2003

Middle School Student Attitudes Towards Robotics, Science and Technology

J. Jill Rogers

THESIS/FIELD EXPERIENCE PAPER
REPRODUCTION CERTIFICATE

TO: Graduate Degree Candidates (who have written formal theses)

SUBJECT: Permission to Reproduce Theses

The University Library is receiving a number of request from other institutions asking permission to reproduce dissertations for inclusion in their library holdings. Although no copyright laws are involved, we feel that professional courtesy demands that permission be obtained from the author before we allow these to be copied.

PLEASE SIGN ONE OF THE FOLLOWING STATEMENTS:

Booth Library of Eastern Illinois University has my permission to lend my thesis to a reputable college or university for the purpose of copying it for inclusion in that institution's library or research holdings.

Aug. 19, 2003
Date

I respectfully request Booth Library of Eastern Illinois University **NOT** allow my thesis to be reproduced because:

____

____

____

_______________________ _______________
Author's Signature Date

MIDDLE SCHOOL STUDENT ATTITUDES TOWARDS ROBOTICS, SCIENCE AND TECHNOLOGY

BY

J. JILL ROGERS (FRISBY)

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE IN ELEMENTARY EDUCATION

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

2003

I HEREBY RECOMMEND THAT THIS THESIS BE ACCEPTED AS FULFILLING THIS PART OF THE GRADUATE DEGREE CITIED ABOVE

6 Aug 03
DATE

August 6, 2003
DATE

ABSTRACT

In 2000, the National Science Foundation (NSF) conducted a biennial study on the status of women and minorities in science and engineering. It was revealed that the numbers of women receiving bachelor's degrees in computer science are on the decline. This fact calls for innovative changes in the traditional science curriculum. Science instruction with the implementation of robotics could provide female students the needed motivation. Therefore, the examination of female middle school student attitudes towards robotic enhanced science instruction is needed. Descriptive research was conducted to assess middle school student attitudes towards robots, technology and science. Gender differences were studied. The subjects were two classrooms of sixth grade students (N=53) and eighth grade students (N=74) from Charleston, Illinois. Observational checklists were completed to examine student behavior in the science classroom. A Likert-type questionnaire consisting of 20 items was administered to the male and female students to obtain their perceptions towards robotics and technology and to explore if gender differences existed in their responses. A Cronbach's □ analysis was applied to the data to measure reliability and Pearson chi-square and independent sample t-test analyses were used to compare genders. Finally, interviews were conducted with female middle school students (N= 8) to obtain in-depth information on their perceptions and attitudes towards robots, technology and the science. Results showed that middle school students exhibited positive attitudes towards robots, careers in robotics, science and technology. In many respects, female student attitudes were more positive than their male counter parts. Due to the motivation robotics enhanced instruction provides as well as the subtle way robotic implementation teaches computer programming, mathematics and creative problem solving, it is recommended that activities incorporating robotics be a part of every science curriculum.

DEDICATION

I would like to dedicate this work to:

My two children, Samantha and Andrew Frisby, without their love and sacrifice all of this would not be possible.

Dr. M. Anthony Lewis, due to his contagious passion for robotics and constant belief in me, I have completed this research.

My parents, Dr. Donald and Ferne Rogers who listened to my woes and always told me that I could do anything I set my mind to.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people who have been instrumental in the completion of this thesis.

Dr. Marilyn Lisowski, my thesis director, has given me expert guidance and support throughout the process. She has remained calm and injected humor at times when all seemed hopeless. Her expertise in the field of science education has played a pivotal role in the synthesis and completion of this work.

Dr. Mary Ellen Varble, thesis committee member, has given me encouragement and advice throughout my academic career at Eastern Illinois University. She has been kind, compassionate and optimistic.

Dr. Patricia Fewell, thesis committee member, has given me advice and friendly support throughout my academic career at Eastern Illinois University.

Dr. Carol Helwig, former department chairperson and Dr. Marybeth Brunning, current department chairperson have both enthusiastically offered me the resources and support of the Education Department at Eastern Illinois University.

Tim McCollum, Pat Murphy and Debra Landsaw, public school teachers in Charleston, Illinois, have all eagerly opened their classrooms to me and made this study possible.

Dr. M. Anthony Lewis, founder and C.E.O. of Iguana Robotics, Inc. Urbana, Illinois, has generously opened his laboratory to my work and procured funding for this research.

Dr. Amy Rogers, my statistician, has patiently explained to me what all the numbers mean. This was done during three-hour long telephone conversations, across the North American continent. She is a true friend and sister.

TABLE OF CONTENTS

CHAPTER FOUR – RESULTS

CHAPTER FIVE – SUMMARY, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

APPENDICES

LIST OF TABLES

LIST OF BAR GRAPHS

CHAPTER ONE

INTRODUCTION

Importance of Study

In 2000, the National Science Foundation (NSF) conducted a biennial study on the status of women and minorities in science and engineering. This study revealed that the numbers of women receiving bachelor's degrees in computer science is on the decline. In the initial study conducted in 1984, it was found that 33 percent of the bachelors' degrees in computer science were awarded to women. Regrettably, the 2000 study showed that the number of female computer science graduates dropped to 28 percent. The NSF predicts that, in the near future, more than half of all careers will involve advanced technologies; yet, presently few young women are going into technology based careers. The cause for this gender gap is unclear; however, young women are in danger of being left behind if they continue to avoid the opportunities science and technology have to offer. Innovative changes in the traditional science curriculum could lure more young women into the fields of science and technology.

Science instruction with the implementation of robotics could provide the needed impetus. Robots offer the opportunity for creative expression, problem solving and constructivist learning. The sometimes tedious skills of mathematics and computer programming are deeply imbedded in the novelty and kinesthetic nature of the robot. Introduction to robotics at a young age could open doors and pique the imaginations of adolescent girls.

The literature shows that the use of robotics in the science classroom provides motivation, however do female and male students feel equally motivated? Limited research has been conducted on the benefits of robot enhanced instruction. Therefore, further study on the attitudes of adolescent girls and boys towards robotics is warranted.

<u>Problem Statement</u>

What are student attitudes towards robotics and the technological sciences? Are female student attitudes different from male attitudes?

<u>Hypotheses:</u>

Middle school students will exhibit positive attitudes towards robotics, careers in robotics and the technological sciences.

Female middle school students will exhibit positive attitudes towards robotics, careers in robotics and the technological sciences.

<u>Definition of Terms:</u>

<u>Attitude</u> – refers to a perception, feeling or emotion towards an idea

<u>Behavioral Mode</u> - refers to a form of communication or an expressing of feelings through behavior

<u>Constructionist Learning-</u> refers to project based learning that strengthens student skills in mathematics, engineering and problem solving through the assembly of a structure or device.

<u>Constructivist Learning</u> – refers to learning that is student centered, problem based and often built on the student's personal experience

Gender Difference – refers to a pattern of behaviors, opinions and attitudes that form along gender lines

Gender Gap – refers to extensive differences found in humans, based on sex

Gender-Role Stereotyping – refers to the assumption that particular behaviors or skills will be present due to gender

Manipulative – refers to an object or objects that are held and operated with the hands

Middle School – refers to the students who are in sixth, seventh and eighth grades

Non-verbal Mode – refers to a form of communication or an expressing of feelings that is accomplished without speaking

Parental Gender-Typing – refers to gender-role stereotyping that is conveyed to children from their parents

Perception – refers to an opinion or mental image

Robot – refers to an autonomous, mechanical device capable of sensing and then reacting to a changing environment

Robotic – refers to a robot, adjective

Robotic Enhanced Science Instruction – refers to science instruction that incorporates robotics as a tool that assists the teacher in the conveyance of various science concepts

Robotic Model – refers to a mechanical device that moves and reacts, for example the life-sized, animated dinosaurs found in museums

Rogers Robot and Science Attitude Questionnaire (RRSAQ) – A four point, Likert-type survey consisting of 20 closed ended questions and four, open ended questions that assesses middle school student attitudes towards robotics and the technological sciences

Robot Scale (RSCALE)- refers to the first 14 questions on the RRSAQ which deal with student opinion about careers in robotics

Science Anxiety – refers to a phenomena in which people exhibit unsubstantiated fears of science and science related subjects

Technology – refers to any mechanical or electronic device that assists humans, for example, computers

Technological Sciences – refers to all the sciences that are not biological to include the study of computers and other electronic devises

Technology Based Career – refers to a career that involves the study of sciences that are not biological and/or is deeply centered around computers and other technological devices

Verbal Mode – refers to a form of communication or an expression of feelings through the spoken word

Assumptions

The following assumptions will underlie this study:

1. Assessing the attitudes of middle school students towards robotics, technology and science is valuable and worthy of research.
2. Comparing the attitudes of female and male students is valuable and worthy of study.
3. Questions for the Rogers Robot and Science Attitude Questionnaire (RRSAQ) will be carefully written, examined and reviewed.
4. Students will complete the RRSAQ honestly and to the best of their ability.
5. Students will be given as much time as needed to complete the RRSAQ.
6. A trained individual will administer the RRSAQ in a careful and unbiased manner.
7. The RRSAQ is a valid and reliable measure of student attitudes.
8. The three raters selected to observe classroom behaviors will be trained and unbiased.
9. Students will behave in a normal manner while being observed.
10. The three, trained raters will observe one complete physical science lesson taught by the regular instructor.
11. Observational checklists will be completed once for each of the four classrooms participating in the study.
12. Observational checklists will be a valid and reliable measure of student attitudes.
13. Interviews will be conducted in a professional manner with no implied answers or pressure from the interviewer.

14. During the interview, students will share information in an honest and candid way.

15. Students will be made to feel comfortable during the interview process.

16. Interviews will not exceed 15 minutes.

17. The female students for the personal interviews will be randomly selected.

18. The personal interviews will be a valid and reliable measure of female student attitudes.

19. The sixth and eighth grade classrooms participating in the study will be randomly selected.

20. Selected classrooms will not be ability grouped and will contain students who are of varied academic abilities.

21. Gender and racial distribution will be representative of the population.

<u>Delimitations</u>

The following delimitations will underlie this study:

1. The study will be limited to a small rural school system in Charleston, Illinois.

2. The study will be limited to two randomly selected sixth grade classrooms and two randomly selected eighth grade classrooms.

3. The lessons observed during the observational portion of the study will be limited to lessons dealing with the physical sciences.

4. The behaviors recorded during the observational portion of the study will be limited to student response behaviors.

5. The observational study will be limited to one class period for each classroom observed.
6. The questions asked on the written student survey will be limited to the topics of technological science and robotics.
7. The interview portion of study will be limited to fifteen minutes for each student interviewed.
8. The number of students randomly selected for the interview portion of the study will be limited to eight.
9. The students randomly selected for personal interviews will be limited to females.
10. Data obtained will be limited to student responses to the Rogers Robot and Science Attitude Questionnaire, classroom observations and personal interviews.
11. The study will be limited to students who receive parental permission to participate.
12. The study will be limited to students who are enrolled in the regular physical science class.
13. The study will be limited to student attitudes, not other topics such as student achievement.

Limitations

The following limitations of this study include:

1. The use of sixth and eighth grade students, thereby preventing generalizability to other grade levels, such as kindergarten.
2. The use of students from a small rural community, thus limiting generalizability to other students, such as those from a large, urban school district.
3. The focus of student attitudes towards robotics and technological science, thereby limiting the generalizability to other subjects, such as language arts.
4. The focus of student attitudes, limiting generalizability to student achievement.
5. The use of subjects with limited racial diversity will limit the generalizabilty to populations with higher racial diversity.

CHAPTER TWO

REVIEW OF LITERATURE

This chapter will review literature related to robotics and youth. The literature reviewed will consist of the following categories: robotic implementation with youth, perceptions of technology and science based on gender and student attitudes towards robotics. A summary of the literature review will follow.

Robotic Implementation with Youth

This section will focus on the current literature relating to the implementation and application of robot technology for youth in the classroom and elsewhere.

Wagner (1999) conducted a study to compare the impact on student science achievement and problem solving as a result of instruction using robotics, a battery-powered manipulative or a traditionally taught science class. Classrooms (N=15) of fourth, fifth and sixth graders of which there were males (N=244) and females (N=209) participated in the study. The study consisted of two treatment groups and one control group. Treatment groups received a week of instruction using robots or battery powered manipulatives. The control group from each grade was given the traditional lesson, a week in duration. The study found that students in the robotics group had higher scores on programming and logic-problem solving than did the battery-powered group. Both experimental groups scored higher than the traditionally taught science class.

A study was designed by Jones (1987) to determine quality of student learning experiences offered by a four-lesson multimedia program for robotics instruction. The program, as developed by Jones, included the commercial film, "Robot Revolution," and the videocassette tape "Robotics" and two author-developed slide/audiotape presentations. Student interaction with two robots, Hero I and Robie was also included. Developmental testing occurred using a group of students (N=41) who ranged in grade level from fourth to eighth and in ability from above average to those with specific learning disabilities. A summative evaluation indicated that the program was of high quality, led to positive learning experiences, and was interesting to the students.

Aitken (1986) implemented a study to determine the influence of robotic-technologically-oriented cartoons on attitudes and behaviors of children. The study focused on "The Transformers," a cartoon featuring superhero type robots. Two major forces precipitated the program: the popularity of superhero cartoons and the appeal of the innovative Transformer toys. To obtain information about children's perceptions of "The Transformers" television show, children (N=34) were asked to watch the cartoon and respond to a questionnaire on the program. Additionally, children participated in an oral discussion about the program, which they generally enjoyed. To analyze program content, a group of college students (N=37) were asked to rate "The Transformers" as to violence, characters, and language. The results of the college students' analyses indicated that the program contained inappropriate technical language, a complexity of evil lines and a harsh portrayal of moral values. It was concluded that while Transformer toys might offer children a creative manipulative outlet, the extension of "The Transformers" into a television series has negative associations for children.

Tunnicliffe and Reiss (1999) developed a study that examined what children learned about animals by observing robotic models, preserved animals in a museum and preserved animals presented in a school setting. The museum study was conducted with groups of pupils on school visits to the Natural History Museum in London where the children's spontaneous conversations were recorded. In the classroom study, preserved museum animals were taken to the school to record the children's individual responses to pre-determined questions. Overall, anatomical features were cited more often than behavioral or habitat features. In the classroom pupils related their observations to their own past experiences. The analyzed museum conversations suggested that children simply use their everyday knowledge and understanding to interpret what they see and to allocate everyday names using anatomical clues as their guide.

Student Perceptions of Technology and Science Based on Gender

This section will focus on the current literature relating to the gender differences found in perceptions and interest in science and technology.

A study was designed by Buck (2002) to explore adolescent girls' ideas and feelings about the contemporary structure of middle level science instruction. The qualitative study investigated the opinions of science teachers (N=11) and female seventh and eighth grade students (N=51) from various locations across the continental United States. In small interview/focus groups consisting of four to six female students, issues were discussed such as favorite science topics, comfort level in science classrooms and curiosities about the physical world. The study revealed that adolescent girls strive to make a connection to science. They saw how science helped them to better understand themselves and their world, but they seldom found such correlations in contemporary science classrooms. Further, the female students realized that they needed to have choices in their studies. Teachers interpreted the girls' request from an assimilative perspective by seeking ways to help the female students "fit" into the existing structure of science education.

In an unpublished study, Padmaraju (2003) examined the correlation between teacher learning styles and attitudes towards the usage of technology. The subjects were inservice teachers (N=80) from public schools in Illinois. Teachers were given the Multiple Intelligences Development Assessment Scales (MIDAS) and asked to keep a detailed log of computer use in and out of school. Results from both data sets were examined to determine if a relationship existed between learning style and technology use existed. Data showed that there is a significant correlation between the learning style of the teacher and their propensity for using technology in the classroom. The most significant correlation found was between logical-mathematical intelligence and time spent on computers.

In a recent study Hurd (2002) explored differences among students' learning styles and their attitudes toward technology. Students (N=260) were in seventh and eight grades from two private schools in Dallas, Texas. Data were collected from scores on the Murphy-Meisgeier Type Indicator for Children (MMTIC) and the Pupils' Attitudes Toward Technology (PATT). An independent t-test was given to test for gender differences. Finally, the Spearman's Rho Coefficient Correlation Ratio was used to compare home environment to student attitudes toward technology. The findings showed that gender and home environment did not provide statistically significant evidence as a predictor of student attitudes. The MMTIC test showed differences among the four different learning style combinations. Students who exhibited an Introversion-Sensing learning style were the least interested in technology.

A report was released by the American Association of University Women's (AAUW) Educational Foundation Commission on Technology, Gender and Teacher Education (2000) examining female students' attitudes towards the existing computer culture and the methods of instruction in computer education courses. The report consisted of interviews with experts in the cyberculture and education fields (N=14), an online survey of teachers (N=892) and qualitative focus group research with female students (N=70) from all over the United States. A review of the current research on the topic was also conducted. It was revealed that females are under represented in computer science and technology fields. The report stated that females find computer programming classes tedious and computer games redundant and violent. The report determined that changes in technology educational methods and software design need to be made in order to meet the needs of all students, regardless of gender.

Schott and Selwyn (2000) conducted a study focusing on gender and social competency of the frequent and infrequent computer user. The study explored the negative stereotype of the frequent computer user: one who is male, socially inadequate and an isolated individual. Twelfth year students (N=117) from the United Kingdom were surveyed to determine if the negative labels given to computer users caused them to avoid coming into contact with information and communications technology (ICT). Interview data from students who reported "high" and "low" ICT use was compared. Results suggested that students who are highly oriented toward ICT are just as likely to be female as they are male and are no less popular, sociable, or self-assured their non-ICT users. It is postulated that the vast increases in ICT use over the past ten years has created a more accessible "computer culture" to which most students are now subscribing.

Brownlow, Rogers and Jacobi (2000) created a study, which examined the influence of gender and various background and personality factors on science anxiety. Subjects were men (N=37) and women (N=50) who were given the Science Anxiety Scale and asked questions about school accomplishments, teachers, gender-role stereotyping, and personality. Students with high science anxiety were found to take fewer science courses in college, had lower SAT-Q scores and reported that their high school science teachers were not helpful. Mathematics and science preparation for men and women was equal, although women reported better grades and science experiences. Findings illustrated that gender differences were due to women and men's differential interpretations of their abilities and the influence of parental gender typing on the pursuit of science as a career.

Arch (1998) reported on a study that explored the difference between girls and boys in their attitudes towards technology and science. High school students from the Pacific Northwest participated in a project-based science course designed to encourage girls as well as boys to develop interest in technology and science. Students were given pre- and post-tests that measured student attitudes towards computers and science, prior experience with computers, and students' sense of efficacy in learning new technologies. A Bem Scale of Masculinity/ Femininity was also given. The results showed that even with careful construction of the learning environment, differences still remained between attitudes of girls and boys.

Hendley, Parkinson, Stables and Tanner (1995) conducted a study on student attitudes towards various school subjects. Pupils (N=4,263) were from National Curriculum Key Stage 3, in South Wales, England. In the Likert questionnaires male students were shown to exhibit positive attitudes in mathematics, science, and technology. Female students showed more positive attitudes towards reading and writing.

A study was conducted by Nickell (1987) considering gender and sex-role differences found in attitudes towards computers. College students (N= 166) completed a Computer Attitude Scale and then the Personal Attributes Questionnaire to determine sex role orientation. Results revealed that males had a more positive attitude towards computers than did females, although the difference was not significant. Males did report using computers more frequently at school and at home. The expectation that computer skills would be necessary in the subject's future occupation varied as a function of sex-role.

Miura (1986) conducted a three year, longitudinal study documenting differences in computer interest and use among middle school students. A questionnaire assessed computer interest and use by middle school students (approximately 400) for three consecutive years, at the end of each school year. During development of the instrument, variables were organized using a newly created version of the "living systems" theory and students were asked to rate them on a scale of one to five. Regression analysis of the data from the questionnaires and additional demographic and descriptive data showed that the gender of the subject appears to be an important characteristic predicting computer interest since there were significant differences found in favor of males. Male students had more opportunities for mastery, more role models to emulate, greater verbal encouragement and less fear of the device. Males also expressed more positive attitudes about the computer's benefit to society than their female counterparts. Over the three year period of the study, there was a decline in the observed gender attitudinal gap.

A study was conducted by Raat and DeVires (1985) that explored attitudes toward technology of 13-year-old students. Students (N=12) were interviewed to learn what they thought of technology and how it was important to them. Other students (N=48) responded to ten questions to determine their attitudes towards technology. Results were used to construct a questionnaire consisting of 80 questions answered in a five-point Likert scale format. The questionnaire was given to 3,000 13-year-old students from different types of schools in different parts of the Netherlands. The results were factor-analyzed and scores were computed to find the differences between boys and girls. Results showed that both genders thought technology was broad, important and not too difficult. Females were found to be less interested in technology; however, both genders felt that girls had an aptitude for technology. Parental influence seemed to play a pivotal role in the students' familiarity with and value placed on technology.

Donovan (1982) conducted a study to determine whether eighth grade science teachers served as sex role models and therefore enhanced female student career interests in science and engineering. Teacher effectiveness was also examined. Teachers which were male (N=14) and female (N=16) participated in the study. The subjects were eighth-grade students from Brevard County, Florida and were male (N=945) and female N=922). All students were given an author-developed career interest survey at the beginning and again near the end of the school year. The study illustrated that as sex role models, the teachers were not shown to enhance the science and engineering career interests of their students. The study also demonstrated that eighth-grade girls' interests in science and engineering was not enhanced by the effectiveness of the teacher.

Attitudes Towards Robotics

This section will focus on the literature relating to opinions and perceptions about robots.

Moore (1985) developed a survey focusing on secondary school pupils' attitudes towards computers and robotics. Focus groups of 13 year-old British students (N=8 to15) were asked questions about modern technological changes. From the focus group discussions a pilot questionnaire consisting of 110 questions was devised. The pilot instrument was administered to students (N=994) ranging in ages of 13-16 years. Statistical analyses were performed on the responses to confirm the validity and unbiased nature of each item on the pilot instrument resulting in a 64-item, four point, Likert-format survey. The final test instrument was called the Computers and Robots Attitude Questionnaire (CARAQ) and was administered to pupils of an average age of 14.4 and who were male (N=628) and female (N=646). One year later the CARAQ was again administered to the sample group after a portion of the students had completed a course in computer studies. This course focused on computer programming and applications. Results showed that generally, male students held a more favorable attitude to computers and robots than girls. However, many students' favorable attitudes declined after completion of the course in computer studies. Students who reported high leisure use retained their positive attitudes. An informal learning environment and recreational application of computer skills was found to promote the most positive attitudes towards computers and robots.

Summary of the literature

After a careful review of the literature it appears that the attitudes of middle school students towards robots have not been formally assessed, even though robots are currently being used in classrooms across the country. However, the attitudes of students towards science and technology are well documented and female students have been shown to hold a more negative outlook towards computers and science. Since the turn of the century, this trend in female attitude seems to be moving in a positive direction. An examination of the literature uncovers reasons for the negative opinions of female pupils in the past and begins to explain the recent improvement of attitude. This section will summarize what the literature shows about robotics used in the classroom and then a summary of current literature findings dealing with female student attitudes towards science and technology will be further explored.

An examination of the literature on the subject of robotic enhanced instruction, indicateds that more research needs to be done. Moore's (1985) attitudinal study mentioned robots, but truly focused on computers. While robots have been shown to entertain children (Aitken, 1986), to interest children (Jones, 1987) and to activate prior knowledge about the world (Tunnicliffe & Reiss, 1999) little is known about how a robot might enhance traditional science education and what student attitudes towards robots might be.

Wagner's work (1999) opened the door for further research. Her ground breaking study showed that robots offered students a superior means of learning complicated concepts such as logic-problem solving and programming. Interestingly, the robot out performed the battery powered device in these two categories, illustrating that a robot presents science students more than novelty. Wagner felt that robotics enhanced science instruction proffers a,

> "...learning environment (that) provides students with the opportunity to problem solve in a realistic way: defining the problem, brainstorming for the best solution, and programming the tested model while constantly evaluating immediate feedback from the computer" (1999).

With little research available on the topic of student attitude and robotics, a closer look at attitudes towards science and technology is supportive. Early studies showed that female students were clearly less interested in technology than their male counterparts. Many reasons for this gender difference were cited, to include parental influence (Raat & DeVires, 1885), preference (Hendley et al, 1995), and low self-confidence (Brownlow et al, 2000). However, the dominating factor in the establishment of positive attitudes was familiarity and informal access to computers (Moore, 1985; Miura, 1986; Nickell, 1987; Schott & Selwyn, 2000). Over the past 20 years, computer use and access has increased for the entire population, both female and male, causing a narrowing of the gender differences found in attitude.

The importance of informal access or "play time" on the computer was established by Moore in1985. While Moore discovered a significant difference in male and female attitudes towards computers and robots, the prime indicator of positive attitudes was leisure, home use of computers. It seemed that female students were not choosing computers for their free time activities. Surprisingly, in Moore's study students who took a computer studies course had an actual decline in positive attitude. It was found that a less hurried, more goal oriented approach lead to student satisfaction and positive attitudes. Moore suggested that "...self-chosen home learning and a recreational application" should be the model for formal computer instruction. Moore's results called for innovative methods of instruction

Miura (1986), Nickell (1987) and Schott & Selwyn (2000) later explored the topic of attitude with similar conclusions: familiarity with computers and high leisure use lead to positive attitudes. Schott and Selwyn felt that the vast increases in information and computer technology used over the past ten years have created a more accessible 'computer culture' to which most students are now subscribing (2000). The issue of gender may no longer be a factor in the equation.

Buck's study on adolescent girls and their attitudes toward science revealed many answers to the science and technology gender gap of the late 20th century (2001). Based on the works of Carol Gillian and S. Harding, Buck discovered that the typical science class did not meet the female student's needs. While science teachers tried to listen to their female pupils and adapt curriculum, the need was one of complete redesign. As long as science instruction is modeled by the "White, Western, Masculine voice" it will not hear the (female) voice of the "others" (Buck, 2001).

Buck's concept of the "White, Western, Masculine voice" can be applied to the early lack of female interest in computers as well. According to the recent study entitled, "Tech-Savvy," conducted by the American Association of University Women (AAUW), the arcade, "shoot 'em up" design of most computer games in the early 1990's had, and continues to have, little appeal to the female audience (2000). If Moore's ideas about recreational usage being the key to positive attitudes hold true, then girls were simply not interested because the software available did not have a female appeal. The AAUW results showed that the advent of electronic mail, the Internet and computer games like

The Sims and *Roller Coaster Barron* offered girls the things that interest them; communication, information and roll-play/problem solving. These activities provide girls the much needed familiarity with the computer and are in part responsible for the upward trend in female attitudes towards computers and technology.

Hurd's (2002) and Padmaraju's (2003) ideas about a correlation between learning style and attitudes towards technology support Buck's findings. According to Buck, female student learning styles are typically different from their male counterparts; it follows that gender differences in attitude towards technology and science will exist. As science and technology teachers struggle to meet the needs of every student and learning style, the problem of female disinterest in science and technology seems to be fading. In other words, the tireless efforts of science and technology teachers to successfully teach all students are in effect, closing the gender gap.

Upon first glance, the works of Arch (1998) and Donovan (1982) seem to refute the findings of Hurd, Padmaraju and Buck. It was reported that even with careful reconstruction of the learning environment, (i.e. project-based instruction, female science teachers, small group activities) gender differences in attitude remained. Perhaps these findings lead us back to Buck's assertion that encouraging female students to merely "fit in" to the existing science and technology curriculum is not the solution.

CHAPTER THREE

RESEARCH DESIGN AND PROCEDURES

Procedures involved in this study are outlined in this chapter, which is organized into four sections. They are overall design, population, instrumentation and statistical analysis.

Overall Design

Descriptive research was conducted to assess middle school student attitudes towards robots, technology and science. Female and male attitudes were compared. The subjects were two classrooms of sixth grade students (N=53) and eighth grade students (N=74) from Charleston, Illinois. Observational checklists were completed to examine student behavior in the science classroom. A Likert-type questionnaire consisting of 20 items was administered to the students to obtain their perceptions and to explore if gender differences exist in their responses. Interviews were conducted with female middle school students (N= 8) to obtain in-depth information on their perceptions and attitudes towards robots, technology and the physical sciences.

Population

The population for the study consisted of students (N=127) enrolled in Charleston Community Unit School District #1. Charleston, Illinois, a rural town, has an approximate population of 20,000 including both state university and rural residents. According to the 1990 census, racial demographics for Charleston, Illinois are 96% white, 3% African American and 1% other. Students who were female (N=31) and male (N=22) sixth grade students and female (N=40) and male (N=34) eighth grade students were observed in their regular physical science class and participated in the Likert-type attitude survey. Written permission was obtained from Charleston Community Unit School District #1 to conduct the study (Appendix F). Signed parent/guardian consent forms were obtained for each student who participated (Appendix E) and student's anonymity was maintained through the assignment of subject identification numbers (id#). The observational classrooms and student interviewees were randomly selected from available science classrooms in the two participating public schools.

Instrumentation

Trained raters observed each of the four study classrooms. These three, trained raters examined student attitude based on verbal and behavioral modes. A modification of the Group Dynamics Observations instrument, funded by the National Science Foundation (NSF): Program for Women and Girls, was used (Appendix A). The observational instrument was developed to identify student interactions by gender. During a physical science lesson taught by the regular instructor, the raters completed an eight-point checklist that recorded student responses and large group classroom behavior. A chart for recording small group leadership and level of participation was also included. Additionally, the raters were instructed to record interesting, qualitative observations on the back of the provided checklists.

A 20-item survey was devised and entitled the Rogers Robot and Science Attitude Questionnaire (RRSAQ). This survey measures personal attitudes about robots, technology and careers in science (Appendix B). The RRSAQ was based on the Student Survey for Girls in Science and Technology (GIST) provided by the NSF. The GIST survey consisted of 48 items and was originally developed in 1998 as part of the GIST

Project at the University of Mississippi (see Appendix C). The 48 original items were edited to 33 and adapted to focus on robots as well as science and technology. The questions were carefully constructed based on the GIST instrument and pilot tested on seventh grade girls (N=15). Using an informal focus group format, girls participating in the pilot were encouraged to discuss the questions and their clarity. Once the final 20 items for the RRSAQ were selected, the normal classroom instructor administered the survey to the subjects during their regular science period.

Informal interviews were conducted with students to discuss their opinions and observe individual behavior. Randomly selected female pupils (N=8) from the survey classrooms were interviewed privately to obtain more detailed and candid information. Some interviews (N=7) were recorded on audiotape while one student, who did not wish to be tape recorded, was interviewed and her responses written down. Students were asked 12, predetermined questions and encouraged to explain their answers (see Appendix D). Pictures of robots and an actual Lego© Mindstorms robot were used to elicit spontaneous remarks and actions. The interview was conducted in an informal setting and students were encouraged to openly share their personal feelings about the topic.

Statistical Analysis

Statistical analysis procedures were conducted in the department of elementary education at Eastern Illinois University. Amy A. Rogers, Ph.D, statistician and assistant professor from the department of Psychology at Delaware State University provided professional consultation on analysis methodology. Statistical Packages for the Social

Sciences (SPSS) was used to correlate data from the three assessment tools and to do descriptive analysis for the RRSAQ and the classroom observations.

CHAPTER FOUR

RESULTS

Results for this study are recorded in this chapter. The chapter is divided into four sections: quantitative results from the RRSAQ survey, qualitative results from the classroom observations, qualitative results from the personal interviews and hypothesis.

The RRSAQ survey results

The items in the RRSAQ survey were tested for reliability. A Cronbach's α test with a range of 0 to 1 was run and a value of .76 was found (Table 1). This value determines that the reliability of the RRSAQ is solid and the results discovered from the instrument can be considered dependable. For this analysis items 3, 4, 7, 10 and 12 were reverse coded to establish a consistent result.

Table 1

RELIABILITY ANALYSIS - SCALE α (ALPHA)

Statistics for:	Mean	Variance	Std Dev	N of Variables
SCALE	46.0984	27.2630	5.2214	14

Analysis of Variance

Source of Variation	Sum of Sq.	DF	Mean Square	F	Prob.
Between people	235.6300	121	1.9474		
Within people	816.0000	1586	.5145		
Between measures	90.1874	13	6.9375	15.0351	.0000
Residual	725.8126	1573	.4614		
Total	1051.6300	1707	.6161		

Grand Mean 3.2927

Reliability Coefficients

N of Cases = 122.0 N of Items = 14

Alpha = .7631

Next, descriptive analyses of the RRSAQ data were conducted. The subjects' ages ranged from 11 years to 15 years. Questions 1 through 14 dealt with student perceptions about robotics as a career and are referred to as the RSCALE or "robot scale" (Appendix

B). The values of the RSCALE had a range of 1 to 4 with any score over 2.50 indicative of a positive attitude. Values for the RSCALE for all students surveyed showed a mean of 3.30, a median of 3.40, with .37 standard deviation (Table 2).

Sixth grade females had a mean of 3.43 compared to a 3.22 for the males. Eighth grade females had a mean of 3.34 and males had a mean of 3.16 (Table 2). These values clearly show a positive student attitude towards careers in robotics for all students and a significantly more positive attitude for females.

Table 2
ROBOT SCALE (RSCALE) RESULTS

	All subjects	All 6th grade	All 8th grade	6th grade girls	6th grade boys	8th grade girls	8th grade boys
Mean	3.30	3.35	3.26	3.43	3.22	3.34	3.16
Median	3.36	3.43	3.29	3.50	3.29	3.36	3.29
Standard Deviation	.37	.41	.33	.32	.49	.29	.36
Minimum	2.29	2.29	2.29	2.86	2.29	2.71	2.29
Maximum	3.93	3.93	3.93	3.93	3.86	3.93	3.71

Comparative analyses were conducted on items 1 to 14, or RSCALE. An independent sample t-test was run on the data collected to examine gender differences. Since the scale is formed from an average of many ordinal data, the resulting scale has many different values. The scale has enough values to be considered interval data. This method of analysis is further explained by Nunnally & Berstein (1994). The value of t for the RSCALE was found to be 3.07 with a significance of level of .003 (Table 3).

Table 3

ROBOT SCALE (RSCALE) INDEPENDENT SAMPLE T-TEST

Group Statistics

	Subject's Sex	N	Mean	Std. Deviation	Std. Error Mean
RSCALE	female	71	3.3831	.30717	.03645
	male	56	3.1877	.41055	.05486

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
RSCALE	Equal variances assumed	3.338	.070	3.067	125	.003	.1954	.06369	.06931	.32141
	Equal variances not assumed			2.966	99.109	.004	.1954	.06587	.06466	.32605

Items 15 to 20 dealt with personal attitudes towards robots, science and technology and will be referred to as the Attitude Scale (ASCALE). Overall, student attitudes measured in the ASCALE were less positive than those found in the RSCALE (Appendix B). These questions were worded in a personal manner. For example, students were asked if they wanted to "know more about robots" and if they were" good at science." When faced with the subject of robots and technological science in a personal way, female students were less enthusiastic than the males. However, with a range 1 to 4, any mean score on the ASCALE over 2.5 was considered a positive response. The whole group mean was 2.97 thus illustrating a positive attitude (Table 4).

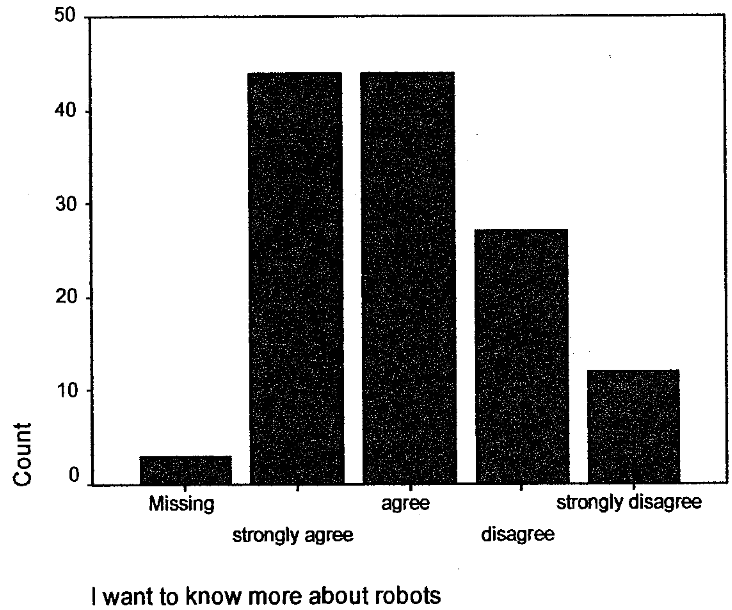
Table 4

ATTITUDE SCALE (ASCALE) RESULTS

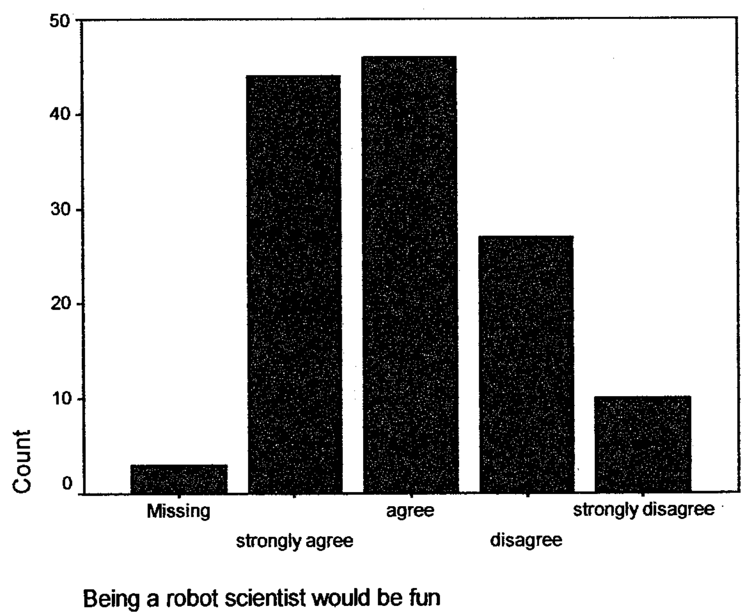
	All subjects	6th grade girls	6th grade boys	8th grade girls	8th grade boys
Mean score	2.97	2.93	3.15	2.89	2.96

The whole group responses to item 15, "I want to know more about robots," and item 18, "Being a robot scientist would be fun" were positive, with a mean score of 2.94 and 2.98 consecutively (Bar Graph 1, Bar Graph 2).

Bar Graph 1
Whole group response to item 15

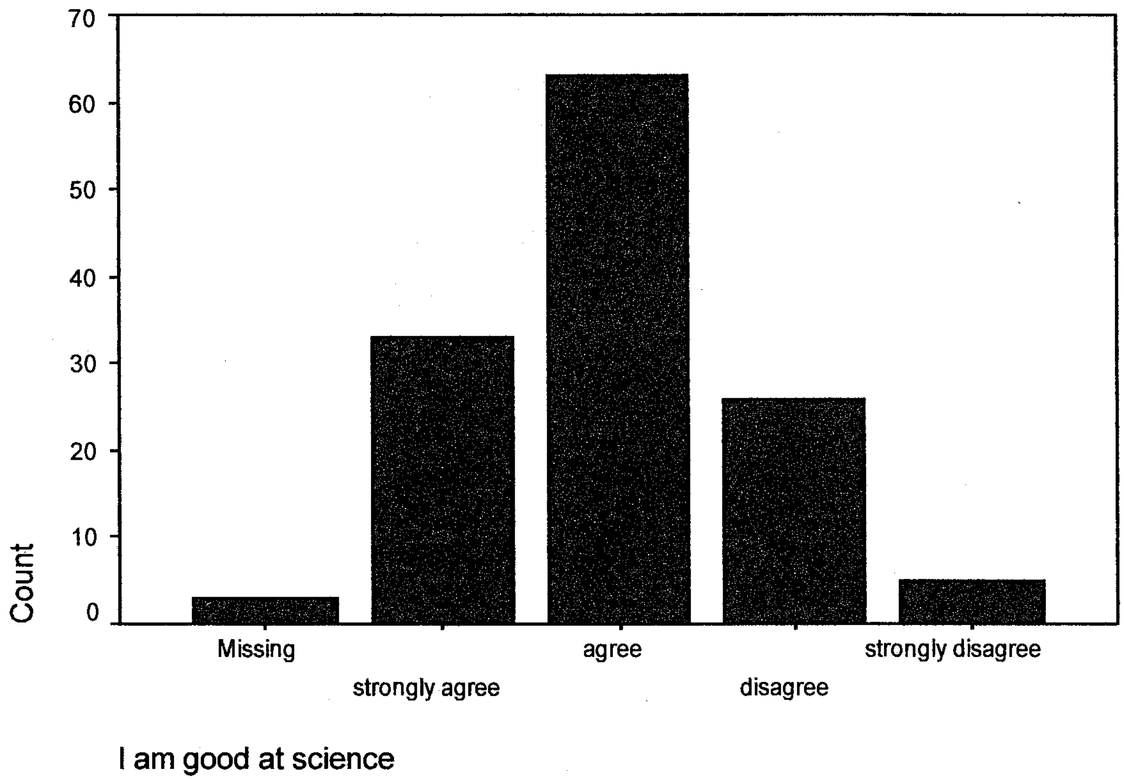


Bar Graph 2
Whole group response to item 18



Student self-assessment on science ability was optimistic. With a whole group mean score of 2.98 on item 16, "I am good at Science," students appeared to be self-confident (Bar graph 3).

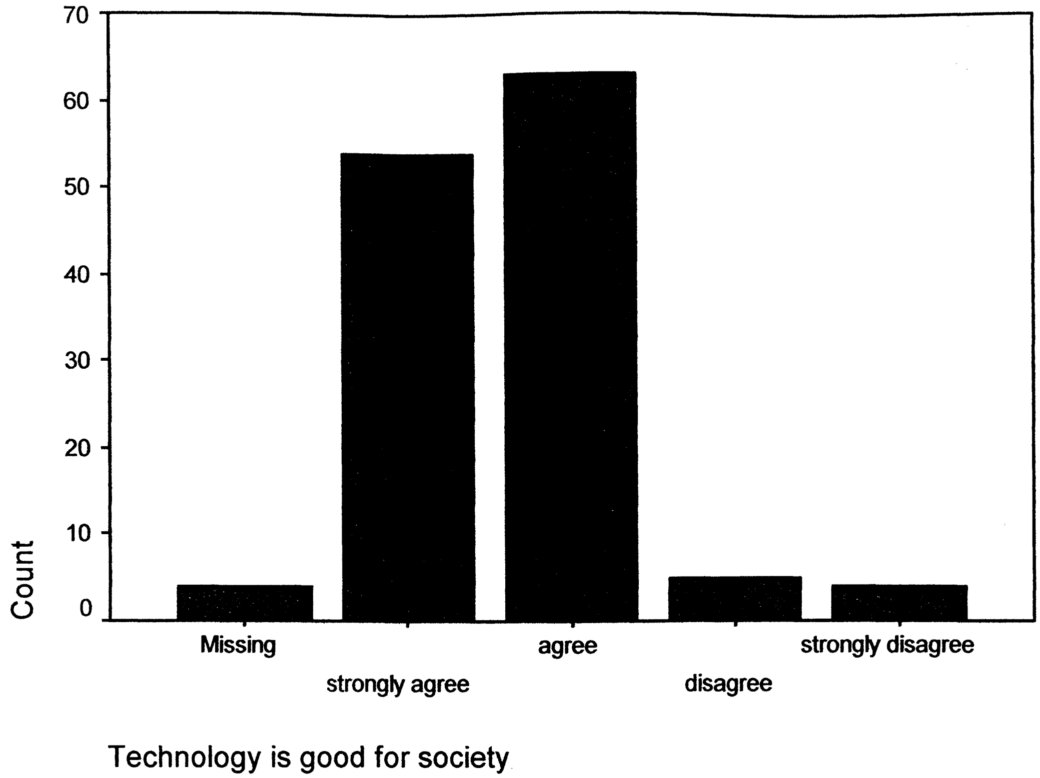
Bar graph 3
Whole group response to item 16



The benefits of technology seemed to be evident to most students. Whole group mean scores on item 17, "Technology is good for society" showed a value of 3.33 (Bar Graph 4).

Bar Graph 4

Whole group response to item 17



Comparative analyses were done on the items in the ASCALE to examine differences found by gender. Since the data is ordinal, a Pearson chi-square analysis was applied to these questions. Responses to item 17, "I want to know more about robots," showed significantly more positive response from male students with a chi-square value of 10.77[a] or $\div 2 = (3,127) = 10.77$[a], $p < .013$ (Table 5). Responses to items 15, 16, 18, 19 and 20 showed minimal variance along gender lines, therefore, the results from these chi-square analyses are not reported here.

Table 5
CHI-SQUARE ANALYSIS
Item 17, "I want to know more about robots"

Crosstab

Count

		Subject's Sex		
		female	male	Total
I want to know more about robots	strongly disagree	7	5	12
	disagree	21	6	27
	agree	26	18	44
	strongly agree	17	27	44
Total		71	56	127

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.773[a]	3	.013
Continuity Correction			
Likelihood Ratio	11.140	3	.011
Linear-by-Linear Association	6.733	1	.009
N of Valid Cases	127		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.29.

Classroom observational qualitative results

For the classroom observational portion of the study, three indicators of attitude were identified. The attitudinal constraints defined by the verbal and nonverbal behaviors observed were: participation, leadership and on task behavior. Verbal participation in the form of asking and responding to questions was recorded by gender and considered a behavior that indicated positive attitude. Leadership in the small group setting, either self appointed or elected, was considered an indication of positive attitude. Finally, on task behavior was also considered indicative of positive attitude.

In each physical science class observed, the period was divided up into two sections, there was a teacher led, dialectic portion of class and the remaining time was allotted to small group, lab work. Each observed lesson was conducted by the regular classroom teacher. Three different lectures were observed; two different sixth grade lessons and one eighth grade lecture given twice. One sixth grade lesson dealt with the earth's tectonic plates and the other was an introduction to basic physics using marbles. The eighth grade lessons both dealt with the measurement of boiling and melting points. The attitudinal constraints; participation, leadership assignment and on task behavior were examined in the large and small group setting to look for trends.

On the top portion of the observation form (Appendix A), raters tallied student verbal participation in the large group setting. These responses were divided by gender as well as type of response. For example, separate tallies were kept for those who raised their hands and those who blurted out the answer. The data collected for large group verbal participation was conflicting along grade level lines and somewhat inconclusive.

The results for the sixth grade showed that students of both genders were actively engaged in the discussion. Female students participated more frequently than their male classmates and the females were more likely to raise their hands and then respond appropriately. Results for the eighth grade classroom observations were less conclusive. Eighth grade boys participated a bit more frequently and tended to shout out answers, without being called on by the teacher. However, due to a different teacher lecture style the total number of eighth grade responses was considerably lower than the sixth grade, making these figures less reliable.

Data collected on verbal participation during the small group portion of class provided the most support for the hypothesis. Female students at both grade levels were repeatedly shown to speak openly and ask questions in the more relaxed, small group setting. Most groups with more than one female were very talkative and focused on the work at hand. Sixth grade girls from one group were observed grabbing the experimental equipment from a male classmate while insisting, "Give us a turn!" Female leaders in the eighth grade answered questions about the experiment for their own groups and students from other groups sought their help as well. This behavior of checking around for group consensus seemed to be a mostly female behavior.

When considering the desire and ability to lead the females held their own. In the large group the girls were responsive and active in the discussion. However, leadership could be more closely examined in the small group environment. As each small group was observed, the raters tried to determine who the leader was based on verbal interactions and task assignments.

A balanced, or shared leadership style seemed to develop in most groups. Tallies collected by the three raters showed that females led their small groups 35% of the time, males led 26% of the time and leadership was shared 39% of the time. Leadership and other task assignments were sometimes handled informally by group consensus and occasionally by individual demand.

Females held the responsibility of "recorder" 80% of the time. This was often a self appointed task, however one male student was observed tossing the lab book to his female lab partner and declaring, "Here, you write the stuff down." For the purposes of this study, the job of "recorder" was not considered a position of leadership.

Personal interviews, qualitative results

Eight female students were randomly selected from the observational classrooms for individual interviews, four were sixth grade students and four were eighth graders. Twelve questions were asked of each subject and spontaneous remarks were encouraged (Appendix D). The first two questions dealt with science as a subject in school, the next five questions explored the topic of computers. Using a recent article about robotics found in *Newsweek* as a prompt, the last five questions focused on robots (Stone, 2003). After the twelve questions were asked an actual Lego© Mindstorm robot was presented to the interviewee and each student's reactions were recorded.

When asked if they were "good at science," half of the students interviewed answered a firm "Yes." An eighth grade subject (id# 835) answered, "Oh ya, I get good grades. I understand most things in science. Its like, I get to my own interests in science class. It's not like that in other classes." Three of the eight felt that they were average science students and one student reported that she got good grades, but she wasn't really interested in science. All of the eight students interviewed felt that the best parts of science class are the hands on activities and experiments.

The female students also exhibited positive opinions about computers. All eight enthusiastically claimed to like computers and each had a computer at home. The most popular uses for their computers were: electronic mail, instant messaging, and exploring the Internet. When it came to playing games, three subjects reported playing roll-playing games like *The Sims.* One eighth grade subject (id# 852) explained why she liked *The Sims* computer game, "It's neat to build the houses and get the people to do things. It's pretty hard to keep them happy all the time."

The girls seemed interested in how the computer works. One student (id# 25) claimed, "Sometimes I like, wonder why it (the computer) goes so slow. It would be so much fun to know why." Five out of the eight interview subjects expressed interest in the workings of the computer. One very bright eighth grade girl (id# 835) said that computers are "amazing" and plans to study computer science in college. However, not all responses were positive, a sixth grade student (id# 4) claimed that she did not really care about how the computer works, "I'd rather just use it."

When it came to problem solving at the computer the group was divided in the middle. If a problem developed at the computer, four students reported that they would get help from a parent and four would try to solve the dilemma on their own.

On the subject of robots the students exhibited a variety of responses. All of the girls could recall a positive experience with robots in the past, either with a robotic toy such as Furbee© or with an educational robot used in the classroom. Most of the girls complained that Furbee© was annoying and would not be quiet however, this did not seem to dampen their enthusiasm for the robotic toy. One student (id# 832) made a rather profound remark about robots, " We use robots in so many ways but I don't think they will like ever run our lives." Another student (id# 19) suggested that she would like to invent robots that do housework and cook.

Initially, the interviewees seemed only moderately in,terested in the Lego© robot set in front of them for the final portion of the interview. Many of the girls reported that they didn't play with Lego© and felt that it was a toy for younger children. Once the robot was put into motion, the reactions changed. Exclamations like, "Wow, pretty cool" and "I should get this!" were common. Additionally, nonverbal body language conveyed a lot about student attitude. Most of the subjects were eager to play with the Lego© Mindstorms robot. When the moving robot was aimed directly towards the student, two of the girls allowed the robot to crawl on their leg, four subjects reached excitedly for it and two moved out of the way, appearing uninterested.

HYPOTHESIS

Data resulting from the analysis of the study were employed in the acceptance or the rejection of the hypothesis.

Hypothesis

The whole group, mean scores for both sections of the RRSAQ survey, 3.30 for the RSCALE and 2.97 for the ASCALE, illustrate positive student attitudes towards robots, technological science and careers in robotics. These solid numbers support the hypotheses in a qualitative way. The independent t-test comparative analyses on RSCALE data looking for gender differences illustrated that females felt more positive about careers in robotics than their male classmates. Pearson chi-square analyses conducted on each ASCALE item demonstrated that there were no significant gender differences found in student responses to five out of the six items. On item 17, "I want to know more about robots" male students scored higher and more positively than female students. The ASCALE items dealt with robots, science and technology in a personal way.

Behaviors noted during the classroom observations demonstrated positive student attitude and supported the hypotheses. Trained raters observed four physical science lessons and identified three constraints that expressed positive attitudes: leadership, on task behavior and participation. Female students clearly out performed their male classmates in the leadership and on task behavior categories. In the area of classroom participation, the rater's tally marks showed student responses to be distributed equally between the two sexes. Study subjects exhibited positive attitudes towards their science class and females seemed to be clearly more motivated and attentive.

Data collected during the eight personal interviews focused on female students and their opinions about science class, computers and robots. All interview subjects made enthusiastic remarks about computers and their uses. Seven out of the eight girls were optimistic about their personal science abilities. All subjects reported positive prior experiences with robots and seemed interested in the Lego© robot, once it was set into motion.

After consideration of the quantitative RRSAQ values, the personal interviews and qualitative rater remarks from classroom observations, it appears that there is strong evidence to support both hypotheses. Middle school students exhibit positive attitudes towards robots, the technological sciences and careers in robotics. Female middle school students exhibit positive opinions about robots, the technological sciences and careers in robotics. The hypotheses are therefore accepted and recommendations for further research are given in Chapter 5.

CHAPTER FIVE

SUMMARY, DISCUSSION, CONCLUSIONS, RECOMMENDATIONS

In this chapter a summary of this study is provided, conclusions are drawn and recommendations for further study and practice are made.

Summary

This study was conducted to determine if middle school students possess positive attitudes towards robotics, the technological sciences and careers in robotics. Female and male attitudes were also compared to assess gender differences.

Discussion

The last two decades have shown an improvement in female student attitudes towards science and technology. The literature demonstrates that when technology can be used to assist females in activities that interest them, it becomes a vastly interesting and desirable pastime. Once extensive leisure use is established, positive attitudes will follow. It seems that female students need innovation in the area of science and technology education in order to find further inspiration. Robotics could be a solution to this multifaceted problem. Since female student attitudes towards robotics have been shown to be positive, perhaps robotics enhanced science instruction could motivate young girls. Certainly, all students, male and female, could benefit from the recreational, constructionist approach to science education that robotics has to offer.

Major Conclusions

The findings of this study allow the following conclusions to be drawn:

1. Middle school students express positive attitudes towards robots, technological science and careers in robotics.
2. Female middle school students express a more positive attitude towards careers in robotics than males (RSCALE).
3. Male middle school students consider robots somewhat more entertaining and interesting than females (ASCALE).
4. Middle school students can benefit from robotic enhanced science education due to the positive attitudes expressed by students of both genders.

Recommendations for further research

Based on the findings of this study, the following recommendations for future research are:

1. It is suggested that high school students participate in a descriptive study focusing on attitudes towards robotics and technological science.
2. It is suggested that experimental research be conducted on students of all grade levels to determine the benefits of robotic enhanced instruction on academic achievement.
3. It is suggested that case studies be conducted on middle school female students focusing on attitudes and interest in robotics and the technological sciences.

4. It is suggested that a longitudinal study be conducted focusing on attitudes and interest in robotics and the technological sciences, following female students from 4th grade to high school graduation.

5. It is suggested that an observational study be conducted assessing female middle school student leadership qualities.

6. It is suggested that comparative studies be conducted on the four sixth grade students interviewed in this study once they reach eighth grade and after they have completed the technology course offered at Charleston Middle School.

7. It is suggested that descriptive research be conducted investigating urban, high school student attitudes towards robotics and technological science.

8. It is suggested that comparison research be conducted to determine female student attitudes towards robotics and technological science in 7th grade and again in 12th grade.

9. It is suggested that attitudes towards robotics and technological sciences of middle school students from an urban school district be surveyed.

10. It is suggested that primary level (K-3) students be surveyed to assess their attitudes towards robotics and the technological sciences.

11. It is suggested that a study be conducted to determine the number of elementary schools in Illinois that currently incorporate robotic-enhanced instruction in the classroom.

Recommendations for further practice

Based on the findings of this study, the following recommendations for further practice are suggested.

1. During a district-wide training session, conducted annually, teachers in science and technology classrooms should be made aware of gender differences and preferences through the analysis of a video of girls working in a science classroom.
2. Each year at the annual orientation meeting, a one page suggestion sheet should be provided to each teacher, offering new ideas about how to engage and encourage girls in the sciences and how to create lessons that are gender neutral.
3. Each science teacher, grades K-12, should be provided with a $300 stipend to purchase a Lego© Mindstorms robotics set for classroom use.
4. Each teacher who teaches science should receive $300 to attend two full day workshops that demonstrate how to use the Lego© Mindstorms robotics set and how to incorporate it into the science curriculum.
5. Intermediate elementary, middle school and high school buildings should hold an annual robotics fair, which highlights student work. The focus of the event should be on creative, problem solving applications of robotics, not competition. Categories could include; dancing robots, robots that make life easier or robots that make life safer.
6. A female engineer or robot scientist should be invited to give a motivational speech during a school wide assembly conducted at each school in the district.

This assembly should incorporate the use of a robot or other clever technological device.

7. Teachers should be provided with a list of websites and other resources that offer suggestions and motivation for girls interested in robotics and the technological sciences.

8. Local female scientists should be located and invited to participate in school "career days." This would provide female models for male and female students.

9. Pre-service teachers should be offered scholarships and grants to attend training and workshops on the topics of robotics and the technological sciences.

10. Mentoring programs should be developed for female high school students interested in robotics and the technological sciences. Local female scientist should be asked to support female high school students by offering encouragement and advice.

11. Segregated science classes should be offered for girls who wish to study the subject without distractions. Gender segregation could be elective or required by the school district.

12. During the summer, the school district or a local university should offer robot/technology camps for girls. These camps should be for female students grades 5th to 10th and offer a variety of robotic and technological experiences.

13. Science teachers should talk with their female students to determine what science topics interest them and how they want to learn about them.

14. Education professors, who teach science methods to pre-service teachers, should include robotics instructional methods as part of their regular curriculum.

BIBLIOGRAPHY

Aitken, J.E. (1986). *The role of language and gender in "The Transformers": An analysis of messages in cartoons for children.* (Eric Document Reproduction Service No. ED 293 187).

American Association of University Women Educational Foundation. (2002). *Tech savvy: Educating girls in the new computer age.* Washington DC: Author.

Arch, E.C. (1995). *The Baldwin Effect: A basis for sex differences in attitudes towards technology and science.* (Eric Document Reproduction Service No. ED 387 121).

Brownlow, S., Rogers, M., & Jacobi, T. (2000). *Science anxiety as a function of personality, gender roles, experience with science.* (Eric Document Reproduction Service No. ED 443 733).

Buck, G. (2002). Teaching discourses: Science teachers' responses to the voices of adolescent girls. *Learning Environments Research, 5*(1), 29-50.

Donovan, E. (1982). *The influence of the eighth grade science teacher's gender, classroom laboratory emphasis, level of understanding of science and career interest on eighth grade girls' science and engineering career interests.* (Eric Document Reproduction Service No. ED 260 935).

Hendly, D., Parkinson, J., Stables, A., & Tanner, H. (1995) Gender differences in pupil attitudes to the National Curriculum Foundation subjects of English, mathematics, science and technology in Key Stage 3 in South Wales. *Educational Studies, 21*(1), 85-97.

Hurd, P. (2002). *Learning styles and students' attitudes towards technology.* (Dissertation Abstracts International No. 2002-95013-106).

Padmaraju, K. (2003). *Learning styles of teachers and usage of technology.* Unpublished master's thesis, Eastern Illinois University, Charleston.

Miura, I. T. (1986). *Understanding gender differences in middle school computer interest and use*. (Eric Document Reproduction Service No. ED 273 246).

Moore, J. L. (1985). An empirical study of pupils' attitudes to computers and robots. *Journal of Computer Assisted Learning, 1*(2), 87-98.

Moore, J. L. (1985). Development of a questionnaire to measure secondary school pupils' attitudes to computers and robots. *Educational Studies, 11*(1), 33-41.

Nickell, G. S. (1987). *Gender and sex role differences in computer attitudes and experience.* (Eric Document Reproduction Service No. ED 284 114).

Nunnally, J. C. & Bernstein, I. H. (1994). Psycometric Theory, 3rd edition. New York: McGraw-Hill.

Raat, J. & De Vires, M. (1985). *What do 13-year old pupils think about technology? The conception of and attitude towards technology of 13-year old girls and boys.* (Eric Document Reproduction Services No. ED 262 998).

Schott, G., & Selwyn, N. (2000). Examining the "male, antisocial" stereotype of high computer users. *Journal of Educational Computing Research 23*(3), 291-303.

Stone, B. (2003). Real world robots. *Newsweek, 141*(12), 42-44.

Tunnicliffe, S. D., & Reiss, M. J. (1999). *What sense do co children make of three-dimensional life-sized "representations" of Animals?* (Eric Document Reproduction Services No. ED 433 213).

Wagner, S. P. (1998). Robotics and children: Science achievement and problem solving. *Journal of Computing in Childhood Education, 9*(2), 149-192.

http://www..aauw.org/research/girls_education/techsavvy.cfm

http://www.nsf.gov/seb/srs/nsf00327/start.htm

http://oerl.sri.com/

http://venus.census.gov/cdrom/lookup/1046972836

APPENDIX A

OBSERVATIONAL CHECKLIST

CLASS OBSERVATION FORM

Class title________________________ Reviewer____________________________________

Grade level__________ Time___________ Date________________________

Student observations- record occurrences by gender

Instructional portion of class

Who asks questions in the class? How do they ask questions? (for example, do they raise their hand, do they blurt out answers) Who answers questions?

Please use tally marks or capital letters

Male asks	Female asks	Male answers	Female answers		Blurt out (MB or FB) or Raise hand (MRor FR)			
					MB	FB	MR	FR

Small group activities

Who leads the group? How frequently do males and females contribute to the discussion? How many males and females are present?

Group number	Male leads group	Female leads group	Males talk more	Females talk more
1				
2				
3				
4				
5				
6				

Notes on back….

APPENDIX B

ROGERS ROBOT AND SCIENCE

ATTITUDE QUESTIONAIRE (RRSAQ)

Name____

Grade________ Age________

Girl________ Boy_________ (Check One)

Opinion. Indicate your true feelings, not what you think may be an answer that is expected. Circle the appropriate answer according to the scale below. It is important that all questions are answered by circling only one number.

1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree

PART A consists of statements numbered 1 to 14 which complete the following sentence:

When I think about a robotics scientist, I think of a person who:		Strongly Agree	(Circle One)		Strongly Disagree
1.	Takes his/her work seriously.	1	2	3	4
2.	Is open minded.	1	2	3	4
3.	Is so involved in work that he/she doesn't know what's happening in the world.	1	2	3	4
4.	Sits in front of a computer all day.	1	2	3	4
5.	Is intelligent.	1	2	3	4
6.	Has spent many years studying.	1	2	3	4
7.	Works in a dreary laboratory.	1	2	3	4
8.	Is careful in his/her work.	1	2	3	4
9.	Neglects his/her family.	1	2	3	4
10.	Has little social life.	1	2	3	4
11.	Stands up for his/her ideas when attacked.	1	2	3	4
12.	Has few hobbies or means of relaxation.	1	2	3	4
13.	Is prepared to work long hours.	1	2	3	4
14.	Is creative.	1	2	3	4

PART B consists of complete statements. Please circle the number that best describes your opinion.

15.	I would like to know more about robots.	1	2	3	4
16.	I am good at science.	1	2	3	4
17.	Technology is necessary for the good of society.	1	2	3	4
18.	Being a robotics scientist would be fun.	1	2	3	4
19.	Programming computers is difficult.	1	2	3	4
20.	A computer scientist's work is exciting.	1	2	3	4

APPENDIX C

GIRLS IN SCIENCE AND TECHNOLOGY (GIST) ORIGINAL SURVEY

lStudent Survey for Girls in Science and Technology

Project: Girls in Science and Technology
University of Mississippi
Funding Source: NSF: Program for Women and Girls (HRD)
Purpose: To gather information on student attitudes concerning scientists and scientific careers
Administered To: Participating students
Topics Covered:

- Attitudes & Beliefs (Student): *education, profession*

Format/Length: questions

Name ______________________________

Opinion. Indicate your true feelings, not what you think may be an answer that is expected. Circle the appropriate answer according to the scale below. It is important that all questions are answered by circling only one number.

1. Strongly Agree
2. Agree
3. Mildly Agree

4. Mildly Disagree
5. Disagree
6. Strongly Disagree

PART A consists of statements numbered 1 to 32 which complete the following sentence:

When I think about a scientist, I think of a person who:	Circle ONE number
1. Sits in a laboratory all day.	1 2 3 4 5 6
2. Pours chemicals from one test tube to another.	1 2 3 4 5 6
3. Takes his/her work seriously.	1 2 3 4 5 6
4. Is considered just a small part in a machine, if he/she works for a large corporation.	1 2 3 4 5 6
5. Is courageous.	1 2 3 4 5 6
6. Believes that there is no God.	1 2 3 4 5 6
7. Is open minded.	1 2 3 4 5 6
8. Is so involved in work that he/she doesn't know what's happening in the world.	1 2 3 4 5 6
9. Records data carefully.	1 2 3 4 5 6
10. Uses words few people understand.	1 2 3 4 5 6
11. Is dedicated.	1 2 3 4 5 6
12. Is usually reading a book.	1 2 3 4 5 6
13. Does not work for money, fame or self-glory.	1 2 3 4 5 6
14. Works for the benefit of human kind.	1 2 3 4 5 6
15. Is intelligent.	1 2 3 4 5 6
16. Has spent many years studying.	1 2 3 4 5 6
17. Works in a dreary laboratory.	1 2 3 4 5 6
18. Has heavy expenses if he/she works alone.	1 2 3 4 5 6
19. Is careful in his/her work.	1 2 3 4 5 6
20. Is patient.	1 2 3 4 5 6
21. Must keep secrets if he/she works for the government.	1 2 3 4 5 6
22. Knows his/her subject.	1 2 3 4 5 6

19. Is careful in his/her work.	1	2	3	4	5	6
20. Is patient.	1	2	3	4	5	6
21. Must keep secrets if he/she works for the government.	1	2	3	4	5	6
22. Knows his/her subject.	1	2	3	4	5	6
23. Neglects his/her family.	1	2	3	4	5	6
24. Has little social life.	1	2	3	4	5	6
25. Stands up for his/her ideas when attacked.	1	2	3	4	5	6
26. Has few hobbies or means of relaxation.	1	2	3	4	5	6
27. Is prepared to work long hours.	1	2	3	4	5	6
28. Is prepared to work years without getting results.	1	2	3	4	5	6
29. Is rarely home.	1	2	3	4	5	6
30. May work for years without success.	1	2	3	4	5	6
31. Works at an uninteresting job.	1	2	3	4	5	6
32. Makes the world a better place to live.	1	2	3	4	5	6

1. Strongly Agree
2. Agree
3. Mildly Agree

4. Mildly Disagree
5. Disagree
6. Strongly Disagree

PART B consists of complete statements numbered 33 to 48.

33. A scientist's work is dangerous.	1	2	3	4	5	6
34. I would like to be a scientist.	1	2	3	4	5	6
35. Science is responsible for causing pollution.	1	2	3	4	5	6
36. Scientists are good for society because they help find cures.	1	2	3	4	5	6
37. Science is responsible for wars.	1	2	3	4	5	6
38. Science is necessary for the defense of our country.	1	2	3	4	5	6
39. I would like to marry a scientist.	1	2	3	4	5	6
40. We would be better off without scientists.	1	2	3	4	5	6
41. Without scientists we would still be living in caves.	1	2	3	4	5	6
42. Being a scientist would be fun.	1	2	3	4	5	6
43. Science is responsible for progress.	1	2	3	4	5	6
44. A scientist's work is dull.	1	2	3	4	5	6
45. A scientist's work is boring.	1	2	3	4	5	6
46. Science is responsible for preserving more lives.	1	2	3	4	5	6
47. A scientist's work is time consuming.	1	2	3	4	5	6
48. Science is responsible for improving the health and comfort of the population.	1	2	3	4	5	6

From the Online Educational Research site
http://www.oerl.sri.com/instruments/up/studsurv/instr127.html

APPENDIX D

PERSONAL INTERVIEW QUESTIONS

STUDENT ATTITUDES TOWARDS ROBOTS AND TECHNOLOGY
PERSONAL INTERVIEW QUESTIONS

1. ARE YOU GOOD AT SCIENCE? TELL HOW ABOUT WHY OR WHY NOT.

2. WHICH PARTS OF SCIENCE CLASS DO YOU LIKE BEST?

3. DO YOU LIKE COMPUTERS?

4. WHAT DO YOU SPEND THE MOST TIME ON THE COMPUTER DOING?

5. DO YOU HAVE A COMPUTER AT HOME?

6. DO YOU EVER WONDER ABOUT HOW THE COMPUTER WORKS?

7. WHAT DO YOU DO WHEN SOMETHING ON THE COMPUTER DOESN'T WORK PROPERLY?

8. LOOK AT THIS NEWSWEEK ARTICLE. TELL ME WHAT DO YOU THIHK ABOUT THIS ROBOT IN THE PICTURE.

9. WHAT OTHER ROBOTS HAVE YOU HEARD OF?

10. HAVE YOU EVER PLAYED WITH POPULAR ROBOT TOYS LIKE TAMIGUCHI, ROBOT DOG, FURBEE? DO YOU LIKE TOYS LIKE THIS?

11. HAVE YOU EVER USED THE LEGO MINDSTORMS ROBOTS?

12. IF SO, DID YOU LIKE TO PLAY WITH THEM? WHAT DID YOU DO WITH THEM?

APPENDIX E

PARENT CONSENT FORM

Parent Consent Form

March 31, 2003

Dear Parents,

Your student's science classroom has been selected to participate in a survey as part of an Eastern Illinois University thesis research study. This study will consist of three parts. The science class will be observed during a regular science class. All students will be given a brief written survey to complete and a few students will be randomly selected for personal interviews. Your child's name will not be used in any publication. This study will be used to improve educational practices in the future. If you have any questions, please feel free to contact me: Jill Frisby at 348-5019. Thank you in advance for your cooperation.

My child_______________________________(print name here) has my permission to participate in the science attitude survey and interviews. I understand that all data collected will be used for research purposes and that my child's name will not be used in any publication.

_____________________________date_____________

(Parent or guardian signature)

APPENDIX F

COPY OF CHARLESTON COMMUNITY

UNIT SCHOOL DISTRICT #1

PERMISSION TO CONDUCT STUDY

CHARLESTON
Community Unit School District

District Administration Office
Phone: (217) 345-2106 410 West Polk Avenue, Charleston, IL 61920 Fax: (217) 345-8121

TO: BUILDING ADMINISTRATORS AND SECRETARIES

SUBJECT: DISTRIBUTION OF HANDOUTS

ORGANIZATION/ACTIVITY________________________

NAME OF PUBLICATION Research Design - "Student Attitudes Toward Robots"

APPROVED

____ Place in office for pickup

____ Place on table(s) for students Grade(s)________

____ Distribute through classroom Grade(s)________

____ Building administrator's prerogative to distribute to interested staff

____ Post in building

____ Place in faculty lounge

OTHER APPROVED INFORMATION FOR DISTRIBUTION

____ Representative will be contacting the building administrator. Participation is determined by the building principal.

✓ Permission to conduct survey providing the building administrator and teacher(s) involved are agreeable. All necessary documentation is on file with the Assistant Superintendent.

____ DENIED

Reason:____

3-26-03
Date

*This form must be presented, in person, at each attendance center where materials are to be distributed.