their relative statistical significance.

Although the overall pattern appears to be quite similar in the case of the two schools, there are some significant differences. These are not only in magnitude but also in direction. For example, both schools showed a positive correlation between SMET (intending to choose a technology major) and CONF (self-confidence in math and science) for both boys and girls. But School B had a slightly higher statistically significant correlation for girls, while School C showed a higher statistically significant correlation for boys. In the case of the variables TECH (confidence in knowledge of technology products and processes) and WORK (opinion that technology work is fun), both schools showed a positive correlation in the case of girls. However, in the case of boys, one school (School C) showed a positive correlation while the other (School B) showed a negative correlation, although the result for School B was not statistically significant. For the variables SMET and FAM (opinion that people in technology have no family life), both schools showed a statistically significant negative correlations in the case of boys, but neither showed statistically significant correlations for girls. The correlation between the variables WORK and CONF was statistically significant and positive for girls in both schools, but only statistically significant for boys in the case of

School C. Similarly, the correlation between the variables CONF and FAM was statistically significant and negative for girls in both schools, but negative and statistically significant for boys in the case of School C.

The individual results obtained from each school are summarized in a set of charts and tables that follow. Figures B1 and B2 show the results graphically for each school for quick reference. The detailed results (Table B1) include the Pearson correlation matrix and some significant bivariate correlation results by gender for each school. The correlation matrix shows correlations for all variables for the entire sample, so the variables that correlated strongly for both boys and girls can be seen in this table. Table B2 gives some statistically significant differences across genders using selective data.

The following set of results was obtained in School B. Notice some of the interesting differences across genders; For example, the correlation between CONF (self-confidence in math and science) and FAM (opinion that people in technology have no family life). In the case of girls the spike is negative, while in the case of boys it is positive. Moreover, in the case of girls the correlation is statistically significant at alpha level of <0.05. Thus, the more the girls think that people in technology have no family life, the lower their self-confidence in math and science tends to be (-0.295*). In the case of boys, the more they think that people in technology have no family life, the higher their self-confidence in math and science tends to be (.0175). Similar results were found in the case of school C as well.

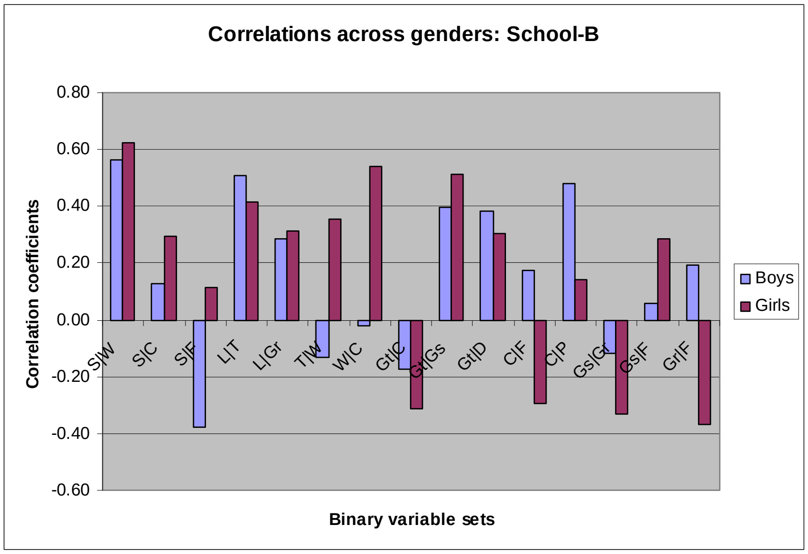


Figure B1. Correlation coefficients across principle variables for School B

Binary Variables	
S|W	SMET|WORK
S|C	SMET|CONF
S|F	SMET|FAM
L|T	LOC|TECH
L|Gr	LOC|GRAD
T|W	TECH|WORK
W|C	WORK|CONF
Gt|C	GTP|CONF
Gt|Gs	GTP|GSS
Gt|D	GTP|DIFF
C|F	CONF|FAM
C|P	CONF|PRNT
Gs|Gr	GSS|GRAD
Gs|F	GSS|FAM
Gr|F	GRAD|FAM

Table B1
Pearson Correlation Matrix between SMET, WORK, CONF, FAM, LOC, TECH, GRAD, GTP, GSS, DIFF, and PRNT for the Entire Sample for School B

***p≤.05**p≤.0**

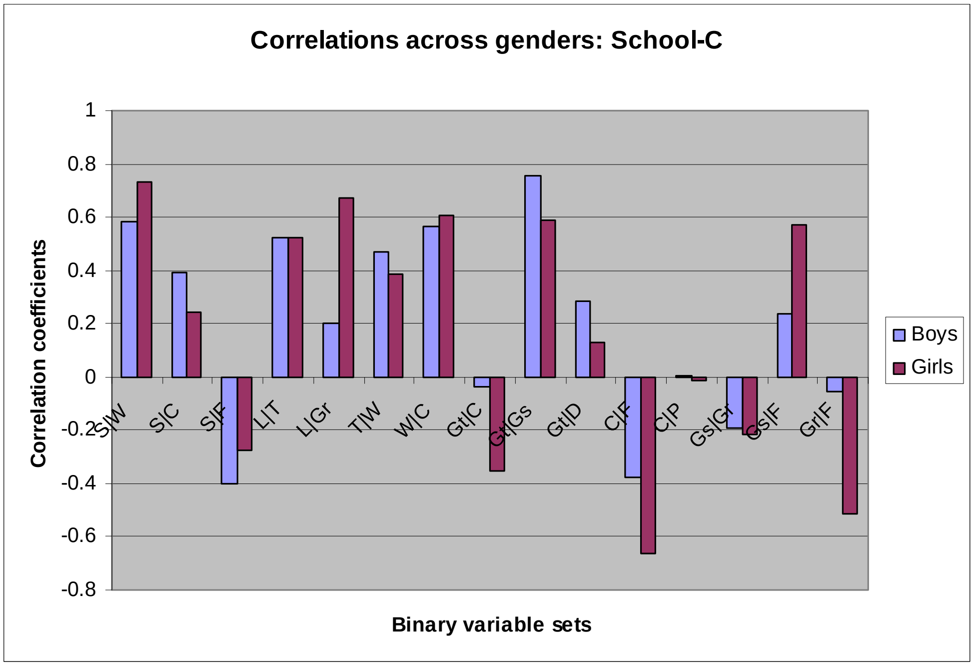
N=81		*1:SMET*	*2:WORK*	*3:CONF*	*4:FAM*	*5:LOC*	*6:TECH*	*7:GRAD*	*8:GTP*	*9:GSS*	*10:DIFF*	*11:PRNT*
1	SMET	----										
2	WORK	.629**	----									
3	CONF	.263*	.342**	----								
4	FAM	-.067	-.125	-.108	----							
5	LOC	.088	.152	.307**	.022	----						
6	TECH	.126	.224*	.151	.136	.474**	----					
7	GRAD	-.179	-.023	.065	-.166	.290**	.136	----				
8	GTP	.040	-.009	-.212	-.023	-.128	.059	-.139	----			
9	GSS	-.046	-.160	-.181	.188	-.182	.101	-.253*	.435**	----		
10	DIFF	-.125	-.015	-.160	-.067	-.024	.097	.245*	.241*	.068	----	
11	PRNT	.143	-.058	.250*	-.068	.199	-.181	.044	-.092	-.243*	-.136	----

Table B2

Pearson Correlation results between variables SMET, WORK, CONF, FAM, LOC, TECH, GRAD, GTP, GSS, DIFF, and PRNT by gender for School-B

Variable1	Variable 2	Boys N=31	Girls N=50	Total N=81	Variable definitions	
SMET	WORK	.562**	.623**	.629**		
SMET	CONF	.128	.297*	.263*	SMET	Intent to choose a tech major in college
SMET	FAM	-.376*	.115	-.067	WORK	Working in technology is fun
LOC	TECH	.507**	.415**	.474**	CONF	Self-confidence in math and science
LOC	GRAD	.285	.313*	.290**	FAM	Opinion that people in technology have practically no family life
TECH	WORK	-.133	.354*	.224*	LOC	Perception of control over one's life's outcomes
WORK	CONF	-.022	.540**	.342**	TECH	Confident of performing specific technology tasks
GTP	CONF	-.175	-.312*	-.212	GRAD	Confident of graduating from high school and entering college
GTP	GSS	.396*	.512**	.435**	GTP	Perception that boys are better at technology than girls
GTP	DIFF	.382*	.305*	.241*	GSS	Messages from school that technology as an area is more suitable for boys.
CONF	FAM	.175	-.295*	-.108	DIFF	Gender differences (not better or worse) in opinions about technology
CONF	PRNT	.479**	.140	.250*	PRNT	My parents' opinion about my future is important to me.
GSS	GRAD	-.116	-.331*	-.253*		
GSS	FAM	.058	.286*	.188	*** ρ ≤ .05 ** ρ ≤ .01**	
GRAD	FAM	.191	-.367**	-.166		

Similarly, the following chart shows the correlations obtained for School C:



Binary Variables	
S|W	SMET|WORK
S|C	SMET|CONF
S|F	SMET|FAM
L|T	LOC|TECH
L|Gr	LOC|GRAD
T|W	TECH|WORK
W|C	WORK|CONF
Gt|C	GTP|CONF
Gt|Gs	GTP|GSS
Gt|D	GTP|DIFF
C|F	CONF|FAM
C|P	CONF|PRNT
Gs|Gr	GSS|GRAD
Gs|F	GSS|FAM
Gr|F	GRAD|FAM

Figure B2. Correlation coefficients across principle variables for School C

Note that although magnitudes of correlation coefficients vary for most bivariate sets, the direction tends to remain the same in the case of both genders. However, marked differences are noticeable in some cases. The case of the two variables considered previously was quite similar for instance: FAM (opinion that people in technology have no family life) and CONF (self-confidence in math and science). In the case of girls the negative spike is significantly lower than in the case of boys. In each case the negative correlation is statistically significant, but in the case of boys it is -0.374 at alpha level of <0.05, while in the case of girls it dips down to -0.660 at alpha level of <0.01. In other words, the more that girls tend to think that people in technology have no family life, the lower their self-confidence in math and science tends to be. This relation is not as statistically significant in the case of boys. See Table B3 for the Pearson correlation coefficient matrix for School C. Table B4 lays out statistically significant correlations between boys and girls for School C.

Table B 3.
Pearson Correlation Matrix between SMET, WORK, CONF, FAM, LOC, TECH, GRAD, GTP, GSS, DIFF, and PRNT for the Entire Sample for School C

N=71		*1:SMET*	*2:WORK*	*3:CONF*	*4:FAM*	*5:LOC*	*6:TECH*	*7:GRAD*	*8:GTP*	*9:GSS*	*10:DIFF*	*11:PRNT*
1	SMET	----										
2	WORK	.647**	---									
3	CONF	.270*	.546**	----								
4	FAM	-.294*	-.580**	-.492**	----							
5	LOC	.223	.390**	.599**	-.467**	----						
6	TECH	.376**	.445**	.141	-.303*	.424**	----					
7	GRAD	.089	.093	.269*	-.248*	.445**	.162	----				
8	GTP	.147	-.153	-.203	.334**	-.331**	.010	-.168	----			
9	GSS	.022	-.244*	-.242*	.384**	-.335**	-.066	-.192	.712**	----		
10	DIFF	.136	.023	-.030	.109	.034	-.004	-.158	.157	-.007	----	
11	PRNT	.063	-.008	.022	.023	.172	-.149	.261*	-.137	-.310**	.064	----

Table B4.

Pearson Correlation results between variables SMET, WORK, CONF, FAM, LOC, TECH, GRAD, GTP, GSS, DIFF, and PRNT by gender for School C.

Variable1	**Variable2**	**Boys N=41**	**Girls N=30**	**Total N=71**	**Variable definitions**	
SMET	WORK	.585**	.732**	.647**		
SMET	CONF	.393*	.245	.270*	SMET	Intent to choose a technology major in college
SMET	FAM	-.403**	-.274	-.294*	WORK	Working in technology is fun
LOC	TECH	.522**	.521**	.424**	CONF	Self-confidence in math and science
LOC	GRAD	.202	.673**	.445**	FAM	Opinion that people in technology have practically no family life
TECH	WORK	.467**	.385*	.445**	LOC	Perception of control over one's life's outcomes
WORK	CONF	.564**	.604**	.546**	TECH	Confident of performing specific technology tasks
GTP	CONF	-.037	-.354	-.203	GRAD	Confident of graduating from high school and entering college
GTP	GSS	.758**	.590**	.712**	GTP	Perception that boys are better at technology than girls
GTP	DIFF	.287	.130	.157	GSS	Messages they received from school that technology as an area is more suitable for boys.
CONF	FAM	-.374*	-.660**	-.492**	DIFF	Gender differences (not better or worse) in opinions about technology
CONF	PRNT	.002	-.012	.022	PRNT	My parents' opinion about my future is important to me.
GSS	GRAD	-.193	-.215	-.192		
GSS	FAM	.238	.569**	.384**	**$* \rho \leq .05$ $** \rho \leq .01$**	
GRAD	FAM	-.054	-.513**	-.248*		

Appendix C: PATT Survey Instrument

Pupils' Attitude Towards Technology[8]

We are interested in your opinion on technology. Therefore, we would like you to answer some questions on this subject. This is not a test. There are no right or wrong answers. You are not to be graded on this. Do not take too much time for on question. You should only need about 25 minutes for the whole questionnaire. The first set of questions are about you so we can get to know you better. These are followed by statements about technology. Indicate to what extent you agree or disagree with them. In the last set of statements you only have to indicate agree, disagree or don't know.

Please give a short description of what you think technology is:

----

1. Are you a boy or a girl? ___ Boy ___ Girl
2. How old are you? 12 or younger, 13, 14, 15, 16 or older
3. What is your grade in school? 6, 7, 8

4. If your father has a job, indicate to what extent it has to do with technology?
○ Very much ○ Much ○ Little ○ Nothing

5. If your mother has a job, indicate to what extent it has to do with technology?
○ Very much ○ Much ○ Little ○ Nothing

6. Do you have technical toys, like Tinkertoy, Erector Set or LEGO at home?
○ Yes ○ No

7. Is there a technical workshop in your home?
○ Yes ○ No

8. Is there a personal computer in your home?
○ Yes ○ No

9. Do you think you will choose a technological profession?
○ Yes ○ No

10. Do you have brothers or sisters that have a technological profession or that are studying for it?
○ Yes ○ No

---

[8] "What do girls and boys think of technology? Pupils' attitudes towards technology," PATT Workshop report: Mar 6-11, 1986. Eindhoven University of Technology, The Netherlands.

11. Are you taking or have you taken Technology Education/Industrial Arts?
○ Yes ○ No

12. When something new is discovered, I want to know more about it immediately.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

13. Technology is as difficult for boys as it is for girls.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

14. Technology is good for the future of this country.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

15. To understand something of technology you have to take a difficult training course.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

16. At school you hear a lot about technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

17. I will probably choose a job in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

18. I would like to know more about computers.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

19. A girl can very well have a technological job.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

20. Technology makes everything work better.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

21. You have to be smart to study technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

22. I would not like to learn more about technology at school.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

23. I like to read technological magazines.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

24. A girl can become a car mechanic.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

25. Technology is very important in life.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

26. Technology is only for smart people.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

27. Technology lessons are important.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

28. I will not consider a job in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

29. There should be less TV and radio programs about technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

30. Boys are able to do practical things better than girls.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

31. Everyone needs technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

32. I would rather not have technology lessons at school.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

33. I do not understand why anyone would want a job in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

34. If there was a school club about technology I would certainly join it.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

35. Girls are able to operate a computer.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

36. Technology has brought more good things than bad.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

37. You have to be strong for most technological jobs.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

38. Technology at home is something schools should teach about.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

39. I would enjoy a job in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

40. I think visiting a factory is boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

41. Boys know more about technology than girls do.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

42. The world would be a better place without technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

43. To study technology you have to be talented.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

44. I should be able to take technology as a school subject.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

45. I would like a career in technology later on.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

46. I am not interested in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

47. Boys are more capable of doing technological jobs than girls.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

48. Using technology makes a country less prosperous.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

49. You can study technology only when you are good at both mathematics and science.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

50. There should be more education about technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

51. Working in technology would be boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

52. I enjoy repairing things at home.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

53. More girls should work in technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

54. Technology causes large unemployment.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

55. Technology does not need a lot of mathematics.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

56. Technology as a subject should be taken by all pupils.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

57. Most jobs in technology are boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

58. I think machines are boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

59. Girls prefer not to go to a technical school.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

60. Because technology causes pollution, we should use less of it.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

61. Everybody can study technology.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

62. Technology lessons help to train you for a good job.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

63. Working in technology would be interesting.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

64. A technological hobby is boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

65. Girls think technology is boring.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

66. Technology is the subject of the future.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

67. Everybody can have a technological job.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

68. Not everyone needs technology lessons at school.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

69. With a technological job your future is promised.
○ Agree ○ Tend to agree ○ Neutral ○ Tend to disagree ○ Disagree

70. When I think of technology I mostly think of computers.
○ Agree ○ Disagree ○ Don't know

71. I think science and technology are related.
○ Agree ○ Disagree ○ Don't know

72. In technology, you can seldom use your imagination.
○ Agree ○ Disagree ○ Don't know

73. I think technology has little to do with our energy problem.
○ Agree ○ Disagree ○ Don't know

74. When I think of technology, I mostly think of equipment.
○ Agree ○ Disagree ○ Don't know

75. To me technology and science are the same.
○ Agree ○ Disagree ○ Don't know

76. In my opinion, technology is not very old.
○ Agree ○ Disagree ○ Don't know

77. In technology, you can think up new things.
○ Agree ○ Disagree ○ Don't know

78. Working with information is an important part of technology.
○ Agree ○ Disagree ○ Don't know

79. Technology is as old as humans.
○ Agree ○ Disagree ○ Don't know

80. Elements of science are seldom used in technology.
○ Agree ○ Disagree ○ Don't know

81. You need not be technological to invent a new piece of equipment.
○ Agree ○ Disagree ○ Don't know

82. Technology has a large influence on people.
○ Agree ○ Disagree ○ Don't know

83. I think technology is often used in science.
○ Agree ○ Disagree ○ Don't know

84. Working with your hands is part of technology.
○ Agree ○ Disagree ○ Don't know

85. In everyday life, I have a lot to do with technology.
○ Agree ○ Disagree ○ Don't know

86. In technology, there is little opportunity to think up things yourself.
○ Agree ○ Disagree ○ Don't know

87. Science and technology have nothing in common.
○ Agree ○ Disagree ○ Don't know

88. The government can have influence on technology.
○ Agree ○ Disagree ○ Don't know

89. I think the conversion of energy is also part of technology.
○ Agree ○ Disagree ○ Don't know

90. In technology, you use tools.
○ Agree ○ Disagree ○ Don't know

91. Technology is meant to make our life more comfortable.
○ Agree ○ Disagree ○ Don't know

92. When I think of technology, I mainly think of computer programs.
○ Agree ○ Disagree ○ Don't know

93. Only technicians are in charge of technology.
○ Agree ○ Disagree ○ Don't know

94. Technology has always to do with mass production.
○ Agree ○ Disagree ○ Don't know

95. In technology, there are less opportunities to do things with your hands.
○ Agree ○ Disagree ○ Don't know

96. Working with materials is an important part of technology.
○ Agree ○ Disagree ○ Don't know

97. Technology has little to do with daily life.
○ Agree ○ Disagree ○ Don't know

98. When I think of technology I mainly think of working with wood.
○ Agree ○ Disagree ○ Don't know

99. Technology can mainly be found in industry.
○ Agree ○ Disagree ○ Don't know

100. There is a relationship between technology and science.
○ Agree ○ Disagree ○ Don't know

Appendix D: Pilot Studies

Original Survey Instrument

The survey template used for this research was derived from the Assessing Women in Engineering (AWE) initiative (AWE, 05)[9], a national survey sponsored by the National Science Foundation, NSF (HRD 0120642). AWE has designed several exportable assessment instruments for programs for women in engineering. The purpose of the AWE program is to provide a measurement tool for outreach programs, usually developed for and delivered by universities, to encourage girls to study engineering. The programs themselves attempt to determine what influences girls' opinion to major in engineering. The goal is to enhance girls' opinions of engineering so that they will consider engineering majors and careers. AWE has designed three surveys that test opinions of the participants: Before the activity (a summer camp, for example), immediately after it, and then three months later. The final survey instrument used in this research was developed from the AWE survey. However, the original instrument had several limitations from the point of view of statistical analysis. Substantial modifications were made to it to arrive at the final questionnaire that was used for this research. The design limitations encountered with the AWE survey are briefly discussed in the following section to underscore the need for developing a new instrument for this study. The original AWE survey is included in Appendix E. As mentioned earlier three pilot studies were used to develop the final survey instrument. The first of these used the unaltered AWE survey.

[9] See Appendix E for a copy of the AWE survey that was used unaltered for pilot study 1; http://www.engr.psu.edu/awe/

Pilot Study 1: Engineering Camp for Girls 1

The first pilot study was carried out in an engineering summer camp for girls organized by a large research Midwestern university college of engineering. The camp was organized to introduce and encourage engineering career options among girls, particularly computer programming. The girls were rising 10th and 11th graders. It was a week-long program that included hands-on sessions, technology demos, tours of university science facilities, and lectures about engineering careers. The unaltered AWE survey was administered to the girls at the end of this experience. There were 37 girls in this sample. The demographic makeup of this sample was as follows: Twenty Caucasians (54%), thirteen African Americans (35%) and four who classified themselves as neither (11%). Since this was a small sample the "other" category was not differentiated any further. There was a fairly even distribution across grades, with fourteen rising 10th graders, twelve rising 11th graders, and eleven rising 12th graders.

The following details about this sample are noteworthy. First, this was an all girls' sample. There was no input from boys. Second, these girls were self-selected, although there were no questions to determine if the students were persuaded to attend the program by their parents. They had chosen to attend the summer camp designed expressly for introducing engineering major/career options. The intent to attend this camp was quite strong because the parents of the girls had to pay in order for them to be able to attend, although there were a few scholarships. Thus this sample was not random. However, it did serve as a good sounding board for developing the instrument for a more general audience. It provided an insight into their interests, influences, and opinions. Their responses to various survey questions reflected their level of confidence and interest.

This sample had a very high percentage (78%) of engineers in the families. Most participants (84%) had been to a university campus before. This indicated a selective sample that was pre-disposed to interest in engineering, math, and science. High numbers of engineering professionals in the family also indicated that the girls likely came from middle or higher socio-economic group. When presented with an advanced math problem, 36% of them thought that they could figure it out by themselves, and an overwhelming majority (70%) thought that it was only a matter of taking the right class.

One of the survey questions asked them about what they thought the work of engineers might be. Answer choices included “They mainly work on machine and computers,” “They work with other people to solve problems,” and “They have lot of choices about what they can do in their jobs.” Interestingly, only 30% chose the (perhaps) more obvious option that engineers work with computers, while 80% chose the option that engineers work with people. Seventy percent chose the third option about engineers having choices in their jobs. (They could pick any two of the choices given.)

The survey asked as to who would they talk to about continuing their education. 94% of the respondents indicated that they would talk to their parents. Teachers and counselors at school were selected by a high number of students (60%), but in the case of this particular sample, parents were the most influential group. The results indicated a strong parental influence on students’ decisions to continue their education. However, these results cannot be generalized as the sample was not random. Parents had paid for their daughters to attend this camp, and a large number of the parents were professionals.

The survey asked the respondents for their reasons regarding why a job would be important to them. Some interesting results were obtained. For example, the strongest reason for making a job choice was “work that is fun” (85%). Second most often selected reason (80%) was “challenging work that makes me think.” “Work that allows time with family” was chosen by 72% of the respondents. Interestingly, only 45% selected the option “work that makes a lot of money.”

The survey asked if they would recommend this camp to their friends. Interestingly, they confined their vote to only those friends who were already interested in math or science. In other words, they did not see this activity as a way to develop interest in math or science in their friends who were not already interested in math and science.

At the end of the camp, when asked if they were more likely to study engineering in college, only 9% picked engineering as their first choice despite having spent a week learning about engineering career options. These are small numbers given such a highly select group of girls as evidenced by their expressed interest in math and science and the large number of engineering professionals in their family. This first pilot survey served to reinforce the long-standing perceptions of girls being less likely to choose engineering/technology majors and thus underscored the research question: What do high school students think about technology?

This initial survey provided a number of clues regarding the direction to take in this research. The pilot study opened up more questions than it answered. There was something preventing the girls from choosing engineering majors in college. The next set of pilot surveys was designed to try and figure out the reasons.

Prior to administering the next set of surveys the AWE questionnaire was modified in certain ways. The first pilot study showed that the students only appeared to stay on task when filling out the survey for about 10-15 minutes. Hence the subsequent questionnaire was edited for length and reduction of duplication. Ambiguous questions were removed, and as much as possible, they were checked for clarity of interpretation. The AWE instrument referred only to engineering in its questions. However, as discussed previously in Chapter 1, this research focused on technology; therefore, the AWE questions were edited to include technology.

Limitations of the AWE Survey

The AWE instrument has several limitations in terms of the extent of statistical analysis that can be performed on its data. These limitations are briefly outlined in this section. Although it provides rich qualitative data, the AWE instrument does not provide any quantitative data. Statistically, only a limited amount of analysis can be performed on such data. Most of its variables are categorical in nature, meaning that it is not possible to study interrelationships, trends, or perform any correlational analysis. Each question exists in its own silo as it were, and cannot be compared with or related to the data from another question. It is possible to find out, for instance, what percentage of girls chose a certain option from among all the options, but the survey is limited when looking for relationships and correlations between various responses because there were no Likert scale types of questions. Also, it was not possible to find out how the responses to different questions statistically correlated with each other.

On the other hand, a 5-point set of Likert scale options allows the respondents to give a *degree* of agreement instead of a simple yes or no. Likert scale also provides for numerical coding of scores. Once the variables are quantitative, they can be combined to yield composite scores. Thus it becomes possible to measure more complex constructs such as "confidence in knowledge of technology tasks" or "opinions about technology suitability for girls." Each such complex construct can be divided into a set of opinion statements that the respondents can indicate their degree of agreement. Moreover, a set of questions, for instance those that determined the girls' level of interest in engineering, their choice of college major, and their level of self-confidence in technology, can all be examined in reference to each other.

The AWE survey is not constructed in this manner and does not allow for any statistical manipulation as all its variables are categorical and cannot be cross-referenced with each other. It is possible to convert the data into pie charts and bar graphs and reduce numbers to percentages. However, it was necessary to redesign the instrument in order to make the categories more meaningful, and relate them to each other in order to probe more deeply into the pattern of responses. The redesign of the AWE instrument was carried out in stages. The second pilot survey used the first modified version of the original instrument.

One important modification to the AWE instrument was the addition of questions related to technology. The AWE survey used for the first pilot study focused on assessing programs that encourage girls to study engineering. The current research was, on the other hand, modeled to investigate the technology perceptions of high school students in general. The difference between the two approaches, and the need to investigate technology rather than engineering, is discussed in Chapter 1. It therefore became necessary to modify the AWE survey to include technology-related questions and to reword the question response options in the form of a Likert scale.

The new questions were added to investigate if there was a correlation between opinions, experiences, and attitudes towards technology with their intention to choose a technology major in college. The questions were framed around the knowledge of technology as consisting of practical, technical skills working with a variety of technical products. This was remarkably similar to the PATT study, with the exception of the one major change in technology since 1986: the ubiquitous presence of computers at all levels in our society and the education system. Therefore the knowledge and comfort level of working with computers became a major aspect of defining technology, in that the two are often found to be synonymous in today's society. This was reflected in the questionnaire. The development of the final survey instrument is described in detail in later sections of this chapter.

Pilot Study 2: High School A

The modified survey instrument[10] with the technology questions added was administered to a set of fifty 10th graders in three biology classes in School A in a small Midwestern suburban/rural district. This constituted the second pilot study for this research. The students in this group were substantially different from the ones in the previous study. It was a co-ed group, and students were required to take biology. Therefore, there was no self-selection, unlike in the first pilot study where the participating girls, with permission of their parents, chose to be in the program based on their interest in science and engineering. The overall high school population was a mixture of suburban and rural students with largely lower-middle and middle-class backgrounds. The school is composed of approximately 78% Caucasians, 20% African American, and 2% Asian and Hispanic students, with many students identifying with more than one ethnic group. With the exception of a few students, all students in the three biology classes, with the permission of their parents, chose to participate in this study. There were 50 students in this sample; 26 were females and 24 were males. The demographic makeup was as follows: 24 Caucasians (48%), 14 African

[10] The modified survey used in pilot study 2 is included in Appendix F.

Americans (28%), 11 identified themselves with two ethnicities (24%) and 1 Latino. This sample was almost entirely composed of 10^{th} graders (46), with just 2 each eleventh and twelfth graders.

As mentioned previously, the instrument for this survey was the modified version of the AWE questionnaire. The survey questions were made gender neutral since this was a co-ed group. Besides the addition of the technology questions mentioned previously, the survey was also edited to include nine locus of control questions. As is evident from the literature on the subject of girls in science, technology, and engineering, self-confidence and the sense of self-esteem is a critical factor (Eccles, 1984, 1990; Nicholls et al, 2006).

Locus of control items provide one way to measure the level of self-esteem (Chubb et al., 1997) and refer to the extent to which individuals believe that they can control events that affect them. Individuals with a high *internal locus of control* believe that events result primarily from their own behavior and actions. Those with a high *external locus of control* believe that powerful others, fate, or chance primarily determine events. Those with a high *internal locus of control* have better control of their behavior than those with a high *external locus of control.* They are more likely to assume that their efforts will be successful. The locus of control construct has been discussed in detail in Chapter 2 along with a review of the pertinent literature. The current research used a set of locus of control questions from the Rotter scale (1966), which has been extensively used in similar research. Since the scale is a general index to measure locus of control, four new questions were added to the scale, addressing technology more specifically. The addition of new questions to a well-established scale was duly validated before their inclusion in the final survey instrument. Validation was performed by analyzing the data from pilot studies 2 and 3 that each included the locus of control questions. (Pilot study 3 is discussed below.) The data for the five original Rotter questions and that for the four new questions were tested for scale reliability in SPSS. Table D1 gives the reliability output. Table D2 shows the correlation between the Rotter LOC questions and the new LOC questions added to the survey. The process of scale development is detailed out in Appendix G.

Table D1
Reliability output for LOC scale

Reliability Statistics

Cronbach's Alpha	N of Items
.725	9

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
34.13	31.941	5.652	9

The overall reliability statistic for the scale of 9 items was 0.725. The items were also analyzed for internal correlation with each other. The original five question set showed a statistically significant high positive correlation with the added four questions (0.713** at alpha < 0.01 level).

Table D2
Correlations between the original set and the added questions to the LOC scale

Correlations

		locRotter	locBhatnagar	LOC
locRotter	Pearson Correlation	1	.713**	.940**
	Sig. (2-tailed)		.000	.000
	N	48	48	48
locBhatnagar	Pearson Correlation	.713**	1	.909**
	Sig. (2-tailed)	.000		.000
	N	48	48	48
LOC	Pearson Correlation	.940**	.909**	1
	Sig. (2-tailed)	.000	.000	
	N	48	48	48

**. Correlation is significant at the 0.01 level (2-tailed).

The original Rotter scale as well as the modified version with added questions are included in Appendix G. By adding the locus of control (LOC) questions, the pilot survey at School A was able to examine how self-esteem correlated with other questions in the survey. Several statistically significant correlations were found among gender, ethnicity, LOC, and students' choice to attend college and/or major in a technology subject such as engineering. For example, it was possible to see if there was any correlation between the students' sense of self-esteem and their intent to choose engineering or technology college majors. Correlation analysis was performed on their LOC scores, their "Intent to major in Engineering/Technology," and their "Intent to attend college" for both gender groups. It was interesting to note that a division by gender yielded statistically significant differences. Statistically significant correlation was found for girls between LOC and their intent to attend college; however, no such correlation was found in the case of boys.

The modified AWE survey questions used for pilot study 2 focused on the 10th graders' ideas about the work of technologists/engineers, the students' expectations from a technology/engineering job, their interest in technology/engineering careers, the people and/or activities influencing them, and the role of their school teachers, counselors, and activities in promoting their interest in science and technology. Following are the results obtained for each of the items in the survey. The output data were largely categorical and required mostly qualitative analysis. The results are illustrated as charts wherever possible. The final section contains the quantitative correlation results obtained by the newly introduced LOC variable.

Pilot Study 2 results

A set of questions asked the respondents about Advanced Placement (AP) courses. They were asked if they were currently enrolled in an AP or Honors class, if they had been encouraged to enroll in one, if they planned to enroll in one next year, and if anyone had talked to them about the importance of enrolling in such a class. Their enrollment status in AP courses was a good indicator of their major and career interests as AP courses represent a head start to college. It was found that 19 of the 50 students surveyed were then enrolled in AP courses. Of these, 11 were girls and 8 were boys. For every one of these questions, the number of girls responding positively outnumbered the boys. This finding seems to support other research confirming that girls are finding parity in the K-12 educational system (Freeman, 2004), in that they are being encouraged to push their academic abilities just as much as the boys. Figure D1 illustrates these results. The questions related to AP courses were coded as follows:

"Currently enrolled": 'Are you currently enrolled in honors or advanced classes?'

"Plan to enroll": 'Do you plan to enroll in honors or advanced classes next year?'

"Encouraged to enroll": 'Have you been encouraged to enroll in honors or advanced classes?'

"Imp of enrolling": 'Has anyone talked to you about the importance of taking college prep classes?'

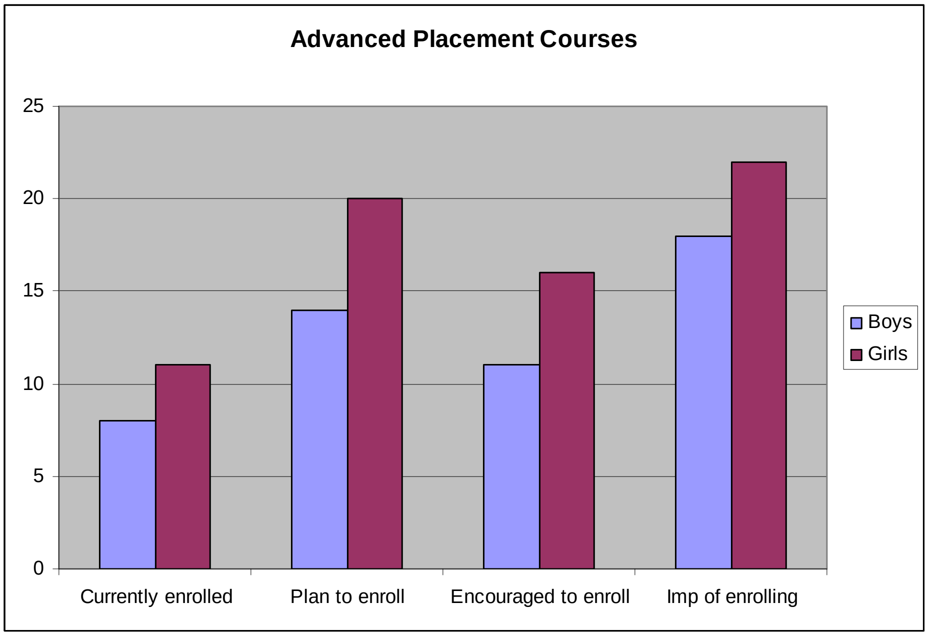


Figure D1. Advanced Placement course enrollment numbers for boys and girls

The questionnaire tried to assess how well the students understood the field of engineering. Several questions were designed to find out their opinions and impressions regarding engineering jobs. The questions gave them choices about engineering work where they could pick the option closest to their opinion. Frequency analysis was performed for each gender group. When asked if engineers work "with machines and computers," out of the 31 students who indicated agreement, 48% were boys and 52% were girls; out of the 30 students who indicated agreement with "engineers work with people to solve problems," 46% were boys and 54% were girls**.** There was no significant gender difference, contrary to the expectations that girls would view engineers as working with machines. Overall, in this case 55% of the students chose the option that "engineers mainly work with machine and computers," unlike in the first pilot study where only 30% of the respondents had chosen that option. Figure D2 illustrates these results. This sample was more random when compared to the highly selected computer summer camp, where it is likely that the participant girls had a greater understanding of engineering and technology, and the fact that engineering careers primarily involve problem solving and working with people.

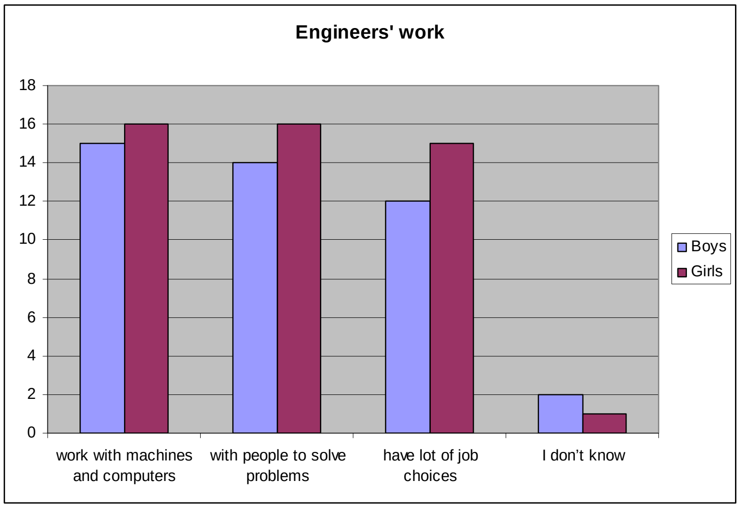


Figure D2. Engineers' work according to boys and girls

The students were asked if they were interested in exploring engineering or technology as a possible study or job choice. Fifty percent of the students (25) answered in the affirmative. However, an overwhelming majority (17) of these were boys. Only 8 girls expressed interest in pursuing engineering or technology as a possible college major or job choice. Table D3 and Figure D3 illustrate these results.

Table D3

Interest in exploring engineering or technology as a major/ career by boys and girls

Gender * EngCareer Crosstabulation

Count

		EngCareer		Total
		no	yes	
Gender	male	7	17	24
	female	18	8	26
Total		25	25	50

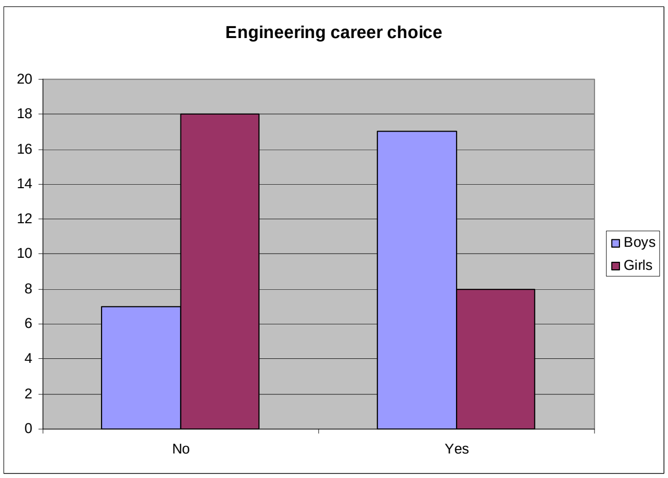


Figure D3. Interest in exploring engineering or technology as a major or career by boys and girls

The students who did express interest in exploring engineering or technology fields were asked to identify the three most important activities or people who influenced their decision. Math/science classes or clubs were only somewhat effective in influencing students to consider engineering/technology, although this could be school dependent. Six boys compared to only one girl reported being influenced by math/science classes or clubs. Out of the twelve who reported being influenced by science or technology teachers, 8 were boys while only 4 were girls. In other words, both science/math classes and clubs and science/math teachers were perceived to encourage more boys than girls in the same ratios that boys and girls reported being interested in engineering/technology college majors. Teachers and classes and clubs accounted for most of the 25 students who said they were interested in exploring engineering or technology majors (19 out of 25). Thus teachers, classes, and even clubs to some extent were found to play a role in influencing a student in majoring in engineering or technology. It is interesting to note that out of the 27 students who reported receiving encouragement from their parents, 18 were boys while only 9 were girls. This was found to be true in later studies as well. However, 16 girls reported being encouraged by their teachers to take AP courses, compared to 11 boys. This observed difference is interesting; however, this could be school dependent and needs further investigation with a larger sample.

Teachers, television, and movies were the largest influence factors for this sample. Ironically, parents are about as influential as movies, although 62% of parents of pilot study 2 were also technical professionals. In general the influence of the media (combining TV and movies) and that of the teachers was found to exceed that of parents. The research reported is limited to studying influences from school and did not include media as part of this investigation. As mentioned in Chapter 2, this decision was necessitated by the limited scope of this work, being a student project with budget and time constraints. The results of pilot study 2, however, did point to teachers and school being a possible point of study for the final questionnaire research. Teachers influence not only students' opinions about technology but also their knowledge about the nature of work and the possible career options. Figure D4 illustrates the relative influence of activities or people on boys' and girls' choices for engineering/technology majors.

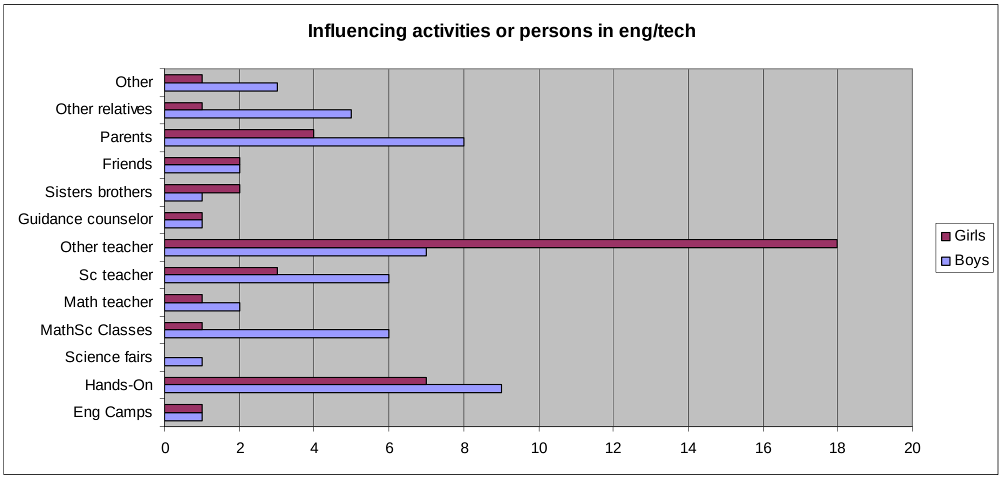


Figure D4. Activities or people as important influences for engineering/tech majors or careers for boys and girls

The students were asked how important were a set of (given) reasons for choosing a job or a career. Figure D5 illustrates these results. Interesting gender differences were found. More boys selected “making money” and “use math/science” as their reasons, while more girls selected “allow family time,” “help my community” and “solve problems for people.” Interestingly, more girls (24) than boys (16) selected the reason as “being lot of fun.”

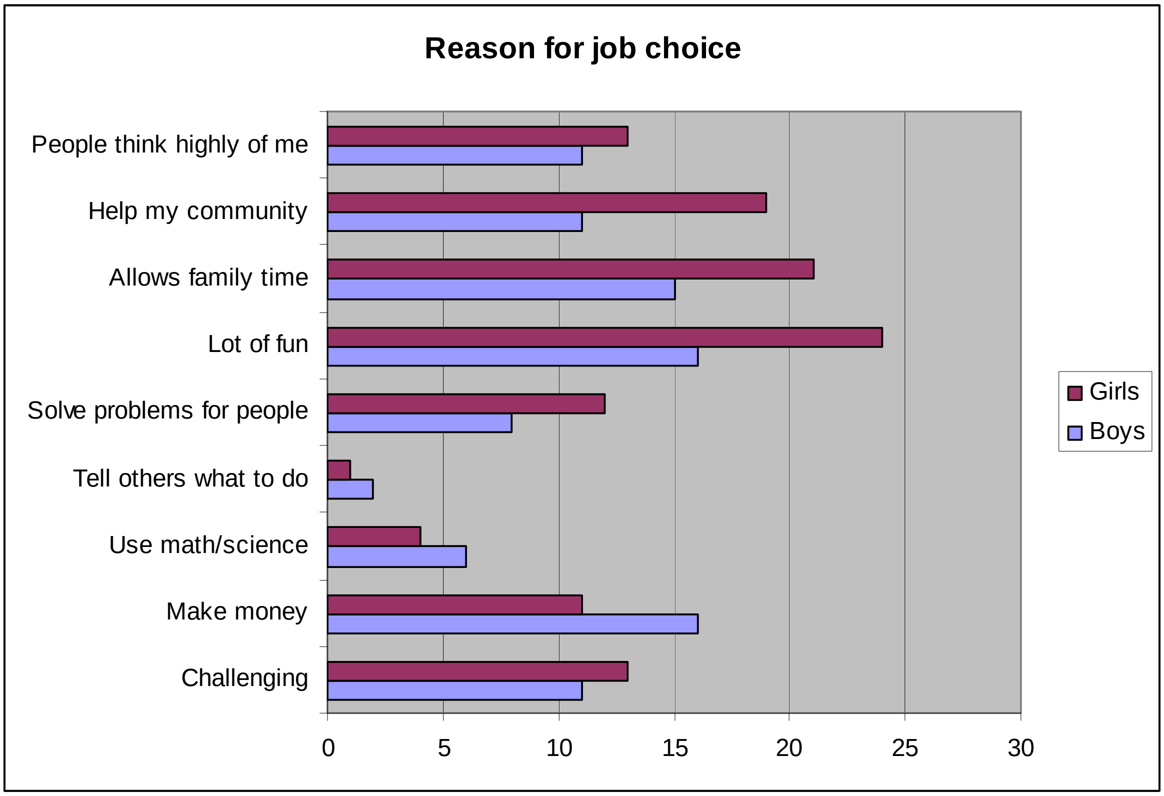


Figure D5. Important reasons for a selecting a job for boys and girls

The students were asked about the people whom they could talk to about continuing their education. Out of the 34 students who reported that they would talk to their math teacher, 70% were boys and only 30% were girls. Similarly, out of the 33 students who reported that they would talk to their science or technology teacher, 80% were boys and only 20% were girls. But it is interesting to note that teachers appear to encourage girls to take AP courses while encouraging more boys to consider technical careers. Talking to family members gave results opposite to those of talking to their teachers. It was found that out of the 32 students who reported that they would talk to their parents or guardians about technical careers, 60% were girls, compared to only 40% boys. But as mentioned earlier, out of the 27 students who reported receiving encouragement from their parents to take AP classes, 2/3rd were boys and only 1/3rd were girls. Girls tend to be better students and receive encouragement to take more difficult high school classes like advanced placement courses, but in general boys are still more likely to be encouraged to consider a technical career by teachers and parents (Nicholls et al., 2006).

The questionnaire asked them if they knew someone who was an engineer or in a technology intensive field (Table D4), and if so, who (Figure D6). More girls answered in the affirmative to this question than the boys. Most of the engineers they knew were in the family, either parents or described as “other relative.” It is interesting to note that three times as many boys than girls had a friend who was an engineer. This might point to the boys having larger networking capabilities, although this sample was too small to draw any conclusions.

Table D4
Those who personally knew an engineer among boys and girls

Gender * KnowEngineer Crosstabulation

Count

		KnowEngineer			
		no	yes	don't know	Total
Gender	male	5	14	5	24
	female	3	18	5	26
Total		8	32	10	50

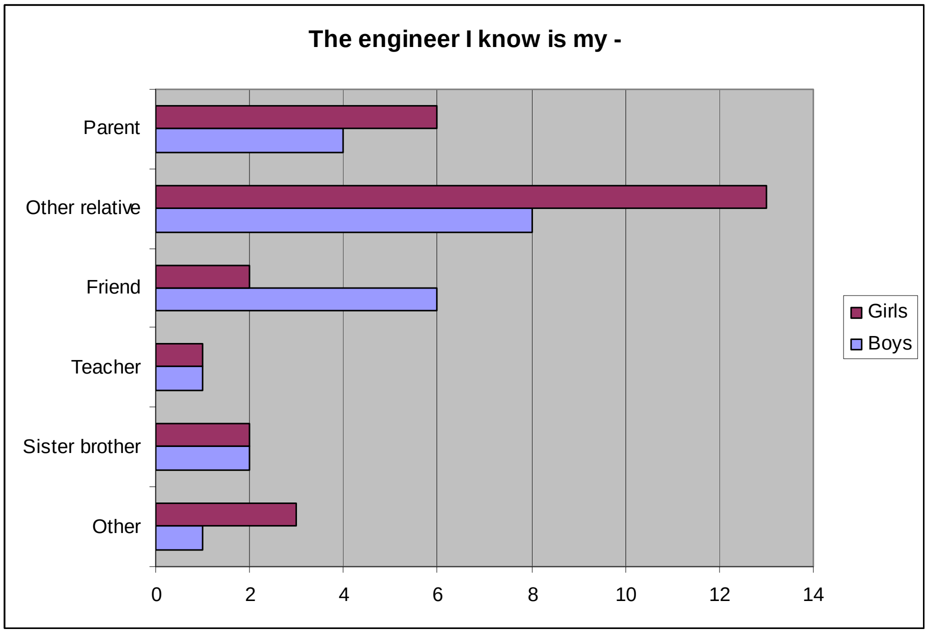


Figure D6. The category of people they knew who were engineers

There is an overwhelming degree of computing know-how involved in technology today, and, therefore, it appears to be almost subconsciously linked to the meaning that students assign to technology. So the questionnaire asked them to indicate where they had heard that computers were synonymous with technology. Their choices included teachers, parents, television, and movies. They could pick more than one choice. See Figure D7 for results. A majority of both boys and girls (56%) chose their teachers and television over parents and movies. Parents were about as influential as the movies, although 62% of the parents in this study were technical professionals. In general the influence of the media (combining TV and movies) and that of the teachers was found to exceed that of parents. The results suggested school and/or media as a possible point of study for the final questionnaire research. As mentioned previously, due to the budget and time-constraints inherent in a student project, only one of these influences, namely the school/teachers, was selected for detailed analysis. Teachers influence not only students' opinions about technology but also their knowledge about the nature of work and the possible career options available to them. Although significant gender differences were observed in the influence of teachers, teachers and math and science classes in general did not appear to influence girls to choose or not choose technology majors. Despite being encouraged to take AP classes, girls did not seem to derive the same degree of encouragement to pursue and/or seek advice from teachers or parents as their male counterparts. Although there were no significant gender differences in students' opinions about technology jobs, technologists' work and their expectations from a job, differences were seen in the relatively lower confident/willingness among girls to talk to their science/math teachers about making college major or career choices.

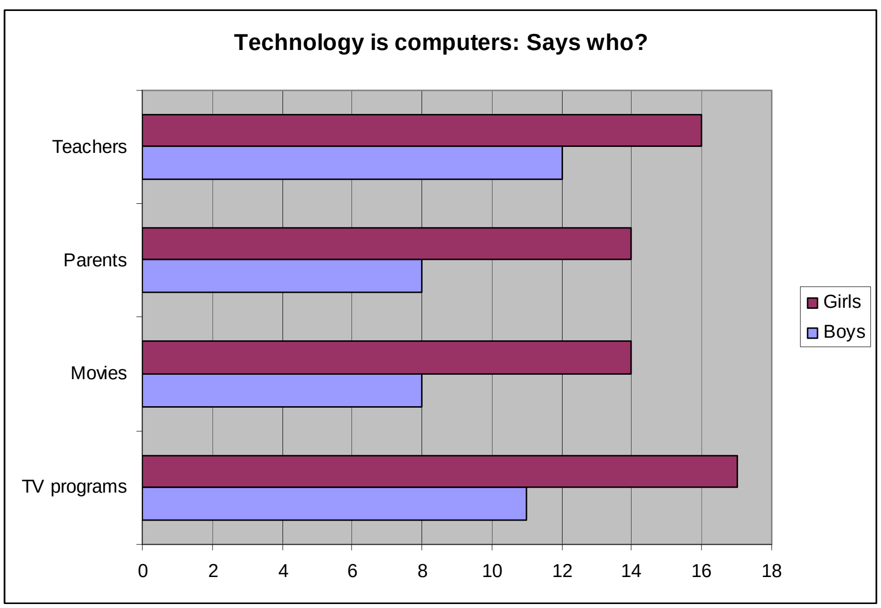


Figure D7. Where have you heard the opinion that technology is mostly about computers?

The second pilot study survey showed a very difficult math problem and asked the students what they would do if they did not know how to solve the problem. They were not asked to actually solve the problem. Of the various responses, 25% of the boys said they would try to figure it out themselves and only 4% indicated that they would ask for help from their parent. But 29% said they would ask for help from their math teacher. Thus, over 50% of the boys said they would find a way to solve the math problem right away. Figure D8 illustrates the result for boys. Figure D9 shows the results of same questions for girls. 27% of the girls said they would try and figure it out for themselves, but 12% indicated that they would ask their parents for help. 23% of the girls (compared to 29% of the boys) said they would ask their math teacher for help. Although these are not big differences, the results indicate boys looking to teachers for help, compared to girls looking to parents for help.

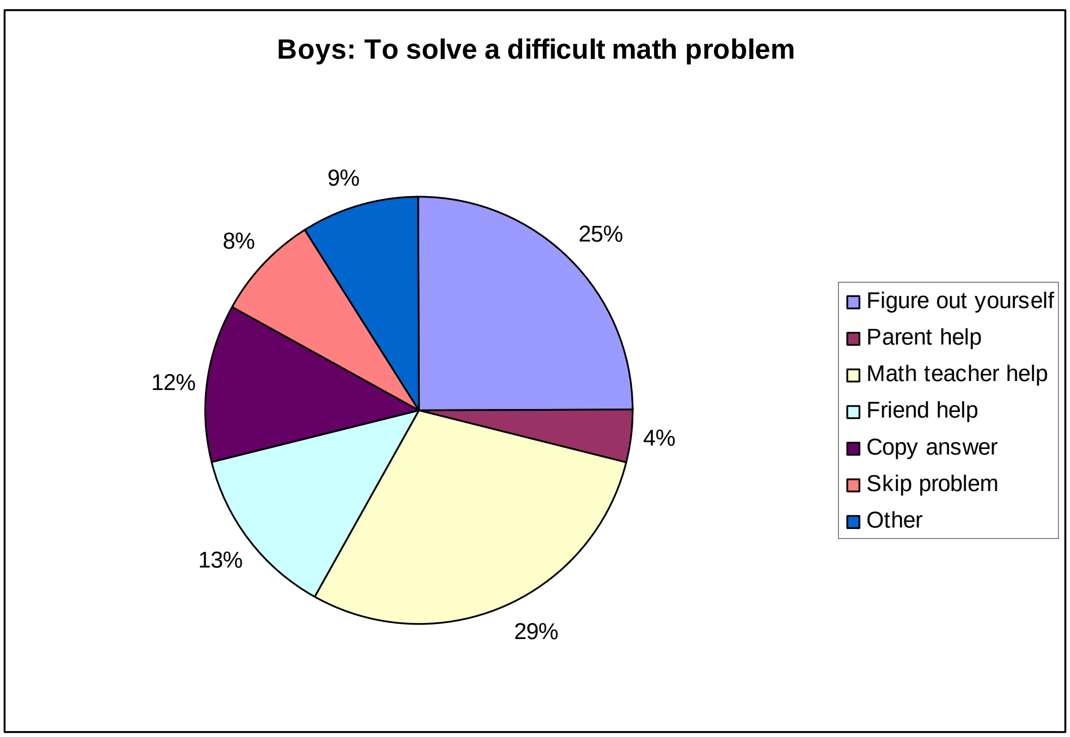


Figure D8. Boys' choices for solving a difficult math problem

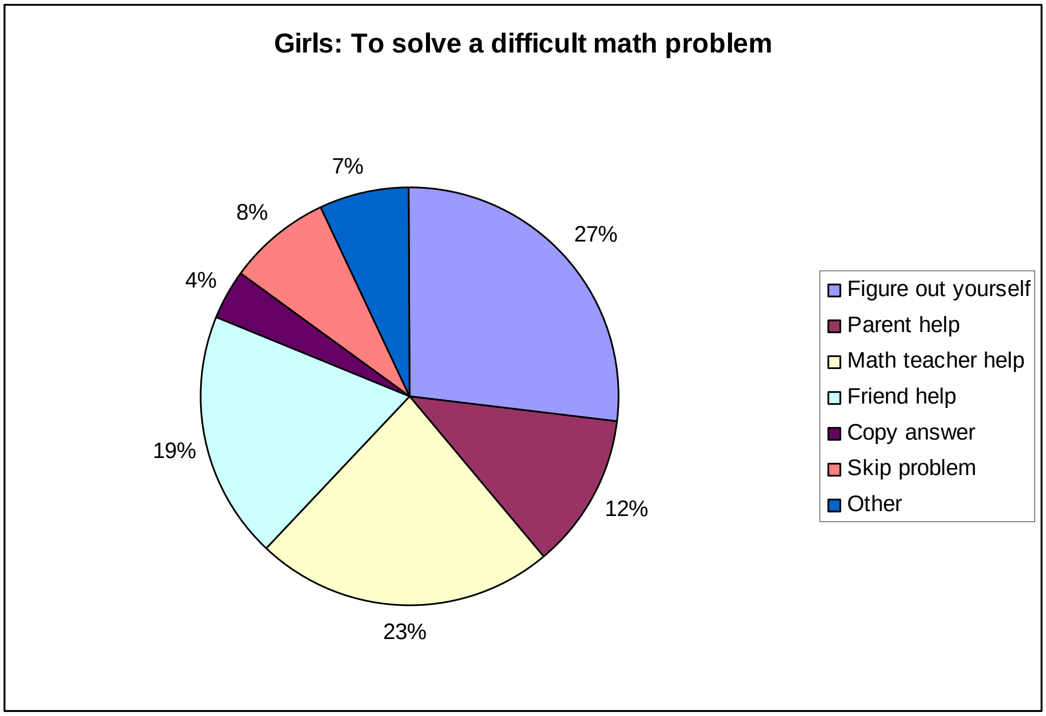


Figure D9. Girls' choices for solving a difficult math problem

The next question was regarding their ability to *learn* to solve that particular problem. In answer to this question, both girls (73%) and boys (67%) were confident that they would be able to solve the problem once they took the right class. Eight percent of the boys were confident of solving the problem now, but only 4% of the girls were as confident. Only 4% of the boys indicated that they were not interested in learning to solve this type of problem, however; this number increased to 15% in the case of girls. Figures D10 and D11 illustrate the different results obtained for this question for boys and girls respectively.

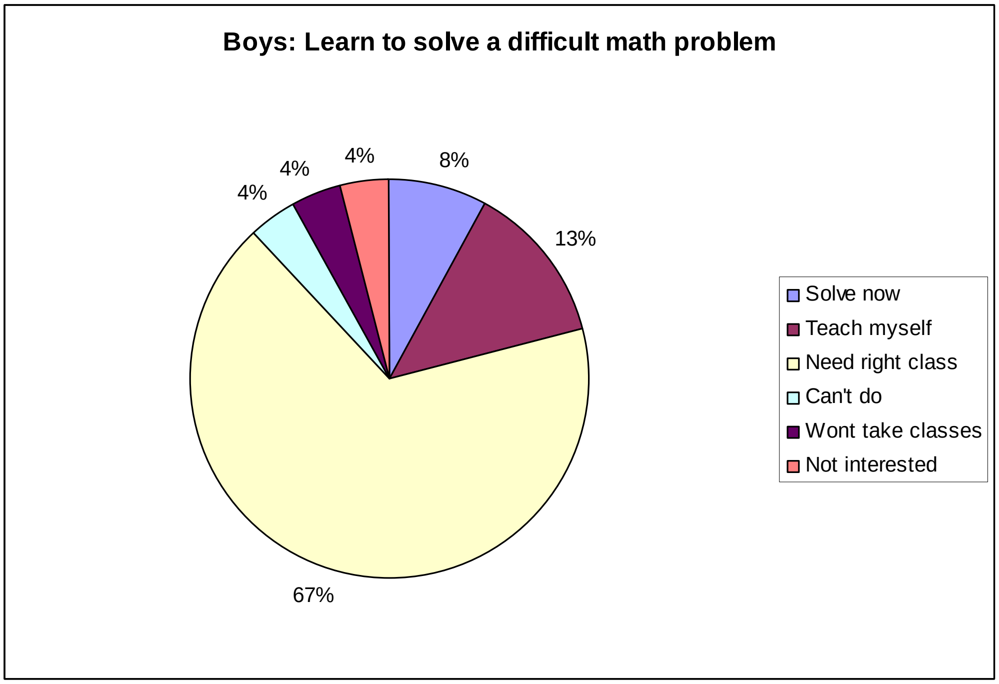


Figure D10. Boys' choices for learning to solve a difficult math problem

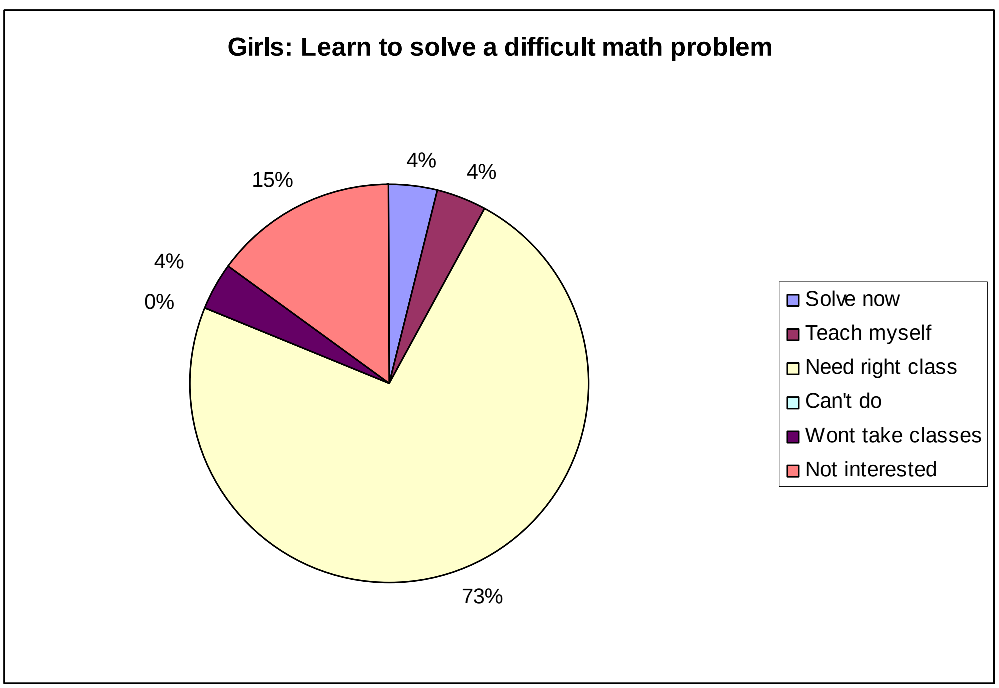


Figure D11. Girls' choices for learning to solve a difficult math problem

The students were asked, “When my teachers talk about people in technology, they are mostly talking about people in….” From several choices, *computer technology* was listed by 58% of all of the students, *medical fields* by 19%, and *manufacturing* by 11%. See Figure D12 for results. There was no significant gender difference in this question. It is interesting to note that the majority view technology as dealing with computers.

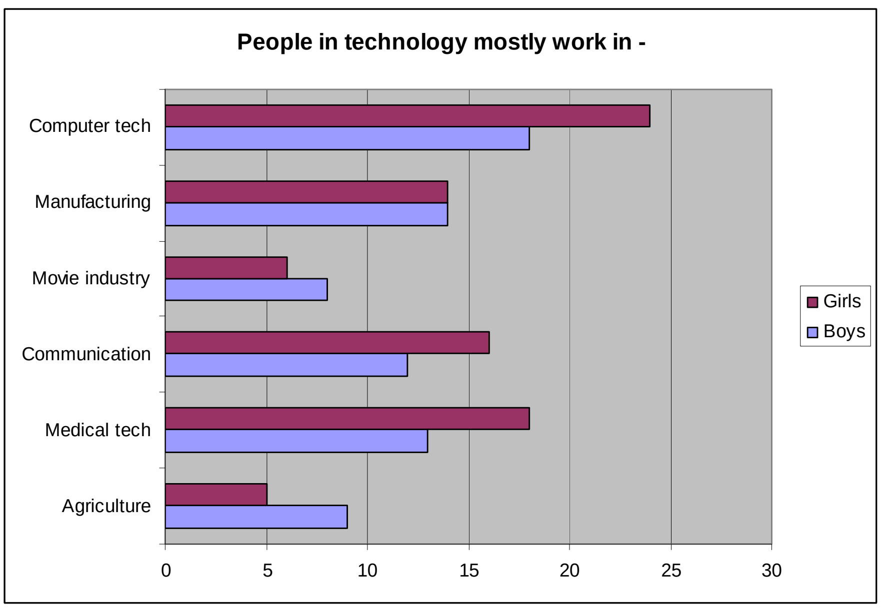


Figure D12. People in technology mostly work in these fields

The survey included a how-to question about fixing a broken bike and a choice of tools to use. It was interesting to note that out of the 15 students who selected the option “don’t know,” 9 were girls and 6 were boys. But it is not clear if today’s students ride bikes as much as they did in the recent past. Therefore it would be unfair to make any generalizations based on this question. See Table D5 for results.

Table D5
I know which tool to use to fix a broken gear on my bike

Gender * DontKnow Crosstabulation

Count

		DontKnow		Total
		no	yes	
Gender	male	18	6	24
	female	17	9	26
Total		35	15	50

Finally the survey gave the students a choice of a large number of products, and asked them which of these they were likely to think as “technical.” It was found that students overwhelmingly identified technology with digital technology (80%), with the option of “computers” topping the list. The complete graph is given below (See Figure D13). They also tended to identify technology with everyday digital products such as the video games, HDTVs, cell phones, and the Internet, in addition to personal computers. However, items such as the printing press, the bulletproof vest, or contact lenses tended to get much fewer votes. This question provided an insight into the technology perceptions of young people today and helped in framing the final survey instrument.

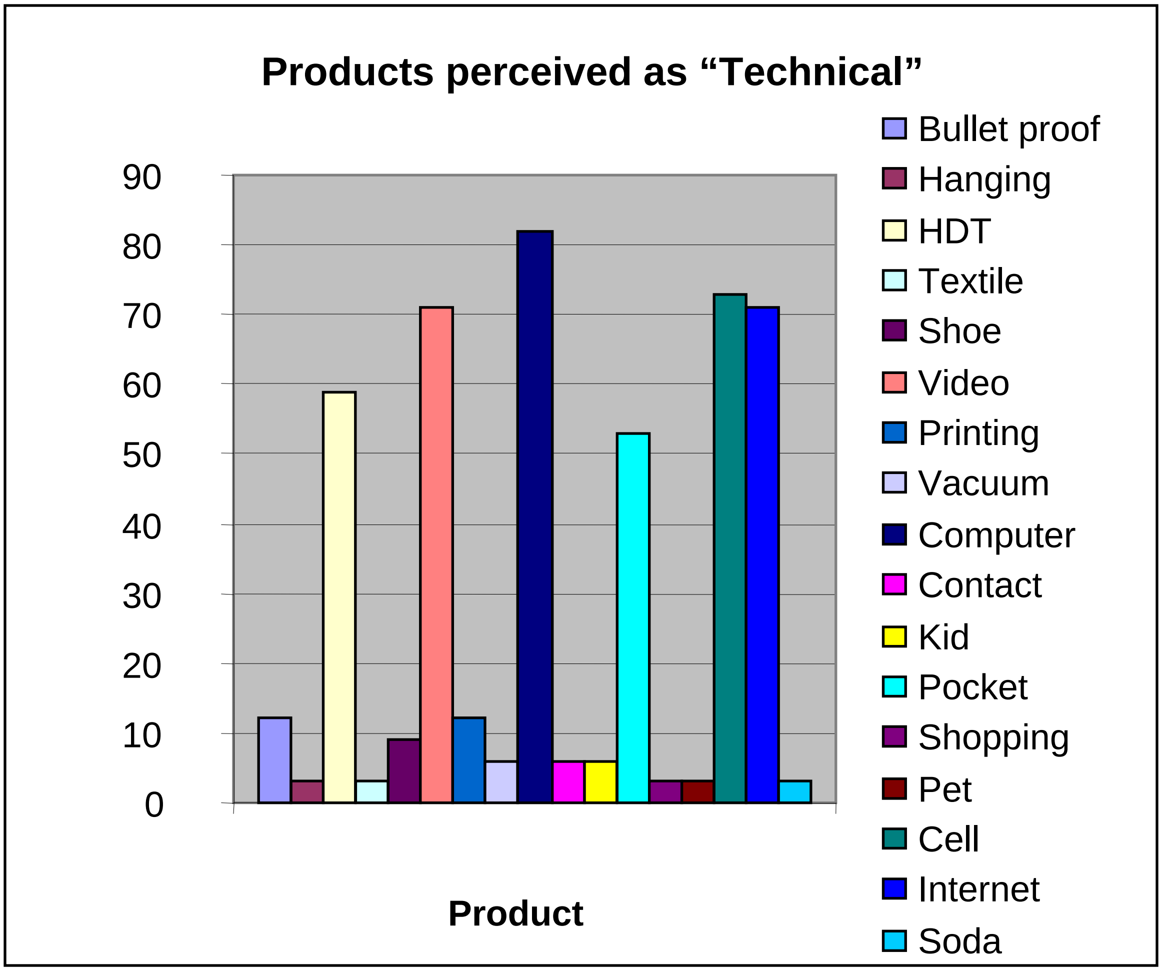


Figure D13. Products perceived as "technical" in Pilot study 2

The following table shows quantitative analysis findings for pilot study 2:

Table D6
Correlation findings by gender: School A data

Gender	Number	α : LOC and Intent to attend college	α : LOC and Intent to major in Engineering	Mean LOC scores (on 1-5 scale) <Error bar>
Girls	26	0.501**	-0.115	3.86 ±0.53
Boys	24	0.385	-0.205	3.71 ±0.53

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Although the correlation between LOC and the intent to major in engineering was not statistically significant in the case of either boys or girls, the numbers were negative in both cases. This is an interesting finding and needs to be investigated further. However, even at the early stage in the research process it was evident that locus of control, which is one way to measure self-esteem, was an important indicator of interest in technology courses in the case of girls but not so much in the case of boys. High scores on locus of control correlated with high scores on girls' intent to attend college, but no such correlation was found in the case of boys.

The data were also segmented by ethnicity, to investigate if there were any statistically significant differences among different ethnic groups by gender. The results obtained are shown in Table D7. Several statistically significant correlations were obtained. However, the actual numbers of the segmented samples are too small to draw any general conclusions. This result points to the need for further research in this area.

Table D7.
Correlation findings by ethnicity and gender: School A data

Ethnicity[11]	**Number of Students**	**Pearson Correlation Coefficient: LOC & SMET**	**Pearson Correlation Coefficient: LOC & SMET**	**Mean LOC scores (on 1-5 scale)**
Caucasians	24	0.527**	0.060	3.74 ±0.53
African Americans	14	0.177	-0.633*	3.77 ±0.53
Multiethnic†	11	0.508	-0.348	3.87 ±0.53
Caucasian Females	11	0.663*	-0.079	3.84 ±0.53
Caucasian Males	12	0.408	0.270	3.65 ±0.53
African American Females	7	0.052	-0.335	3.84 ±0.53
African American Males	7	0.818*	-0.834*	3.70 ±0.53
Multiethnic Females	7	0.565	-0.383	3.81 ±0.53
Multiethnic Males	4	NA	-0.997	4.00 ±0.53

† Those students who used two ethnicities to describe their parents are labeled as multiethnic.

NA There were not enough data to analyze this category.

[11] Final survey focused on gender alone. The study of ethnicity in this context is a subject for future work. It was discontinued in the final research due to the limitations inherent in this study.

Pilot Study 3: Engineering Camp for Girls 2

The third pilot study was conducted in a girls' engineering summer camp, similar to the first study but the following summer. It constituted the penultimate stage in the development of the final survey. The survey used for this pilot is included in Appendix H. Conducted by a large research Midwestern university with an engineering program, the camp was organized to introduce and encourage engineering career options among girls, particularly computer programming. The girls were rising 10th and 11th graders, and they came from different high schools from around the country. It was a week-long program that included hands-on sessions, technology demos, tours of university science facilities, and lectures about engineering careers. The sample size for this pilot study was 35. The ethnic breakdown was as follows:

Caucasian: 16

African American: 9

Asian: 6

Multiethnic: 4

The survey instrument was used as a testing ground for the development of a new set of variables designed to determine the technology perceptions of the respondents and their intent to choose a technology major in college. The first two pilot studies had provided valuable pointers regarding the kind of questions that a survey of this sort could fruitfully ask. With a focus on technology rather than engineering, including questions that addressed students' sense of self-esteem, the third pilot study instrument evolved out of the basic questions that this research was looking to answer. These questions included:

- Is there a correlation between students' level of self-esteem and their intent to major in technology?

- Is there a correlation between their level of confidence in tackling math and science problems and their intent to major in engineering or technology?

- Does greater confidence in knowing about technology and technology devices correlate with increased intent to choose an engineering and/or technology major in college?

A set of research variables was formulated from these questions that could be later analyzed with correlational analysis using SPSS. A description of each variable follows. These were designed as composites consisting of a series of questions.[12] All questions were coded for a 5-anchor point Likert scale ranging from "strongly agree" to "strongly disagree." The final score for the variable was computed in SPSS by adding all the component scores. Following is an enumeration of the variables, with their descriptions, as well as the corresponding questions from the survey instrument that were used to compute final scores.

Variable 1: Gender Signals School (GSS)

Variable Description: *This represents all the messages/signals a student may get from his or her school that imply that boys are superior in math and science.*

Variable Components:

(GSS1) The teachers in my school give the impression that technology courses are more appropriate for boys than girls.

(GSS2) The counselors in my school encourage boys more than girls to pursue engineering/ technology careers.

[12] Questions that asked contradictory information were appropriately reverse-coded in SPSS for analysis.

(GSS3) The teachers in my school encourage boys more than girls to take Advanced Placement courses in math and science.

(GSS4) Boys in my school are more vocal and aggressive in math and science classes.

(GSS5) Teachers in my school call on boys more than on girls in math and science classes.

(GSS6) When I do well on a test or quiz in a math or science class, I am embarrassed and don't want my friends to know.

Variable 2: Gender Technology Perception (GTP)

Variable Description: *This is their level of gender bias – that is, considering boys as being more suitable for technology and technology jobs than girls.*

Variable Components:

(GTP1) I feel that boys are better at math and science than girls.

(GTP2) Most of the "nerds" I know are boys.

(GTP3) Most of the adults I know who work in technology are men.

(GTP4) I feel that women are better at non-technical jobs, particularly ones that deal directly with people, such as psychologists or social workers.

(GTP5) I feel that men are better at technical jobs like engineering compared to women.

(GTP6) Subjects such as science, math, engineering, technology, and computers are easier for boys.

(GTP7) Subjects such as art, literature, and social studies are easier for girls.

Variable 3: Intent to choose science, math, engineering & tech majors in college (SMET)

Variable Description: *This is the expressed intent of students to choose a technology major in college.*

Variable Components:

(SMET1) I am interested in engineering or technology as a possible college major choice.

(SMET2) I am interested in or have taken advanced placement courses in math and science.

Variable 4: Locus of Control (LOC)

Variable Description: *These are locus of control questions to measure their self-esteem based upon Rotter (1966).*

Variable Components:

(LOC1) I am in control of my career goals and choices.

(LOC2) Becoming a success is a matter of hard work; luck has little or nothing to do with it.

(LOC3) When I make plans I am almost certain I can make them work.

(LOC4) If I study hard, I am confident I will be able to do very well in science and math.

(LOC5) In my case getting what I want (like good grades) has little or nothing to do with luck.

(LOC6) I am easily influenced by other people on what I should do with my career.

(LOC7) Sometimes I feel that I don't have enough control over the direction my life is taking.

(LOC8) Many times I feel that I have little influence over the things that happen to me.

(LOC9) I think advanced science and math classes will be as difficult as everyone tells me.

Variable 5: Knowledge of Technology (TECH)

Variable Description: *This is an indication of their expressed confidence in tackling specific technology tasks.*

Variable Components:

(TECH1) I am confident I can explain to my grandparents how a DVD player works.

(TECH2) I am confident that I can prepare a delicious beef stroganoff dinner from a recipe.

(TECH3) I am confident I can fix a non-working object like a bike, roller-blades or a skateboard.

(TECH4) I am confident that I can change the tire on a car.

(TECH5) I am confident that I can make a collect phone call from a pay phone.

(TECH6) I am confident I can put together a new bike by following the assembly instructions.

(TECH7) I am confident that I can create a web page.

(TECH8) I am confident that I can "rip" a CD and turn music into mp3 or WAV files.

Variable 6: MAJOR

Variable Description: *I am confident that I will major in a technology field such as engineering.* Note that unlike other variables, variable 6 was not a composite of several questions.

The sample for the third pilot study was stratified on the basis of ethnicity and some significant correlations were found. Although the results are interesting, the sample size was too small to allow for any conclusions based on ethnicity. As stated earlier, ethnicity as a variable was removed from the analysis for the final surveys in order to limit the scope of this work. The results of this survey are outlined below.

A statistically significant positive correlation was found between the variables GSS and GTP in the case of Caucasians. (0.648**). Further, a statistically significant positive correlation was found between the variables SMET and MAJOR for Caucasians (0.792**). A statistically significant negative correlation was found between the variables LOC and TECH for Caucasians. (-0.558*) However, a statistically significant positive correlation was found between these same two variables for African Americans (0.723*). So for African-Americans a higher sense of self-esteem tended to correlate positively with higher confidence in technology knowledge and ability. However, for Caucasians a higher sense of self-esteem tended to correlate negatively with confidence in technology ability. This is an interesting result and needs further investigation. Moreover, a very high statistically significant positive correlation was found between MAJOR and TECH variables for African Americans (0.803**). The same was not the case with the Caucasians. As mentioned previously, the post-segmented sample size was too small to draw any definite conclusions. Table D8 summarizes these results.

Table D8
Correlation findings for the Pilot Study 3 survey data

Variable 1	**Variable 2**	**Caucasians** N= 16	**African Americans** N= 9	**Asians** N= 6	**Multiethnic** N= 4	**All** N= 35
GSS	GTP	0.648**	-0.393	-0.194	0.195	0.382*
GSS	SMET	-0.459	-0.104	0.150	0.258	-0.199
GSS	LOC	-0.052	0.028	-0.246	-0.934	-0.035
GSS	MAJOR	-0.484	-0.437	0.933**	-0.405	-0.182
GSS	TECH	0.129	-0.461	0.392	0.000	-0.009
GTP	SMET	-0.028	0.114	0.666	0.992**	0.101
GTP	LOC	0.016	0.420	0.023	0.167	0.236
GTP	MAJOR	-0.064	0.214	-0.118	0.764	0.090
GTP	TECH	-0.217	0.354	0.029	0.847	0.076
SMET	LOC	-0.315	0.578	-0.171	0.101	0.058
SMET	MAJOR	0.792**	0.485	-0.059	0.754	0.601**
SMET	TECH	0.301	0.512	-0.101	0.775	0.281
LOC	MAJOR	-0.360	0.642	-0.171	0.682	0.050
LOC	TECH	-0.558*	0.723*	-0.498	0.311	0.071
MAJOR	TECH	0.132	0.803**	0.506	0.584	0.328

Appendix E: Pilot Survey 1: Engineering Camp for Girls

AWE High school Pre-Activity Survey[13]

<Date of Activity><Your Institution Name>

AWE surveys contain items (such as the major list) that you can tailor to your institution and space to add additional formative items. To identify items that can be changed, refer to http://www.engr.psu.edu/awe/Instrument_Instructions.aspx on aweonline.org. Make changes directly to this document. Before distributing the survey, delete this message and replace or delete any items that read "Flexible-add question or delete".

Welcome to >name of activity< at >offering university or college<. (For administered pre-activity survey)
OR
Thank you for registering to participate in >name of activity< at > university or college<. (For mailed pre-activity survey)
Thank you for taking the time to fill out this survey. You will find it very similar to the pre-activity survey that you took. Your answers on both surveys help us understand what you think about this activity, how you may have benefited from it and how to improve it for future offerings. Also, please be sure to have your parents fill out the attached consent form and return it with your survey. If you have questions about the survey, ask any of the people administering it. This survey will take approximately xxx minutes to complete.
Please return this survey to the address below by <date> (For mailed pre-activity survey)
Name and Institutional Address

Name: ________________________________ (Please PRINT your first and last name)
Student Number: ________________
Email: ________________
Name of High school: ________________
Graduating Year: ________________

Gender:
☐ Female
☐ Male

Ethnicity: (Check a maximum of two)
☐ 1. African/Black American
☐ 2. American Indian/Alaskan Native
☐ 3. Asian and Pacific American
☐ 4. Latino/Hispanic American
☐ 5. White American
☐ 6. Other:__________________________

[13] V2.1 AWE Copyright © 2005 A product of AWE-Assessing Women in Engineering (www.aweonline.org). NSF Grant #0120642

1. Check the grade you will enter in Fall 2005. Directions: Check one
□9th □10th □11th □12th

2. What do you expect to get out of this activity? Check all that apply.
□ Meet other girls with interests similar to mine
□Learn more about engineering
□ Learn more about <name of offering college>
□ To have fun
□ Help prepare for college
□ Design and build things
□ Have something to do
□ Make my parents/guardians happy
□ Not sure
□ Other ____

3. How did you hear about this activity? Directions: Check all that apply.
□ My parents told me about it
□ I or my parents did a Web/Internet search
□ A teacher at my school told me about it
□ I saw a newspaper or other advertisement
□ Someone who went to (text) <name of offering college> told me about it
□ I received something in the mail
□ A guidance counselor at my school told me about it
□ Other? _________________________

4. From the list below, check the classes you plan to take next school year in school.
Directions: Check all that apply.

□English	□Physics
□Algebra I	□Foreign languages
□Algebra II	□Computer Applications
□Pre-Calculus	□Computer Science
□Calculus	□Drafting or CAD
□Chemistry	□Other math or science classes ________________________

4a. Are you currently enrolled in honors or advanced classes?	□Yes □No
4b. Have you been encouraged to enroll in honors or advanced classes?	□Yes □No
4c. Do you plan to enroll in honors or advanced classes next year?	□Yes □No
4d. Has anyone talked to you about the importance of taking college prep classes?	□Yes □No

Section I.
(Career Awareness/NOTE: DELETE these items should not appear on final)
1. What do you plan to do when you graduate from high school? Directions: Check one only.

□Go to a College or University
□Go to a Community College
□Attend a technical school (for example: business school, beauty school, technology school, etc)
□Begin work
□Join military
□Get married and work in the home
□Other: ____

2. What do you think engineers do?
Directions: Check the two sentences from the list below that best answer the question.

☐Engineers mainly work on machines and computers
☐Engineers work with other people to solve problems
☐Engineers have lots of choices about what they can do in their jobs
☐Engineers generally work on just one thing
☐Engineers mainly work on things that have nothing to do with me
☐I don't know what engineers do

3. Are you interested in exploring engineering as a possible study/job choice?
☐ Yes ☐ No

If yes, what are the three most important activities or people that have made you decide to explore engineering as a possible study and/or job choice?

Directions: Check no more than three boxes next to the items in the list below.

☐Engineering or other similar camps
☐Hands-on activities related to engineering (like building or making things)
☐Math/science classes or clubs
☐Science Fairs
☐Math Teacher
☐Science, Engineering, or Technology Teacher
☐Other Teacher (Indicate type of teacher: _____________)
☐Guidance Counselor
☐Sisters/Brothers
☐Friends
☐Parent/Guardian(s)
☐Other Relatives
☐Other: ___________________________

4. For the reasons listed below tell us how important you think each is for choosing a job or career.

Directions: "X" the appropriate item below:

- "Not important", if the reason is not important to you;
- "Somewhat important" if the reason is somewhat but not very important;
- "Very important" if the reason is very important to you.

	Not Important	Somewhat Important	Very Important
A. Work that is challenging and makes me think	☐	☐	☐
B. Work that allows me to make lots of money	☐	☐	☐
C. Work that allows me to use math or science skills	☐	☐	☐
D. Work that allows me to tell other people what to do	☐	☐	☐
E. Work that allows me to help solve problems for people	☐	☐	☐
F. Work that is fun to do	☐	☐	☐
G. Work that allows me to have enough time with family	☐	☐	☐

H. Work that allows me to make a difference in my community and/or society	☐	☐	☐
I. Work that makes people think highly of me	☐	☐	☐
J. Other: Work that:	☐	☐	☐

5. In the space below, tell us what you think engineering students do:

Section II.
(Build confidence [efficacy] in STEM Skills; NOTE: DELETE these items should not appear on final)

1. In the space below, make a list of things you think engineers might make or develop that could make a difference in your life (either good or bad):

----

2. The table below lists people who may have talked with you about continuing your education after high school.
Directions: For each individual listed below check one of the following choices

- "Encourages Me to Continue" if the person has encouraged you to continue your education at a college, university or commercial/trade school after you graduate from high school;
- "Discourages Me from Continuing" if that person has discouraged you from continuing your education after high school graduation;
- "Says Nothing About This" if that person has never talked to you about what you might like to do after you graduate from high school.

	Yes	Maybe	No
A. Math Teacher	☐	☐	☐
B. Science, Engineering, or Technology Teacher	☐	☐	☐
C. Other Teacher	☐	☐	☐
D. Guidance Counselor or Advisor	☐	☐	☐
E. Sisters/Brothers	☐	☐	☐
F. Friends	☐	☐	☐
G. Parent/Guardian(s)	☐	☐	☐
H. People who run or help run after school programs or activities	☐	☐	☐
I. Other relatives	☐	☐	☐
I. Other:______________________________	☐	☐	☐

3. Imagine you need to fix a broken gear on your bicycle. Which tools would you use to take it apart?
Directions: Check all that apply.

☐Flat head screwdriver
☐Phillips head screwdriver
☐Socket wrench
☐Monkey wrench
☐Hammer
☐Pliers
☐Don't know
☐Other: ___________________________

4. The table below lists people who encourage your or discourage you about studying math, science or engineering.

Directions: For each individual listed below, check one of the following choices:

- "Encourages Me" in the subject listed if the person has encouraged you to continue studying or to do well in that subject;
- "Discourages me" if that person has discouraged you or told you that you do not have the talent for that subject;
- "Not Applicable" if you do not have such a person (e.g. brother or sister) in your life.

	Yes	Maybe	No
A. Math Teacher	☐	☐	☐
B. Science, Engineering, or Technology Teacher	☐	☐	☐
C. Other Teacher	☐	☐	☐
D. Guidance Counselor or Advisor	☐	☐	☐
E. Sisters/Brothers	☐	☐	☐
F. Friends	☐	☐	☐
G. Parent/Guardian(s)	☐	☐	☐
H. People who run or help run after school programs or activities	☐	☐	☐
I. Other relatives	☐	☐	☐
I. Other:______________________________	☐	☐	☐

Section III.

(Increase academic skills/preparation/improving skills—Note to activity coordinators: For activities that are specifically oriented toward developing specific skills, we suggest developing questions that test the participant's ability to do those skills. NOTE: DELETE these items should not appear on final)

1. If you encounter a math homework problem that you didn't know how to solve, what are you most likely to do?

Directions: Check one only.

☐Take some time and try to figure out how to best approach solving this problem
☐Ask a parent or other family member for help with the problem
☐Call a friend who you know is good at math and ask her or him for help so you can solve it
☐Get help from your math teacher on this problem
☐Just copy the answer from one of your friends
☐Just skip that problem
☐Other (please specify) ____

2. This is an example of an advanced math problem:

$$\int \frac{\left(\frac{2}{9}\right)}{x+1}dx + \int \frac{\left(-\frac{4}{3}\right)}{(x+1)^2}dx + \int \frac{\left(\frac{7}{9}\right)}{x-2}dx = \frac{2}{9}\ln|x+1| + \frac{4}{3}\left(\frac{1}{x+1}\right) + \frac{7}{9}\ln|x-2| + C$$

2a. What do you think your ability to learn to solve this problem is? (Check one)

☐I can solve this problem now
☐I can teach myself to solve this problem
☐I will be able to learn to solve this problem once I take the right classes.
☐Even if I took the right class, I wouldn't be able to learn to solve this problem.
☐I don't think I will ever take a class that has problems this hard.
☐I am not interested in learning to solve this type of math problem.
☐Other:____

Section IV.
(Building supportive community; NOTE: DELETE these items should not appear on final)

1. Tell us how involved you are in any of the activities listed below.
Directions: For each activity listed below check one of the following choices:

- "Not at all" if you never do that kind of activity;
- "Sometimes" if you do that activity sometimes;
- "Often" if you do that activity as often as you can;
- "Not Available To Me" if you don't know about activities listed or if they are not offered at your school.

	Not at all	Sometimes	Often	Not Available to Me
A. School clubs or groups that offer problem solving activities.				
B. School clubs or groups that design and/or build things.				
C. Science Fair Projects				
D. Outside of school clubs that offer activities that involve designing and/or building things				
E. Girl Scouts, Boy Scouts, or another similar club.				
F. Summer camp or program				
G. Other engineering or science/technology activities(provide name):				

2. Choose the sentences below that best describe what is true for you:
Directions: Check all that apply

☐I know older girls who do well in math or science fairs or competitions

□I know older girls who really like to do science projects
□I know older girls who are studying engineering
□I know grown ups who are engineers
□I don't know any one who is an engineer
□I know some older girls but I don't know how interested they are in math or science

3. Imagine that your project has just won first place in your school's science fair. What would you do?
Directions: Check one:
□Tell everyone you know
□Tell your family but not your friends
□Tell your friends but not your family
□Tell some of your friends, but not all of them
□Not tell anyone

4. Do you know anyone who is an engineer?
(Circle One) Yes No Don't Know

If yes, who? Directions: Check all that apply

□Parent or Guardian	□Friend	□Sister/Brother
□Other relative(s)	□Teacher	□Other:

Section V.

(Branding/Long term Recruiting/ Introduce young women to a university environment; NOTE: DELETE these items should not appear on final)

1. Is this the first time you have been on a University campus? □ Yes □ No

2. What is the chance that you will attend <name of offering college>?
Please indicate by marking an "x" on the line below:

No Chance Definitely
←--→
0% 25% 50% 75% 100%

3. What is the chance that you will major in Engineering in college? Please indicate by marking an "x" on the line below.

No Chance Definitely
←--→
0% 25% 50% 75% 100%

Thank You!

Appendix F: Pilot Survey 2: School A

"Computer Chips and Biology" Pre-Survey

Welcome to Computer Chips and Biology. In another class period we will do an activity to show you some examples where computer chips are used to help people manage medical conditions such as Parkinson's disease. We will also show you how computer chips are made and what types of people who make chips.

But before we do the activity, we would like to ask you a few questions. This will help us improve the activity we are going to do. You will be asked to do another survey at the end of the activity. This will help tell us if the activity was useful and if we should do this again with another class. This survey will take approximately 10 - 15 minutes to complete.

Thanks!

Mrs. Bertsos, Lincoln High school
Professor Mary Brake, Eastern Michigan University
Ms. Kaninika Bhatnagar, Eastern Michigan University
Please return this survey to Mrs. Bertsos

Student Number: ________________

Gender:
☐Female
☐Male

Ethnicity: (Check a maximum of two)
☐ 1. White American
☐ 2. African/Black American
☐ 3. Latino/Hispanic American
☐ 4. Asian and Pacific American
☐ 5. American Indian/Alaskan Native
☐ 6. Other:___________________________

PART I

1. What grade are you in? Directions: Check one
9th 10th 11th 12th

2. What do you expect to get out of this activity? Check all that apply.
☐ Learn more about technology
☐ Learn more about ________________________________(Please fill in)
☐ To have fun
☐ Help prepare for college
☐ Design and build things
☐ Make my parents/teacher happy
☐ Not sure

□ Other ____

3. From the list below, check the classes you are currently taking in school this year.
Directions: Check all that apply.

□English	□Physics
□Algebra I	□Foreign languages
□Algebra II	□Computer Applications
□Pre-Calculus	□Computer Science
□Calculus	□Drafting or CAD
□Chemistry	□Other math or science classes

4a. Are you currently enrolled in honors or advanced classes?	□Yes □No
4b. Have you been encouraged to enroll in honors or advanced classes?	□Yes □No
4c. Do you plan to enroll in honors or advanced classes next year?	□Yes □No
4d. Has anyone talked to you about the importance of taking college prep classes?	□Yes □No

5. What do you plan to do when you graduate from high school? Directions: Check one only.

□Go to a College or University
□Go to a Community College
□Attend a technical school (for example: business school, beauty school, technology school, etc)
□Begin work
□Join military
□Get married and work from home
□Other: ______________________________________

6. What do you think engineers and people with technology degrees do?
Directions: Check the two sentences from the list below that best answer the question.

□Engineers/Technologists mainly work on machines and computers
□Engineers/Technologists work with other people to solve problems
□Engineers/Technologists have lots of choices about what they can do in their jobs
□Engineers/Technologists generally work on just one thing
□Engineers/Technologists mainly work on things that have nothing to do with me
□I don't know what engineers/technologists do
□Other: ________________________

7. Are you interested in exploring engineering or technology as a possible study/job choice?
□ Yes □ No
If no, proceed to question 8.
If yes, what are the three most important activities or people that have made you decide to explore engineering or a technology related field as a possible study and/or job choice.
Directions: Check no more than three boxes next to the items in the list below.
□Engineering or other similar camps
□Hands-on activities related to engineering (like building or making things)
□Math/science classes or clubs
□Science Fairs
□Math Teacher
□Science, Engineering, or Technology Teacher
□Other Teacher (Indicate type of teacher: ____________)

☐Guidance Counselor
☐Sisters/Brothers
☐Friends
☐Parent/Guardian(s)
☐Other Relatives
☐Other: ___________________________

8. For the reasons listed below tell us how important you think each is for choosing a job or career.
Directions: "X" the appropriate item below:

- "Not important", if the reason is not important to you;
- "Somewhat important" if the reason is somewhat but not very important;
- "Very important" if the reason is very important to you.

	Not Important	Somewhat Important	Very Important
A. Work that is challenging and makes me think	☐	☐	☐
B. Work that allows me to make lots of money	☐	☐	☐
C. Work that allows me to use math or science skills	☐	☐	☐
D. Work that allows me to tell other people what to do	☐	☐	☐
E. Work that allows me to help solve problems for people	☐	☐	☐
F. Work that is fun to do	☐	☐	☐
G. Work that allows me to have enough time with family	☐	☐	☐
H. Work that allows me to make a difference in my community and/or society	☐	☐	☐
I. Work that makes people think highly of me	☐	☐	☐
J. Other: Work that:	☐	☐	☐

9. In the space below, tell us what you think engineering students do:

10. In the space below, make a list of things you think engineers might make or develop that could make a difference (either good or bad) in your life:

11. The table below lists people that you could talk to about continuing your education at a college, university or commercial/trade school after you graduate from high school.
Directions: Using the scale below, check on one of the choices:

- "Yes" if you would talk to that person about continuing your education at a college, university or commercial/trade school after you graduate from high school;
- "Maybe" if you might talk with that person;
- "No" if you would not talk to that person about what you might like to do after you graduate from high school.

	Yes	Maybe	No
A. Math Teacher	☐	☐	☐
B. Science, Engineering, or Technology Teacher	☐	☐	☐
C. Other Teacher	☐	☐	☐
D. Guidance Counselor or Advisor	☐	☐	☐
E. Sisters/Brothers	☐	☐	☐
F. Friends	☐	☐	☐
G. Parent/Guardian(s)	☐	☐	☐
H. People who run or help run after school programs or activities	☐	☐	☐
I. Other relatives	☐	☐	☐
I. Other:_____________________________	☐	☐	☐

12. Imagine you need to fix a broken gear on your bicycle. Which tools would you use to take it apart? Directions: Check all that apply.

☐Flat head screwdriver
☐Phillips head screwdriver
☐Socket wrench
☐Monkey wrench
☐Hammer
☐Pliers
☐Don't know
☐Other: __________________________

13. The table below lists people that you could talk to about studying math, science or engineering.

Directions: Using the scale below, check on one of the choices:

- "Yes" if you would talk to that person studying math, science or engineering.
- "Maybe" if you might talk with that person;
- "No" if you would not talk to that person about studying math, science or engineering.

	Yes	Maybe	No
A. Math Teacher	☐	☐	☐
B. Science, Engineering, or Technology Teacher	☐	☐	☐
C. Other Teacher	☐	☐	☐
D. Guidance Counselor or Advisor	☐	☐	☐
E. Sisters/Brothers	☐	☐	☐
F. Friends	☐	☐	☐
G. Parent/Guardian(s)	☐	☐	☐
H. People who run or help run after school programs or activities	☐	☐	☐
I. Other relatives	☐	☐	☐

I. Other:______________________________	☐	☐	☐

14. If you encounter a math homework problem that you didn't know how to solve, what are you most likely to do?
Directions: Check one only.
☐Take some time and try to figure out how to best approach solving this problem
☐Ask a parent or other family member for help with the problem
☐Call a friend who you know is good at math and ask her or him for help so you can solve it
☐Get help from your math teacher on this problem
☐Just copy the answer from one of your friends
☐Just skip that problem
☐Other (please specify) ____

15. This is an example of an advanced math problem:

$$\int \frac{\left(\frac{2}{9}\right)}{x+1}dx + \int \frac{\left(-\frac{4}{3}\right)}{(x+1)^2}dx + \int \frac{\left(\frac{7}{9}\right)}{x-2}dx = \frac{2}{9}\ln|x+1| + \frac{4}{3}\left(\frac{1}{x+1}\right) + \frac{7}{9}\ln|x-2| + C$$

What do you think your ability <u>to learn</u> to solve this problem is? (Check one)

☐I can solve this problem now
☐I can teach myself to solve this problem
☐I will be able to learn to solve this problem once I take the right classes.
☐Even if I took the right class, I wouldn't be able to learn to solve this problem.
☐I don't think I will ever take a class that has problems this hard.
☐I am not interested in learning to solve this type of math problem.
☐Other:____

16. Tell us how involved you are in any of the activities listed below.
Directions: For each activity listed below check one of the following choices:

- "Not at all" if you never do that kind of activity;
- "Sometimes" if you do that activity sometimes;
- "Often" if you do that activity as often as you can;
- "Not Available To Me" if you don't know about activities listed or if they are not offered at your school.

	Not at all	Sometimes	Often	Not Available to Me
A. School clubs or groups that offer problem solving activities.				
B. School clubs or groups that design and/or build things.				
C. Science Fair Projects				
D. Outside of school clubs that offer activities that involve designing and/or building things				
E. Girl Scouts, Boy Scouts, or another				

similar club.				
F. Summer camp or program				
G. Other engineering or science/technology activities(provide name):				

17. Choose the sentences below that best describe what is true for you:
Directions: Check all that apply

□I know older students who do well in math or science fairs or competitions
□I know older students who really like to do science projects
□I know older students who are studying engineering
□I know grown ups who are engineers
□I don't know any one who is an engineer
□I know some older students but I don't know how interested they are in math or science

18. Imagine that your project has just won first place in your school's science fair. What would you do?
Directions: Check one:
□Tell everyone you know
□Tell your family but not your friends
□Tell your friends but not your family
□Tell some of your friends, but not all of them
□Not tell anyone

19. Do you know anyone who is an engineer or in a technology intensive field?
(Circle One) Yes No Don't Know

If yes, who? Directions: Check all that apply

□Parent or Guardian	□Friend	□Sister/Brother
□Other relative(s)	□Teacher	□Other:

20. What is the chance that you will attend a college or university?
Please indicate by marking an "x" on the line below:

No Chance Definitely
←---→
0% 25% 50% 75% 100%

21. What is the chance that you will major in Engineering or a Technology major (e.g. industrial technology, engineering management, information security) in college? Please indicate by marking an "x" on the line below.

No Chance Definitely
←---→
0% 25% 50% 75% 100%

PART II

Please check the box that is closest to your opinion in each case:

1. Where have you heard that computers are mostly about technology?

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
TV programs					
Movies					
Parents					
Sisters/brothers					
Friends					
Teachers					

2. When my teachers talk about people in technology, they are mostly talking about people in:

	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Computer technology					
Manufacturing					
Movie industry					
Communication fields					
Agriculture fields					
Medical fields					

3. I am in control of / in charge of my career goals and choices.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

4. My family is the main guiding factor in my choice of a career.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

5. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

6. I get easily influenced by other people on what I should do with my career.

☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

7. Sometimes I feel that I don't have enough control over the direction my life is taking.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

8. When I make plans I am almost certain I can make them work.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

9. If I study hard, I am confident I will be able to do very well in science and math.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

10. Many times I feel that I have little influence over the things that happen to me.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

11. I think advanced science and math classes will be as difficult as everyone tells me.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

12. The reasons I don't get better grades is because the teachers do not do a good job.
☐Strongly agree
☐Somewhat agree
☐Neutral
☐Somewhat disagree
☐Strongly disagree

13. In my case getting what I want has little or nothing to do with luck.
☐Strongly agree
☐Somewhat agree

☐Neutral
☐Somewhat disagree
☐Strongly disagree

14. List two careers that you might find interesting:
a. ________________________________ b. ________________________________

15. List five careers that you think use technology:

a. ________________________________ b. ________________________________

c. ________________________________ d. ________________________________

16. When I think technology, the first few things I think of are:

☐space shuttle	☐printing press	☐shopping cart
☐space station	☐computers	☐solar system
☐bullet proof vest	☐cell phone	☐PDAs
☐hanging folders	☐vacuum cleaner	☐pet toys
☐textiles	☐internet	☐crop rotation
☐internet phone service	☐contact lenses	☐radio
☐shoes	☐kid toys	☐home theater
☐High-definition TV	☐global warming	☐soda bottle
☐video games	☐TIVO	☐pocket PC

Appendix G: LOC Scale Development

Rotter Scale

1. ○ Many of the unhappy things in people's lives are partly due to bad luck
   ○ People's misfortunes result from the mistakes they make.

2. ○ One of the major reasons why we have wars is because people don't take enough interest in politics.
   ○ There will always be wars, no matter how hard people try to prevent them.

3. ○ In the long run, people get the respect they deserve in this world.
   ○ Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

4. ○ The idea that teachers are unfair to students is nonsense.
   ○ Most students don't realize the extent to which their grades are influenced by accidental happenings.

5. ○ Without the right breaks, one cannot be an effective leader.
   ○ Capable people who fail to become leaders have not taken advantage of their opportunities.

6. ○ No matter how hard you try, some people just don't like you.
   ○ People who can't get others to like them don't understand how to get along with others.

7. ○ I have often found that what is going to happen will happen.
   ○ Trusting to fate has never turned out well for me as making a decision to take a definite course of action.

8. ○ In the case of the well prepared student, there is rarely, of ever, such a thing as an unfair test.
   ○ Many times exam questions tend to be so unrelated to course work that studying is really useless.

9. ○ Becoming a success is a matter of hard work, luck has little or nothing to do with it.
   ○ Getting a good job depends mainly on being in the right place at the right time.

10. ○ The average citizen can have an influence in government decisions.
    ○ This world is run by the few people in power, and there is not much the little guy can do about it.

11. ○ When I make plans, I am almost certain that I can make them work.
    ○ It is not always wise to plan too far ahead because many things turn out to be a matter of luck anyway.

12. ○ In my case getting what I want has little or nothing to do with luck.
    ○ Many times we might just as well decide what to do by flipping a coin.

13. ○ What happens to me is my own doing.
    ○ Sometimes I feel that I don't have enough control over the direction my life is taking.

LOC scale used for Schools B and C

Questions taken from Rotter scale:

2. Becoming a success is a matter of hard work; luck has little or nothing to do with it.
(HardWorkNotLuck LOC3)

4. Sometimes I feel that I don't have enough control over the direction my life is taking.
(NoControl LOC5)

5. When I make plans I am almost certain I can make them work.
(MakePlansWork LOC6)

7. Many times I feel that I have little influence over the things that happen to me.
(NoInfluence LOC8)

9. In my case getting what I want has little or nothing to do with luck.
(NotLuck LOC11)

New questions added:

1. I am in control of / in charge of my career goals and choices.
(InControl LOC1)

3. I get easily influenced by other people on what I should do with my career.
(OthersInfluence LOC4)

6. If I study hard, I am confident I will be able to do very well in science and math.
(StudyDoWell LOC7)

8. I think advanced science and math classes will be as difficult as everyone tells me.
(SciMathDifficult LOC9)

Appendix H: Pilot Survey 3: Engineering Camp for girls

Perceptions of Technology

Thank you for taking the time to fill out this survey. Your answers will help us understand how high school students perceive technology. Thanks!

Gender
[] Female
[] Male

Ethnicity (Check a maximum of two)
[] White American
[] African/Black American
[] Latino/Hispanic American
[] Asian and Pacific American
[] American Indian/ Alaskan Native
[] Other

Please check the option that matches your opinion the most:

(GSS1)
1. The teachers in my school give the impression that technology courses are more appropriate for boys than girls.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GSS2)
2. The counselors in my school encourage boys more than girls to pursue engineering/ technology careers.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GSS3)
3. The teachers in my school encourage boys more than girls to take Advanced Placement courses in math and science.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(CONF1)
4. I feel like I don't really belong in math and science classes because I am not very good as these subjects.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(CONF2)
5. I am good at math and science.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GSS4)
6. Boys in my school are more vocal and aggressive in math and science classes.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GSS5)
7. Teachers in my school call on boys more than on girls in math and science classes.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GSS6)
8. When I do well on a test or quiz in a math or science class, I am embarrassed and don't want my friends to know.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

9. My parent's opinion of what I plan to do after high school is very important to me.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

10. My friends' opinion of what I plan to do after high school is very important to me.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP1)
11. I feel that boys are better at math and science than girls.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP2)
12. Most of the 'nerds' I know are boys.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP3)
13. Most of the adults I know who work in technology, are men.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP4)
14. I feel that women are better at non-technical jobs, particularly ones that deal directly with people such as a psychologist or social worker.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP5)
15. I feel that men are better at technical jobs like engineering compared to women.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP6)
16. Subjects such as science, math, engineering, technology and computers are easier for boys.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(GTP7)
17. Subjects such as art, literature and social studies are easier for girls.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(SMET1)
18. I am interested in engineering or technology as a possible college major choice.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

19. I am interested in or have taken advanced placement courses in math and science.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCh1)
20. I am in control of my career goals and choices.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCh2)
21. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCh3)
22. When I make plans I am almost certain I can make them work.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCh4)
23. If I study hard, I am confident I will be able to do very well in science and math.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

24. In general, I am good at math and science courses.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCh5)
25. In my case getting what I want (like good grades) has little or nothing to do with luck.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCl1)
26. I am easily influenced by other people on what I should do with my career.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCl2)
27. Sometimes I feel that I don't have enough control over the direction my life is taking.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCl3)
28. Many times I feel that I have little influence over the things that happen to me.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(LOCl4)
29. I think advanced science and math classes will be as difficult as everyone tells me.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH1)
30. I am confident I can explain to my grandparents how a DVD player works.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH2)
31. I am confident that I can prepare a delicious beef stroganoff dinner from a recipe.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH3)
32. I am confident I can fix a non-working object like a bike, roller-blades or a skateboard.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH4)
33. I am confident that I can change the tire on a car.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree

[] Strongly disagree

(TECH5)
34. I am confident that I can make a collect phone call from a pay phone.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH6)
35. I am confident I can put together a new bike by following the assembly instructions.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

36. It is possible to design a car that is 100% energy efficient.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH7)
37. I am confident that I can create a web page.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(TECH8)
38. I am confident that I can "rip" a CD and turn music into mp3 or WAV files.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

39. I am confident that I will graduate from high school and attend college.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree

(SMET2)
40. I am confident that I will major in a technology field such as engineering.
[] Strongly agree
[] Somewhat agree
[] Neither agree nor disagree
[] Somewhat disagree
[] Strongly disagree
[] I do not plan to attend college.

Thank you for your time!

Appendix I: Suggested New Variables

Questions to measure Emotional Intelligence (EQ)

1. I am comfortable about sharing my emotions with others.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

2. I am able to forgive others when they have offended me.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

3. I can tell when other people's feelings have been hurt.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

4. I tend to be very judgmental of other's mistakes.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

5. I help other people feel better when they are down.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

6. I am a good listener.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

7. I am able to control my emotions.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

8. I know when to express certain emotions in public and when not to.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

Questions to examine opinions on science, society, and gender[14]:

1. Scientists have practically no family life or social life because they need to be so deeply involved in their work.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

2. Some communities produce more scientists than other communities. This happens as a result of the upbringing which children receive from their family, schools and community.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

3. Scientists can solve any practical everyday problem best (for example, getting a car out of a ditch, cooking, or caring for a pet) because scientists know more science.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

4. High technology industries will provide most of the new jobs in the next twenty years.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

5. Women would do science somewhat differently because, by nature or by upbringing, females have different viewpoints, imagination or characteristics (such as patience).
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

6. Men would do science somewhat differently because men do science better.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

7. Women would likely do science somewhat better than men because women must work harder in order to compete in a male dominated field such as science.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

8. Male scientists concentrate only on facts which support an idea. Female scientists in the lab also pay attention to human values.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

9. Male scientists concentrate only on objective (“factual”) reasoning. Female scientists also pay attention to subjective (“personal”) feelings.
Strongly agree Somewhat agree Neutral Somewhat disagree Strongly disagree

Pick One:
10. Technology is:
○ New processes, instruments, tools, machinery, appliances, gadgets, or practical devices for everyday use.
○ Robotics, electronics, computers, communication systems, automation etc.
○ A technique for doing things, or a way of solving practical problems.
○ Inventing, designing and testing things (for example, artificial hearts, computers, space vehicles).
○ Ideas and techniques for designing and manufacturing things, for organizing workers, business people and consumers for the progress of society.

11. Today there are many more male scientists than female scientists. The MAIN reason is:
○ Males are stronger, faster, brighter, and better at concentrating on their studies.
○ Males seem to have more scientific abilities than females, who may excel in other fields.

[14] Some of these questions are from the VOSTS inventory (Aikenhead et al., 1989)

○ Males are just more interested in science than females.
○ The traditional stereotype held by society has been that men are smarter and dominant, while women are weaker and less logical. This prejudice has caused more men to become scientists, even though females are just as capable in science as males.
○ The schools have not done enough to encourage females to take science courses. Females are just as capable in science as males.
○ Until recently, science was thought to be a man's vocation. (women didn't fit television's stereotype image of scientist.) In addition, most women were expected to work in the home or take on traditional jobs. (thus men have had more encouragement to become scientists) But today this is changing. Science is becoming a vocation for women, and women are expected to work in science more and more.
○ Women have been discouraged, or not allowed, to enter the scientific field. Women are just as interested and just as capable as men; but the established scientists (who are males) tend to discourage or intimidate potential female scientists.