



ncete[™]

**NATIONAL CENTER FOR
ENGINEERING
AND TECHNOLOGY
EDUCATION**

Research in Engineering and Technology Education

**YOUNG WOMEN'S PERCEPTIONS
OF TECHNOLOGY AND ENGINEERING:
FACTORS INFLUENCING THEIR PARTICIPATION
IN MATH, SCIENCE AND TECHNOLOGY?**

**Leah C. Roue
University of Wisconsin-Stout, 2007**



This material is based on work supported by the
National Science Foundation Under Grant No. ESI-0426421

Young Women's Perceptions of Technology and Engineering: Factors Influencing Their
Participation in Math, Science and Technology?

by

Leah C. Roue

A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
in

Industrial/Technology Education

Approved: Two Semester Credits

Richard J. Tafalla, Ph.D.

The Graduate School
University of Wisconsin-Stout

May, 2007

|

**The Graduate School
University of Wisconsin-Stout
Menomonie, WI**

Author: Roue, Leah C.

Title: *Young Women's perceptions of Technology and Engineering: Factors
Influencing Their Participation in Math, Science and Technology?*

Graduate Degree/ Major: Industrial/Technology Education

Research Adviser: Richard J. Tafalla, Ph.D.

Month/Year: May, 2007

Number of Pages: 44

Style Manual Used: American Psychological Association, 5th edition

ABSTRACT

The current number of women in technology and engineering only represents a fraction of today's workforce. Technological innovation depends on our nation's best and brightest, representing all segments of our diverse society. Sanders (2005), in talking about women in technology and engineering, stated that women's lack of participation can only be measured in jobs not filled, problems not solved, and technology not created. Research in the area of how young women view technology will provide insights into how to better encourage and prepare them for careers in technology and engineering.

The purpose of this exploratory study was to examine four areas that may present barriers for women in technology and engineering: They are young women's perceptions, self-esteem, self-efficacy, and perceived social support as they relate to their interest in science, technology, engineering, and mathematics (STEM).

The study examined pre-test measures of a group of about 2,800 girls participating in the Summer Technology and Engineering Preview at Stout (STEPS) program. This girls' camp gives young women entering the seventh grade a chance to work in a laboratory setting with their peers with the goal of piquing their interest in the areas of technology and engineering.

The results showed that the greatest predictor of math and science interest was self-esteem, accounting for 36.4% of the variability in the interest scale. Self-efficacy was the second highest predictor, accounting for 26.5% of the variability. Perceived social support accounted for 17.8% of the variability. The least significant predictor of math and science interest was perceptions, accounting for a mere 4.1% of the variability.

The Graduate School
University of Wisconsin Stout
Menomonie, WI
Acknowledgments

Mumsy
Dr. Brian McAlister

TABLE OF CONTENTS

	Page
.....	
ABSTRACT.....	ii
List of Tables	vii
List of Figures.....	vii
Chapter I: Introduction.....	1
<i>Statement of the Problem</i>	2
<i>Purpose of the Study</i>	2
<i>Assumptions of the Study</i>	3
<i>Definition of Terms</i>	3
<i>Limitations of the Study</i>	3
<i>Methodology</i>	4
Chapter II: Literature Review	5
<i>State of the Problem</i>	5
<i>Unfilled Jobs</i>	5
<i>World Economy</i>	6
<i>Untapped Resources and Talents</i>	6
<i>Females in Technology and Engineering Education</i>	7
<i>Females in Technology and Engineering Careers</i>	8
<i>How has the problem changed?</i>	8
<i>Perceptions</i>	9
<i>Self-esteem</i>	10
<i>Perceived Social Support</i>	11
<i>Self-efficacy</i>	13

<i>Summary</i>	14
Chapter III: Methodology	16
<i>Subject Selection and Description</i>	16
<i>Instrumentation</i>	17
<i>Data Collection Procedures</i>	17
<i>Data Analysis</i>	18
<i>Limitations</i>	18
Chapter IV: Results	19
<i>Introduction</i>	19
<i>Correlations Investigated</i>	19
Chapter V: Discussion	27
<i>Limitations</i>	27
<i>Conclusions</i>	28
<i>Correlations Investigated</i>	28
<i>Recommendations</i>	29
References	31
Appendix A: Survey Instrument	35

List of Tables

Table 1: Math and Science Interest Scale Mean Responses: Question Number One.....	20
Table 2: Perceptions Scale Mean Responses: Question Number Six.....	21
Table 3: Self-Efficacy Scale Mean Responses: Question Number Seven.....	22
Table 4: Self-Efficacy Mean Responses: Question Number Eight.....	23
Table 5: Self-Esteem Scale Mean Responses: Question Number Ten, A and B.....	24
Table 6: Perceived Social Support Scale: Question Number Ten, C-P.....	25

Chapter I: Introduction

The science, technology, engineering, and mathematics (STEM) workforce faces the ongoing challenge of increasing the women's involvement (Clewell, Cosentino de Cohen, Tsui, et al. (2005). Technological innovation depends on our nation's best and brightest, representing all segments of our diverse society. Sanders (2005, ¶7) stated that "Women's participation therefore becomes a powerful issue of innovation, competitiveness, and workforce sustainability. They are a valuable untapped resource whose absence can only be measured in technology not created, problems not solved, and jobs not filled." Women in science and engineering remain a distinct minority, representing approximately 10% of professionals in these fields (Zonta International, n. d.). Knowing how young women view technology will provide insights into how to better encourage and prepare them for careers in technology and engineering.

The purpose of this exploratory study was to examine four areas that may present barriers for women in technology and engineering: young women's perceptions, self-esteem, self-efficacy, and perceived social support as they related to their participation in technology and engineering classes or careers.

The study examined pre-test measures of a group of approximately 2,800 girls participating in the Summer Technology and Engineering Preview at Stout (STEPS) program. This girls' camp was established in 1997 to give young women entering the seventh grade a chance to work in a laboratory setting with their peers with the goal of piquing their interest in the areas of technology and engineering (STEPS for Girls, n. d.). Activities included designing, manufacturing, and flying a radio controlled model airplane. The survey data used in this study was gathered from STEPS campers who

attended from 2000 to 2005, the majority of whom (63.3%) were 12 years old. Girls entering the seventh grade were enrolled by their parent(s) and nominated by their school based on their interest, aptitude, or potential in science and math.

Statement of the Problem

Females remain under-represented in STEM careers (Reed-Jenkins, 2003). Female enrollment in technology related fields is at the lowest level since 1985 (Treyvaud & Rounds, 2003). “Balancing the Equation” (1998), a press release by the National Council for Research on Women, stated that the United States workforce was comprised of 45% women in 1996 but only 12% of them held science and engineering jobs. The press release also stated that in 1999, women earned less than 20% of computer science degrees and in 1996 they earned only 18% of engineering degrees.

More research is needed to understand the relationship between girls’ perceptions of STEM fields and their low enrollment and participation in these areas. High school girls perceive mathematicians and scientists as loners, nerds, and social outcasts and also feel that these fields are male dominated and view them as a man’s job (National Engineers Week Foundation, n. d.).

Purpose of the Study

The purpose of this study was to survey girls entering the STEPS program to determine whether young women’s perceptions, perceived social support, self-esteem, and self-efficacy play a role in their participation in technology and engineering education and careers. The study’s findings could potentially be used by educators and employers to increase female participation in the areas of technology and engineering.

Assumptions of the Study

This study assumes that the girls' perceptions are related to their interest and involvement in STEM education and careers. It also assumes the participants answered the questionnaire truthfully and without outside influences. The study assumes that the number of participants surveyed provides a representative sample of students in the STEPS camp and that the survey instrument was adequate in its measurement.

Definition of Terms

Self-efficacy. The belief that one has the capabilities to execute the courses of actions required to manage prospective situations. Self-efficacy relates to a person's perception of their ability to reach a goal.

Self-esteem. A person's subjective appraisal of himself or herself as intrinsically positive or negative to some degree.

Perceptions. The process of acquiring, interpreting, selecting, and organizing sensory information.

Technology. The use of our knowledge, tools, and skills to solve practical problems, and to extend human capabilities.

Limitations of the Study

The following limitations of the study should be taken into account when looking at the overall results of the research.

1. The research was limited to STEPS participants, who were recommended to the program by their teachers.
2. Based on family income, campers' race, and parents' education level, the survey participants may not be representative of this age group as a whole.
3. Participants may not have responded to all questions.

4. The moods, attitudes, and physical condition of the respondents of the participants on the day of the survey.
5. Sample size may not be large enough to make generalizations to all girls in this age group.

Methodology

This research paper examined the relationship between young women's interest in STEM careers and education and their perceptions, self-esteem, self-efficacy, and perceived social support as they relate to STEM. The survey instrument was created by the University of Wisconsin Stout's psychology department to determine the effectiveness of the Summer Technology and Engineering Preview at Stout (STEPS) camp for girls. The study utilizes only some of the questions from the self-report surveys.

Chapter II: Literature Review

This review of literature will address factors that influence females in making education and career choices in technology and engineering. The chapter will focus on four areas that may present barriers for women in technology and engineering careers and education. These four factors are perceptions, self-esteem, self-efficacy, and perceived social support. Additionally, this chapter will provide background information on females in technology and engineering education and careers, the need for qualified workers, and how the problem of low female participation has changed.

State of the Problem

Technological innovation depends on a pool of our nation's best and brightest, representing all segments of our diverse society. Currently the national shortage of qualified workers is costing industry billions of dollars a year. Males and females must equally participate in science, technology, engineering and math to maximize the potential for success on a global scale.

“Women's participation therefore becomes a powerful issue of innovation, competitiveness, and workforce sustainability. They are a valuable untapped resource whose absence can only be measured in technology not created, problems not solved, and jobs not filled” (Sanders, 2005, ¶7).

Unfilled jobs. Marcus (2000) stated that in the year 2000 there were already 400,000 vacant information technology jobs, and that the vacancies were predicted to reach a million by 2003. This is particularly grim news because, by all accounts, the number of information technology jobs will increase dramatically. Sanders (2005) stated that computer-related jobs are predicted by the Department of Labor to increase by more

than 1.5 million by 2012. As far as the number of computer engineers, Marcus said that the Bureau of Labor Statistics anticipated that during the years 2000-2006, the number needed would double. Marcus cited yet a third source, the National Science Foundation, which predicted jobs in engineering would grow at a rate triple that of other jobs.

World economy. Success in a global economy is highly dependent on the education and employment of the best pool of workers in the areas of technology and engineering. The number of engineers produced in the United States per capita is proportionally low compared to developing high-tech countries, such as India and China. The population of the United States is about 300 million people. It produces 60,000 engineers each year (Wei, 2006). India has a population of 1 billion (or about three times that of the United States). India produces 350,000 engineers annually, or six times that of the United States. China, with a population of 1.4 billion (or about four times that of the United States) graduates 600,000 engineers a year. That is 10 times that of the United States (Wei, 2006). Failure to produce qualified workers means that the United States would be left in a position where it must compete abroad for qualified workers.

Untapped resources and talents. It is clear that the nation must draw on all of today's students for tomorrow's vocations or risk falling behind in the global economy. Currently, the number of women in technology and engineering only constitutes a fraction of the total workforce, and the young women who are the prospects for tomorrow are not fully participating in the basic building blocks of math and science. Since the breakdown begins as early as grade school, the timeline for producing students with adequate talents for the engineering and technology jobs of tomorrow stretches out over

another decade. The United States has already lost ground compared to other countries, and turning the tide now will take time and effort.

Females in Technology and Engineering Education

It is imperative we educate all students in STEM, in particular those who are currently least engaged, for the sake of our nation's economy, environment, culture, and competitive edge. Without early education in these areas, students, females in particular, will further ignore careers in technology and engineering. However, statistics cited in this chapter show that women are not following educational paths that lead them to careers in technology and engineering.

During the 1980's, the number of women studying for a career in technology hit its peak, but it has since declined. Women accounted for 37% of the information technology degrees in 1984, but that number dropped to 28% of the degrees in 2001 (Sanders, 2005). Women make up over half of all undergraduates, but attain only about 25% of computing and information science degrees (Sanders, 2005).

In the educational field of engineering, women make an even poorer showing than they do in information technology, although the trend here is increasing instead of decreasing. According to the National Center for Education Statistics, (as cited in Wack, 2006) 57% of all undergraduate and graduate students nationally are female. However, not many are seeking a degree in engineering. According to the American Center for Education Statistics, only 20% of bachelor's degrees in engineering go to women (Wack, 2006). Back in 1966, a mere 3% of doctoral degrees in engineering went to women, while in 2001 that number grew to 16.9% (Hennessy, Hockfield, & Tilghman, 2005).

Females in Technology and Engineering Careers

As in the area of women in technology education, the rate of women's participation in technology careers is comparably low. Women make up only a quarter of systems analysts and less than 30% of programmers (Marcus, 2000). Women represent only 11% of engineers and 16% of architects (Reed-Jenkins, 2003). Wisconsin Department of Public Instruction (2001) stated women make up only 4% of aerospace engineers and computer scientists and 6% of mechanical engineers.

U.S. jobs are growing most rapidly in areas that require science, engineering and technology knowledge and skills (National Engineers Week Foundation, n. d.). Even though the growing demand for qualified engineers will soon reach a critical level in our country, Kingsley (2005) found that only 8.5% of the United States engineers are female. Kingsley (2005) reported that less than 33% of participants' in computer courses and related activities are girls and that 75% of tomorrow's jobs will require the use of computers.

Silverman and Pritchard (1996) conducted a study that reported most girls were not able to picture themselves in technological jobs; they were also very reluctant to be in classes where they were one of the few girls.

How Has the Problem Changed?

The problem of low female participation in STEM has become widely recognized, and various organizations are seeking solutions. President Bush's American Competitiveness Initiative and the Democratic Innovation Agenda are two programs assembled to increase school funding, scholarships, and grants in STEM. Hundreds of programs both publicly and privately funded have been implemented in response to this

national deficit. STEPS for Girls is an example of the many programs and camps created in the past decade to increase diversity in STEM.

Despite the added efforts, participation of women in STEM is still an issue. There is a widespread societal presumption that women have made progress in engineering and computing dating back to the 1970's. The reality is that, despite increased efforts within the last 10 years, women's involvement has stagnated. Most alarming is the steep decline in the number of women pursuing their education in computing. In the early 1980s, the percentage of female freshman students who majored in computer science or engineering peaked at approximately 4.25% of all incoming undergraduates (Wei, 2006). As of 2003, the percentage has dropped to 0.5%. This is the same level as it was three decades earlier, in 1971 and 1972 (Wei, 2006). According to the Higher Education Research Institute at UCLA (as cited in Wei, 2006), interest in computer science among women fell 80% between 1998 and 2004, and 93% since its peak in 1982. Despite recognition of the problem, women are losing ground in engineering and technology.

Perceptions

How are the various areas within STEM perceived by females in American society? Perceptions have obvious implications that have contributed to low levels of female participation in technology and engineering.

The research shows that females view engineering and scientific fields as geeky (Muller, 2002).

“Many girls are turned off by the thought of a career in technology. They are haunted by the image of nerdy male co-workers drinking Red Bull, eating Twinkies and having meaningful relationships with their computers. Sure, we

know it's a cliché, but to kids--and especially young girls--image is everything” (Woodka, 2001, Introduction section, ¶ 1)

Various stereotypical opinions color women's perceptions. The American Association of University Women Educational Foundation (as cited in Goodridge, 2001) surveyed girls and found that they thought of information technology careers as tedious, dull and uninspiring. Engineering is stereotypically thought by girls to be a dirty job requiring heavy labor and the use of large, dangerous equipment (Brown, 2005).

Technology and engineering have long been viewed by women as intimidating because these fields are male dominated (“Beyond the Leaky Pipeline,” n. d.). Females generally believe they have less than adequate skills in comparison to their male counterparts in math and science, which are required in these fields.

Expanding Your Horizons, a one day workshop to help 12-13 year old girls get a hands-on feel for math, was started in hopes of boosting the low proportion of women in science, engineering, and mathematics professions (Wilson, 2005). This program takes place for two days at Westminster's campus in Utah. Based on the feedback from the camp's participants and organizers, some blame for low female enrollment should be placed on negative perceptions of technology and engineering. Wilson interviewed a volunteer who helped organize the program, Suzanne Nissen, who said many girls view these fields as not girl-friendly or something for computer nerds who are friendless and are not considered popular.

Self-Esteem

In the past few decades, many have assumed that high self-esteem brought about positive results without having hard evidence to support this claim. Baumeister,

Campbell, Krueger, and Vohs (2003) conducted a study that investigated this assumption. The study reviewed previously conducted research in order to answer this question. Baumeister et al. concluded that high self-esteem does not indicate good school performance; rather good school performance is partly the result of high self-esteem. The study also found that boosting self-esteem did not result in any measurable benefits.

Rayle, Arredondo, and Kurpius (2005) found that the higher the level of self-esteem in college females, the more they valued an education and the less they experienced academic stress. Gatta and Trigg (2001) stated that women believe they will not succeed in science or technology careers. This relationship between women's negative view of their ability in science and technology careers and today's lack of females in these areas is integral to the equal development of the workforce.

Perceived Social Support

Social support can take various forms. Peers, family, counselors, and teachers are all examples of social supports. Social support can be measured in actual support given, and in perceived availability of support. The survey upon which this research paper is based measured perceived social support, not the actual occurrences of social support.

Natvig, Albrektsen, Aderssen, Qvarnstrom (1999) studied 862 students between the ages of 13-15. The studied focused on school-related stress and psychosomatic symptoms. Examples of the psychosomatic symptoms studied are stomach aches, headaches, feeling low, irritability, and sleeplessness. Natvig et al. (1999) concluded that social support from teachers decreased the risk of illness related to mental and emotional causes in the girls. Social support from peers reduced psychosomatic symptoms from both male and female students, but more so for the males. Social support needs vary

based on gender, and support can help eliminate lack of productivity and focus based on psychosomatic symptoms.

Most of the research that has been conducted in this area has dealt with junior and senior high school students. A study was conducted by Valery, O'Connor, and Jennings (1997) to determine the amount of support college-aged students requested and received from their parents. The study found that support was rarely requested from parents but almost always received. Mothers were perceived as more supportive for both male and female students, and were more often perceived as available for support. Carney-Crompton and Tan (2002) researched traditional (18-22 years of age) and nontraditional (35-44 years of age) female students on various facets of social support, psychological functioning (anxiety and depression) and academic performance. In comparison, the study found that nontraditional students, although having reported less social support, report higher academic achievement. The traditional students, who reported having poor emotional support, reported poorer psychological functioning. The two groups relied on different sources of emotional support; the nontraditional students relied more on their partner, child and other non-family sources, whereas the traditional students relied on parents, grandparents, and boyfriends for the same support.

Many researchers suggest social support has been linked to a greater ability to deal with stress. Women often perceive less support for education, according to Rayle et al. (2001).

Very few studies have been conducted on high school career counselors and guidance counselors as social support. When middle and high school age students start thinking about college and careers, they are often directed to a career or guidance counselor's office. The National Women's Law Center (NWLC; 2001) published an article suggesting the goal of career counselors should be to expose all students to a variety of career options. The same article states that guidance counselors at the middle school level simply assumed that girls would not be interested in traditionally male fields. Not only did they fail to expose all students to a variety of career options, the NWLC found that these counselors actually discouraged the girls who expressed an interest in non-traditional careers.

Self-Efficacy

Self-efficacy, as defined by Margolis and McCabe (2006), is the belief in one's ability to succeed in a specific task or a set of related tasks. Perceived self-efficacy not only sets the slate of options for the future, but it also influences other areas of decision making (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). Self-efficacy has been noted to increase throughout older nontraditional students' academic careers (McCue-Herliby, as stated in Carney-Crompton & Tan, 2002). According to Margolis and McCabe, "Low self-efficacy beliefs, unfortunately, impede academic achievement and, in the long run, create self-fulfilling prophecies of failure and learned helplessness that can devastate psychological well-being" (p. 219).

Rayle et al. (2005) conducted a study that focused on the educational self-efficacy of college women. This study of 530 female undergraduates found that the more these women and their families valued education, the greater their levels of self-efficacy. These findings coincide with research completed by Gloria and Robinson-Kurpius (2001), which confirm that educational self-efficacy is a significant predictor of academic persistence. In summary, if a student and his or her family values education, the student will experience greater levels of self-efficacy, and, in turn, lower the chance of not completing his or her education.

Bandura et al (2001) studied perceived self-efficacy and its influence in children's aspirations and career paths. The study's findings indicate that perceived self efficacy influences level of motivation, perseverance, and one's vulnerability to stress and depression. Perceived self-efficacy was found to influence the kind of occupation the child thought he or she would be best at, determining the careers they would consider and those they would reject. It is interesting to point out that these choices are made based on 'perceived' self-efficacy, not actual academic performance, which may in turn close the door on careers for which the child may have been suited. This study also found that perceived occupational self-efficacy echoed the traditional stereotypes of gender specific career paths.

Summary

The literature review shows the current shortage of women in STEM will be compounded as the numbers of jobs in these areas are expected to grow much faster in comparison to the overall job market. The United States is producing a disproportionately low number of engineers based on population when compared to India

and China. Women are not following educational paths that lead to careers in engineering and technology. Both public and private programs have been initiated to help alleviate this shortage but, despite these efforts, the shortage still exists. More research is needed to determine the reasons behind low female participation in STEM.

Reviewing the available resources revealed a need for more research in the area of girls in STEM. Few resources were available when narrowing the search to specific reasons why girls are reticent in pursuing STEM. More research is needed in the areas of girls' perceptions, self-efficacy, self-esteem, and perceived social support as related to their interest and involvement in STEM education or careers.

The purpose of this exploratory study was to examine womens' perceptions, self-efficacy, self-esteem, and perceived social support and whether they are barriers for women in technology and engineering. This research will provide insights into how to better encourage and prepare females for careers in technology and engineering.

|

Chapter III: Methodology

This chapter outlines the selection and description of survey subjects from the STEPS camp, and describes the survey instrument. It also describes the data collection procedures, how the data was analyzed, and the limitations of the study.

Subject Selection and Description

The subjects were participants in the STEPS camp for girls. STEPS participants must be enrolled by their parents and nominated by their school based on their potential, interest, and aptitude in science and math. The camp is intended primarily for girls entering the seventh grade. Twenty-eight hundred campers were surveyed from 2000-2005.

The largest age group was 12-year-olds at 56.4% of the campers surveyed. Eleven-year-olds comprised the second largest group at 16.5%. The percent of participants who were white was 72.1%. The annual reported family income varied widely. Families reporting under \$18,000 constituted 8.7%, those ranging between \$30,000 - \$59,999 made up 26%, \$60,000 - \$89,999 equaled 25%, and 16.6% reported \$90,000 or more.

The campers' parents' highest level of education ranged from less than eighth grade to a graduate school degree. The breakdown for fathers showed 2.3% did not finish high school and 9.8% completed high school. Fathers who completed some technical or community college level education was at 9.8%, and 9.4% completed their degree. Fathers who attended some college represented 10.5% with 15.5% graduating from college. Those who reported attending some graduate school stood at 10.1%, and 13.2% completed a graduate school degree.

The mothers' educational breakdown showed 1.8% did not finish high school and 6.5% completed high school. Mothers who completed some technical or community college level education was at 8.5%, and 11.5% completed their degree. Mothers who attended some college represented 13.1% with 19.3% graduating from college. Those who reported attending some graduate school stood at 12.9%, and 10.9% completed a graduate school degree.

Instrumentation

The survey instrument was created by the University of Wisconsin Stout's psychology department to determine the effectiveness of the Summer Technology and Engineering Preview at Stout (STEPS) camp for girls. The instrument was approved by the Institutional Review Board. A 10 question survey was administered to the STEPS girls prior to their camp experience. In addition to the survey, parental consent forms were obtained.

Data Collection Procedures

Surveys were distributed between 2000 and 2005 to the STEPS participants on check-in day. Participation in the evaluation was voluntary. The campers were under the age of 18, therefore a parent or guardian's signature was required in order to participate in the survey. Students were only allowed to partake in the survey after providing a signed consent. Upon completion of the survey, the campers returned the instrument (see Appendix A) and the consent form. For confidentiality purposes, each of the girls received an identification number.

Data Analysis

Upon completion of data collection, each survey question was coded and entered. The Statistical Program for Social Sciences, version 10.0, (SPSS, 2002) was used to analyze the data. Independent groups T-Test analyses were conducted.

Limitations

The following limitations of the study should be taken into account when looking at the overall results of the research.

1. The research was limited to STEPS participants, who were recommended to the program by their teachers.
2. Based on family income, campers race, and parents' education level, the survey participants may not be representative of this age group as a whole.
3. Participants may not have responded to all questions.
4. The moods attitudes and physical condition of the respondents of the participants on the day of the survey.
5. All participants were recommended to the program based on interest, aptitude, or potential in STEM, so may not be representative of all girls in the age group.

Chapter IV: Results

The purpose of this study is to determine whether or not young women's perceptions, perceived social support, self-esteem, and self-efficacy play a role in their interest in technology and engineering education and careers. This chapter will evaluate the analyzed survey questions and provide an analysis of the results.

Introduction

This chapter analyzes the questions according to the scale they are measuring in each of the following areas: interest level in math and science; perceptions of females in science, math and engineering; self-esteem in math and science; self-efficacy in various levels of math, science and computing classes; and perceived social support in math and science. Surveys were presented on check-in day at the STEPS for Girls camp. Not all of the questions were filled out on all of the surveys received. Only questions 6-10 pertained to the research topic, therefore they were the only questions analyzed as part of this study.

Correlations Investigated

Pearson correlations (two-tailed) were computed to examine links between math and science interest scale (the constant) and each of the following: perceptions scale, self-esteem scale, self-efficacy scale, and perceived social support scale.

Math and science interest scale The interest level scale was the study's constant and was correlated with all of the other scales using input from 2,566 survey participants. The interest level scale was determined using question number nine from the survey; a multi-part question that reads as follows:

Please mark how interested you are in taking each of the classes or activities:

Rate your responses on a scale from 0-9, where 0 is not at all interested, 9 is very interested.

Table 1

Math and Science Interest Scale Mean Responses: Question Number Nine

Activity	Mean Response
Science class in school	7.40
Math class in school	7.30
Computer classes in school	7.46
Future camps like STEPS	8.18
Joining science or computer clubs	6.02
Reading science magazines	5.20
Entering science fairs	6.28
Writing computer programs	6.04

The mean responses from the math and science interest level scale showed that the STEPS campers exhibited an above average interest in math and science related activities. Again, the interest level scale was the study's constant and was correlated with all other scales.

Perceptions scale. The perceptions scale was correlated with the math and science interest scale using input from 2,559 survey participants. The perceptions scale used question number six from the survey; a multi-part question that reads as follows:

Please mark the column that best describes your present feeling regarding each statement. Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree

Table 2

Perceptions Scale Mean Responses: Question Number Six

Activity	Mean Response
It's okay for a female to work in science?	4.16
It's okay for a female to work in math?	4.25
It's okay for a female to work in engineering?	4.18
It's okay for me to work in the field of science?	3.82
It's okay for me to work in the field of math?	3.80
It's okay for me to work in the field of engineering?	3.86

The results were coded from one to five, with one meaning strongly disagree and five meaning strongly agree. The responses indicate that the campers agreed with the statements, although they tended to agree less when the question pertained directly to them rather than to the general female population.

The primary focus of this research was to determine whether correlations exist between interest, the constant, and the variables, which were perceptions, self-esteem, self-efficacy and perceived social support. The perceptions scale was correlated with the math and science interest scale using input from 2,559 survey participants. The results showed the perceptions scale was a predictor of the math and science interest scale, accounting for 4.1% of the variability in the interest scale, $r = .203$, $p \leq .01$.

Self-efficacy scale. The self-efficacy scale was correlated with the math and science interest scale using input from 2,560 survey participants. The self-efficacy scale

used question number seven and eight from the survey. Question number seven reads as follows:

Please mark how confident you are in successfully doing each of the following tasks. (Confidence means how well you think you can do something.) Rate your responses on a scale from 0-9, where 0 is not at all confident, 9 is very confident.

Table 3

Self-Efficacy Scale Mean Responses: Question Number Seven

Activity	Mean Response
Solving math problems without a calculator.	6.76
Solving math problems with a calculator.	8.21
Completing science projects.	8.23
Using science laboratory equipment.	7.37
Writing computer programs.	5.99

Question number eight reads as follows:

Please mark how confident you are in earning a “B” in each of the following classes. Rate your responses on a scale from 0-9, where 0 is not at all confident, 9 is very confident.

Table 4

Self-Efficacy Scale Mean Responses: Question Number Eight

Activity	Mean Response
Regular math classes.	8.07
Advanced math classes.	6.83
Regular science classes.	8.14
Advanced science classes	6.99
Regular computer classes.	8.00
Advanced computer classes.	6.98

The mean responses for question number seven of the self-efficacy scale showed the STEPS campers had the highest level of confidence when it came to solving math problems with a calculator and completing science projects, they were not as confident when it came to writing computer programs and solving math problems without a calculator.

The mean responses for question number eight of the self-efficacy scale showed the STEPS campers viewed themselves as most likely to get a “B” in regular science classes followed closely by regular math classes and regular computer classes. They were not as confident in any of the advanced classes.

The self-efficacy scale was correlated with the math and science interest scale using input from 2,560 survey participants. The results showed that the self-efficacy scale was a predictor of the math and science interest scale, accounting for 26.5% of the variability in the interest scale, $r = .515$, $p \leq .01$.

Self-esteem scale. The self-esteem scale was correlated with the math and science interest scale using input from 2,558 survey participants. The self-esteem scale was determined using question number 10, part A and B only. The part of question 10 being analyzed here reads as follows:

Please mark how you feel about each of the following statements.

Rate your responses on a scale from 0-9, where 0 is strongly disagree and 9 is strongly agree.

Table 5

Self-Esteem Scale Mean Responses: Question Number Ten, A and B

Activity	Mean Response
A. I am good at math.	7.43
B. I am good at science.	7.59

The results were coded from zero to nine, with zero meaning strongly disagree and nine meaning strongly agree. The responses indicate that the survey participants judged themselves to be above average in math and science.

The self-esteem scale was correlated with the math and science interest scale using input from 2,558 survey participants. The self-esteem scale was the greatest predictor of the math and science interest scale, accounting for 36.4% of the variability in the interest scale, $r = .603$, $p \leq .01$.

Perceived social support scale. The perceived social support scale was correlated with the math and science interest scale using input from 2,439 survey participants. The

perceived social support scale was determined using question number 10, parts C-P. The question reads as follows:

Please mark how you feel about each of the following statements.

Rate your responses on a scale from 0-9, where 0 is strongly disagree and 9 is strongly agree.

Table 6

Perceived Social Support Scale: Question Number Ten, C-P

Activity	Mean Response
C. My friends want “A”s in science and math classes.	7.85
D. My friends are bad in science and math classes.	3.37
E. My friends help me do my best in science and math classes.	6.11
F. My friends encourage me in science and math activities.	6.04
G. People good in science and math are cool.	6.62
H. My teachers help me do my best in science and math classes.	7.90
I. My science and math teachers are cool.	7.20
J. My science and math teachers like me.	7.77
K. My teachers encourage me in science and math.	7.99
L. My parents tell me I am good in science and math.	7.97
M. My parents help me to do my best in science and math.	8.10
N. My mom is good in science and math.	6.92
O. My dad is good in science and math.	7.55
P. My brothers and sisters give me a hard time for taking science and math classes.	1.90

The highest level of perceived social support came from the help of parents, followed by encouragement from teacher, and thirdly from friends who provided encouragement and help.

The perceived social support scale was correlated with the math and science interest scale using input from 2,439 survey participants. The perceived social support scale was a predictor of the math and science interest scale, accounting for 17.8% of the variability in the interest scale, $r = .422$, $p \leq .01$.

Chapter V: Discussion

This thesis examined how young women's perceptions, self-esteem, self-efficacy, and perceived social support influence their interest in math, science and technology. The literature review demonstrated that women are underrepresented in STEM. It also showed that women have negative perceptions of STEM. The majority of the survey participants were 12 years old and entering the seventh grade. All were enrolled in STEPS by their parents and nominated by their school based on interest, aptitude, and potential in science and math. The survey instrument was administered at the start of the STEPS camp and consisted of multi-part questions grouped according to perceptions, self-esteem, self-efficacy, and perceived social support. The total number of respondents from 2000 to 2005 was approximately 2,800.

Limitations

The following limitations of the study should be taken into account when looking at the overall results of the research.

1. The research was limited to STEPS participants, who were recommended to the program by their teachers.
2. Based on family income, campers race, and parents' education level the survey participants may not be representative of this age group as a whole.
3. Participants may not have responded to all questions.
4. The moods attitudes and physical condition of the respondents of the participants on the day of the survey.
5. Sample size may not be large enough to make generalizations to all girls in this age group.

Conclusions

Survey responses indicate that the campers agreed that it was acceptable for females to work in science, math and engineering, but they were slightly less likely to agree when the question pertained directly to them. Campers had the highest level of confidence in solving math problems with a calculator and completing science projects, and were least likely to be confident in writing computer programs. The STEPS campers viewed themselves as most likely to get a “B” in regular science classes, followed closely by regular math classes and regular computer classes. They were not as confident in any of the advanced classes. Survey responses showed that most participants judged themselves to be above average at math and science. The highest level of perceived social support came from the help of parents, followed by encouragement from teachers, and thirdly from friends who provided encouragement and help.

Correlations were drawn between interest in math and science, which was the constant, and perceptions, self-esteem, self-efficacy, and perceived social support. The correlations investigated were all predictors of interest in math and science, but ranged widely between 4.1% and 36.4% correlation.

Correlations Investigated

According to the responses received from the survey, young women’s self-esteem plays the largest role in their interest in STEM, followed by self-efficacy, perceived social support and, least of all, perceptions. Self-esteem and self-efficacy played a very large role in these young women’s interest in math and science. These correlations were decidedly strong, as one may have anticipated.

A more unexpected finding was the insignificant correlation between the girls' interest levels in math and science and their perceptions of science, engineering and math. This indicates that the perceptions scale was the least significant predictor of math and science interest. In the literature review, a major theme that emerged repeatedly was the negative effect of stereotypical perceptions. Numerous sources indicated that women's perceptions of technology, engineering, math and science were a factor in their low participation in STEM. The findings of this study contradict the literature. This may be due to the fact that the survey participants were chosen based on their aptitude, interest and potential in science and math, therefore leading to more positive perceptions in this particular group.

The greatest predictor of math and science interest was self-esteem, accounting for 36.4% of the variability in the interest scale. Self-efficacy was the second highest predictor, accounting for 26.5% of the variability. Perceived social support accounted for 17.8% of the variability. The least significant predictor of math and science interest was perceptions, accounting for a mere 4.1% of the variability.

Recommendations

The survey instrument used for this thesis may provide valuable insights if both pre-camp and post-camp survey responses were reviewed to detect whether the girls' perceptions changed during their week at the STEPS camp. Another useful tool for analysis would be follow-up surveys to detect whether the STEPS camp participants' perceptions and interests in STEM change as the girls advance through high school and into adult years. Such an ongoing follow up study could also track their majors and their career paths. The survey instrument used for this thesis included a broader scope of

questions than those pertaining to the four main categories covered in this thesis, and could provide a pool of valuable information yet to be analyzed.

In order to capture data that is representative of a broader base of girls, the STEPS survey should be administered to girls entering seventh grade who are not in the STEPS camp. Girls outside of the STEPS camp would not necessarily show an interest in math and science, would represent a broader socioeconomic background, and a wider range of parent education levels.

Reviewing the available resources revealed a need for more research in the area of girls in STEM. Few resources were available when narrowing the search to specific reasons why girls are reticent in pursuing STEM. More research is needed in the areas of girls' perceptions, self-efficacy, self-esteem, and perceived social support as related to their interest and involvement in STEM education or careers.

References

- Bandura, A., Barbaranelli, C., Caprara, G., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories [Electronic version]. *Child Development*, 72(1), 187-206.
- Baumeister, R., Campbell, J., Krueger, J., & Vohs, K. (2003). Does high self-esteem cause better performance, interpersonal success, happiness, or healthier lifestyles? [Electronic version] *Psychological Science in the Public Interest*, 4(1), 1-44.
- Beyond the leaky pipeline: Gender roles in engineering and education professions.* (n. d.) Retrieved April 17, 2007 from http://www.ithaca.edu/icjournal/03_womenengineering.pdf
- Brown, S. (2005). *Girls get intro to engineering.* Retrieved August 15, 2006, from <http://web.mit.edu/newsoffice/2005/print/initiative-0316-print.html>
- Carney-Crompton, S., & Tan, J. (2002). Support systems, psychological functioning, and academic performance of nontraditional female students [Electronic version]. *Adult Education Quarterly*, 52(2), 140-154.
- Clewell, B., Cosentino de Cohen, C., Tsui, L., Forcier, L., Gao, E., et al. (2005) *Evaluation of the National Science Foundation Louis Stokes Alliances for Minority Participation Program.* Retrieved April 1, 2007 from http://www.urban.org/UploadedPDF/411301_LSAMP_report_appen.pdf
- Gatta, M., & Trigg, M. (2001). *Bridging the gap: Gender equity in science, engineering, and technology.* Rutgers University, Center for Women and Work. Retrieved July 21, 2006, from <http://www.cww.rutgers.edu/dataPages/smet.pdf>

- Gloria, A. M., & Robinson-Kurpius, S. E. (2001). Influences of self-beliefs, social support, and comfort in the university environment on the academic persistence issues for American Indian undergraduates [Electronic version]. *Cultural Diversity and Ethnic Minority Psychology*, 7, 88-102.
- Goodridge, E. (2001). *Girls don't see IT as career choice*. Retrieved April 17, 2007, from http://www.techweb.com/article/printableArticle.jhtml?articleID=29113190&site_section
- Hennessy, J., Hockfield, S., & Tilghman, S. (2005). *Women in math, engineering and science: Drawing on our country's entire talent pool*. Retrieved August 15, 2006, from <http://web.mit.edu/newsoffice/2005/hockfield-presidents.html>
- Kingsley, C. (2005). Where are the women engineers, asks study. *The Daily Record*. Retrieved September 18, 2005, from EBSCO MegaFILE database.
- Marcus, J. (2000). *Closing the gender gap*. Retrieved April 14, 2007 from <http://www.highereducation.org/crosstalk/ct1000/news1000-gender.shtml>
- Margolis, H., & McCabe, P. (2006). Improving self-efficacy and motivation: What to do, what to say [Electronic version]. *Intervention in School and Clinic*, 41(4), 218-227.
- Muller, C. (2002). *The under-representation of women in engineering and related sciences: Pursuing two complementary paths to parity*. Retrieved April 14, 2007, from <http://mentornet.net/Documents/Files/GUIRR.pdf>
- National Council for Research on Women. (1998). *Balancing the equation*. Retrieved April 18, 2007, from <http://ncrw.org/research/scipress.htm>

- National Engineers Week Foundation. (n. d.). *Girls, women and the engineering profession*. Retrieved July 21, 2006, from <http://www.eweek.org/site/News/Eweek/girlsdayinfo.shtml#1>
- National Women's Law Center. (2001). *Opening the door to economic security: Making career education programs work for women and girls*. Retrieved April 14, 2007, from <http://www.nwlc.org/pdf/CareerEdfactsone.pdf>
- Natvig, G., Albrektsen, G., Aderssen, N., & Qvarnstrom, U. (1999) School-related stress and psychosomatic symptoms among school adolescents [Electronic version]. *Journal of School Health*. 69(9), 362-368.
- Rayle, A., Arredondo, P., & Kurpius, S. (2005). Educational self-efficacy of college women: Implications for theory, research and practice [Electronic version]. *Journal of Counseling & Development*, 83, 361-366.
- Reed-Jenkins, C. (2003) Attracting young women to careers in science, technology, engineering, math – In her own words. *Women in higher education*, 6(22).
- Sanders, L. (2005, October 10). *Technology designed without women's input can be critically one-dimensional*. Retrieved April 16, 2007, from <http://www.sap.info/index.php4?ACTION=noframe&url=http://www.sap.info/public/INT/int/index/Category-12603c61b2d8e182c-int/-1/articlesVersions-481743395f26a547e>
- Silverman, S., & Pritchard, A. (1996). Building their future: Girls and technology education in Connecticut. *Journal of Technology Education*, 7(2), 41-54.
- STEPS for Girls. (n. d.). *History*. Retrieved July 27, 2006, from <http://www.uwstout.edu/ctem/steps/history.html>

- Treyvaud, R., & Rounds, L. (2003). Geek is chic: Integrating technology into the lives of girls. *FET Connections*. Retrieved July 24, 2006, from <http://www.fetc.org/fetcon/2003-Winter/treyvaud.cfm>
- Wack, K. (2006). *The new gender gap*. Retrieved July 25, 2006, from <http://pressherald.maintoday.com/specialrpts/boys/060327engineer.shtml>
- Wei, B. (2006, April). Need more engineers? Recruit women. *The Mercury News*. Retrieved April 11, 2007 from http://findarticles.com/p/articles/mi_kmtmn/is_200604/ai_n16248743
- Wilson, R. (2005). *Science, math, bubble gum, and dreams*. Retrieved July 27, 2006, from http://www.westminstercollege.edu/westminster_in_the_news/index.cfm?parent=4597&detail=4623&content=4983
- Wisconsin Department of Public Instruction. (2001). *Preparing young women for work and citizenship in a technological society*. Retrieved July 27, 2006, from <http://dpi.wi.gov/cte/pdf/tbilib.pdf>
- Woodka, D. (2001). *IT's a girl thing*. Retrieved July 27, 2006, from <http://www.networkcomputing.com/1216/1216colwoodka.html#>
- Valery, J., O'Connor, P., & Jennings, S. (1997). The nature and amount of support college-age adolescents request and receive from parents [Electronic version]. *Adolescence*, 32(126), 323-337.
- Zonta International. (n. d.). *Amelia Earhart fellowships*. Retrieved April 18, 2007, from http://www.zonta.org/site/PageServer?pagename=prog_ae_fellowships

Appendix A: Survey Instrument

Objective: Gain insights into STEPS girls' feelings and perceptions of technology and engineering.

1. What do you think you will be doing when you are 25 years old (for example: single or married, any children, career, etc.)?
- 2A. Do the jobs/careers you are interested in require a college education?
 - Yes No Unsure
- 2B. If yes, please list the college(s) you are interested in attending.
3. What job/careers are you interested in? Please list all that you are interested in.
4. In your future job/career, do you want to be the boss?
 - Yes No
5. In your future job/career, do you want to make important decisions?
 - Yes No
6. Please mark the column that best describes your present feeling regarding each statement. Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree

Perceptions	A. It's okay for a female to work in science?
	B. It's okay for a female to work in math?
	C. It's okay for a female to work in engineering?
	D. It's okay for me to work in the field of science?
	E. It's okay for me to work in the field of math?
	F. It's okay for me to work in the field of engineering?
7. Please mark how confident you are in successfully doing each of the following tasks. (Confidence means how well you think you can do something.)
Rate your responses on a scale from 0-9, where 0 is NOT AT ALL CONFIDENT, 9 is VERY CONFIDENT.

Self Efficacy	A. Solving math problems without a calculator
	B. Solving math problems with a calculator
	C. Completing science projects
	D. Using science laboratory equipment
	E. Writing computer programs
8. Please mark how confident you are in earning a "B" in each of the following classes.
Rate your responses on a scale from 0-9, where 0 is NOT AT ALL CONFIDENT, 9 is VERY CONFIDENT.

Self Efficacy	A. Regular math classes
	B. Advanced math classes
	C. Regular science classes
	D. Advanced science classes
	E. Regular computer classes
	F. Advanced computer classes

9. Please mark how interested you are in taking each of the classes or activities:

Rate your responses on a scale from 0-9, where 0 is NOT AT ALL INTERESTED, 9 is VERY INTERESTED.

- Interest level
- A. Science class in school
 - B. Math class in school
 - C. Computer classes in school
 - D. Future camps like STEPS`
 - E. Joining science or computer clubs
 - F. Reading science magazines
 - G. Entering science fairs
 - H. Writing computer programs

10. Please mark how you feel about each of the following statements.

Rate your responses on a scale from 0-9, where 0 is STRONGLY DISAGREE, 9 is STRONGLY AGREE.

- A & B
Self Esteem
- A. I am good at math
 - B. I am good at science
- C-P
Social Support
- C. My friends want "A"s in science and math classes
 - D. My friends are bad in science and math classes
 - E. My friends help me do my best in science and math classes
 - F. My friends encourage me in science and math activities
 - G. People good in science and math are cool
 - H. My teachers help me do my best in science and math classes
 - I. My science and math teachers are cool
 - J. My science and math teachers like me
 - K. My teachers encourage me in science and math
 - L. My parents tell me I am good in science and math
 - M. My parents help me to do my best in science and math
 - N. My mom is good in science and math
 - O. My dad is good in science and math
 - P. My brothers and sisters give me a hard time for taking science and math classes.

11. Please mark how you feel about each of the following statements. Rate your responses on a scale from 0-9, where 0 is STRONGLY DISAGREE, 9 is STRONGLY AGREE.

- A. My parents encourage me in science and math
- B. My guidance counselor at school encourages me to take science and math activities
- C. My friends will respect me if I take math, science or computer classes
- D. Taking math, science, or technology classes are a waste of time
- E. When I'm an adult, I will get a better job if I take math, science, or computer classes
- F. I will be ready for college if I take math, science or computer classes
- G. When I'm an adult, I want to get married
- H. When I'm an adult, I want to have children
- I. When I'm an adult, I want to stay home full time with children while they are young
- J. When I'm an adult, I want to stay home part time with children while they are young
- K. When I'm an adult, I want to have a full time career
- L. When I'm an adult, I want to have a part time career

On a separate piece of paper, please draw a picture of an engineer. (Be sure to include your eight-digit ID number from the front of this survey.)

Research related to this report was conducted in conjunction with the National Center for Engineering and Technology Education (NCETE). NCETE is a collaboration of nine partner universities: Brigham Young University; California State University, Los Angeles; the University of Georgia; the University of Illinois; Illinois State University; the University of Minnesota; North Carolina A&T State University, Utah State University; and the University of Wisconsin-Stout.

This material is based on work supported by the National Science Foundation Under Grant No. ESI-0426421. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the authors and do not necessarily reflect the view of the National Science Foundation.