Are we being fair to females?: A look at gender differences in science

Keith Andrew Prather

Follow this and additional works at: https://scholarworks.lib.csusb.edu/etd-project

Part of the Gender and Sexuality Commons, and the Science and Mathematics Education Commons

Recommended Citation
Prather, Keith Andrew, "Are we being fair to females?: A look at gender differences in science" (1997). Theses Digitization Project. 1319.
https://scholarworks.lib.csusb.edu/etd-project/1319

This Thesis is brought to you for free and open access by the John M. Pfau Library at CSUSB ScholarWorks. It has been accepted for inclusion in Theses Digitization Project by an authorized administrator of CSUSB ScholarWorks. For more information, please contact scholarworks@csusb.edu.
ARE WE BEING FAIR TO FEMALES?
A LOOK AT GENDER DIFFERENCES IN SCIENCE

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

by
Keith Andrew Prather

June 1997

Approved by:

Dr. Richard Griffiths, First Reader

Dr. Iris Riggs, Second Reader
ABSTRACT

This study examined gender differences in science classes of seventh grade students in a California middle school. Three areas were examined: 1) student-teacher interactions, 2) student achievement, and 3) student attitude toward science. Student-teacher interactions were classified as high-level questions, low-level questions, on-task interactions or off-task interactions. The results show that a gender bias exists in teacher-student interactions although not at a significant level. Males were asked more questions and received more on-task and off-task interactions with teachers. They also received more high-level questions and almost 70% more off-task interactions with teachers than females. Girls achieved a higher grade point average than boys based on their second semester science grades in the 1996-97 academic year. This could be explained as a result of girls having more motivation to do well academically than boys in science. Males held more positive attitudes than females, but it was not significantly different. The fact that males receive more student-teacher interactions than females could give them a decided edge in science classes and influence their attitudes toward science positively. These positive attitudes can lead to later success in science. The findings in this study add to existing research on gender differences in science and include important implications to science students, teachers and science education.
ACKNOWLEDGMENTS

I would like to acknowledge all the people who assisted me in completion of this master's thesis. My wife, Sally, for her support and love. My family for their inspiration and encouragement. My professors, Dr. Griffiths and Dr. Riggs, for their dedication and professionalism. May all who read this paper rethink the way they teach science.
# TABLE OF CONTENTS

ABSTRACT........................................................................................................................................ iii

ACKNOWLEDGMENTS ..................................................................................................................... iv

LIST OF TABLES................................................................................................................................. vii

CHAPTER ONE: INTRODUCTION......................................................................................................... 1

The Problem........................................................................................................................................ 1

Research Question............................................................................................................................. 6

CHAPTER TWO: LITERATURE REVIEW............................................................................................... 8

Introduction......................................................................................................................................... 8

Achievement......................................................................................................................................... 8

Student Attitude................................................................................................................................. 11

Opportunities....................................................................................................................................... 15

Summary............................................................................................................................................. 19

CHAPTER THREE: PROJECT DESIGN................................................................................................. 20

Population/Subjects............................................................................................................................ 20

Methodology....................................................................................................................................... 21

Student-Teacher Interaction Observations.......................................................................................... 21

Student Achievement-Grade Point Average.................................................................................... 22

Student Attitude Toward Science Survey......................................................................................... 23

Data Collection.................................................................................................................................. 24

Student-Teacher Interaction Observations........................................................................................ 24

Student Achievement-Grade Point Average.................................................................................... 24
LIST OF TABLES

1. Student-Teacher Interaction Observation Recording Sheet ........................................ 22
2. Science Grade Conversion Scale .............................................................................. 23
3. Scoring for Student Attitude Survey ......................................................................... 25
4. Contingency Table for Level of Question .................................................................. 27
5. Contingency Table for On-Task and Off-Task Interactions ........................................ 28
6. Contingency Table for Total Interactions .................................................................. 28
7. Student Grade Point Average by Gender ................................................................... 30
8. Student Attitude Toward Science Survey Results by Gender ....................................... 31
CHAPTER ONE

INTRODUCTION

The Problem

Females have made tremendous strides in the work force over the last thirty years opening doors to previously male-dominated careers. However, despite these significant gains in representation and earning power in many “male” careers, they still lack equal representation in the field of science and engineering. Women hold only 16% of the jobs in this field (Vetter, 1994). Females are especially misrepresented in physical science careers with only 10.7% of chemistry and 4.7% of physics and astronomy jobs held by women in this country (Bush, 1990). The National Science Foundation (1986) reports that women constitute half the work force in the United States, but make up only 3% of the engineers (Jones & Wheatley, 1990).

Our country is turning out fewer science professionals every year. The National Science Foundation (1989) reported that in 1983, 30% of men entering colleges had the intention of majoring in science. By 1988, that statistic was down to 21%. This generally male-dominated field must look elsewhere for well educated individuals who could be capable scientists. Women are an under represented, untapped market who could increase the number of scientists in our country.

But why are women under-represented in the sciences? Researchers generally identify three factors in gender differences that may account for females being under represented in the field of science: achievement, attitude in science classes, and opportunities in subject matter throughout their education experience. Also, many
researchers suggest sociological factors play a role in the lack of women in science. These sociological factors are society’s view of science as a masculine career, teacher’s and parent’s low expectations for females due to this perception and toys that each gender traditionally uses. Many toys labeled “for boys” give direct science experiences (models, erector sets, rocket and science kits, etc.), while many toys geared for girls are less likely to focus on math and science.

Achievement, as a contributing factor, is described within the literature at great length. The majority of the research conducted on achievement in grades 3-12 indicates little difference between males and females on science achievement tests except in physics and chemistry (Erickson & Erickson, 1984). Males seem to score significantly higher on these tests. Several studies found females to be slightly better in biology sciences on achievement tests (Locke, 1990). However, the majority of studies found that boys did score better on science achievement tests overall but without significance (Meece & Jones, 1996). It seems that in the early grades there is little difference in test scores, but as students get older the gap widens in achievement scores between males and females topping out in high school where the greatest difference in achievement has been detected (Erickson & Erickson, 1984).

Early research indicated that males’ success in science and science achievement tests had to do with their advantage over females in visual-spatial ability. Visual-spatial abilities have been linked to success in science (MacCoby & Jacklin, 1974). Numerous studies have replicated MacCoby & Jacklin’s work while some studies have reported little significant difference between girls and boys in visual spatial ability
Some studies have indicated few differences between girls and boys in the elementary school years, but by adolescence, differences between visual-spatial ability do begin to emerge (Erickson & Erickson, 1984). Still other studies have shown if a difference does exist, these differences can be overcome through spatial-ability training (Lynn & Hyde, 1989). Also, Tracy (1990) found no correlation between high visual-spatial ability and high science achievement.

Student attitudes toward science have been heavily researched in grades 3-12, too. Studies seem to conclude that attitudes begin favorably in elementary school and get worse with each year the student attends school (Simpson & Oliver, 1985). It appears that the junior high years are seen as the significant year (s) for this negative swing in attitude. Three reasons could contribute to this change. Defining gender roles is one. As girls begin to identify and see changes in themselves, they may begin to accept society's perception of science as being a male field. Two other possible reasons could be exposure to male teachers for females and different learning styles experienced in junior high (Steinkamp & Maehr, 1984). Ninety-four percent of elementary teachers are female. The presence of a male science teacher in junior high may be unsettling and uncomfortable for females. Poor female attitudes have been linked to low self-image due to classroom experiences in science, lack of science experiences both inside and outside the classroom and peer, teacher and parental expectations (Tobin & Garnett, 1987). Meanwhile, male science attitudes remain more positive than those of females, although they also decline as years in school increase.
Despite females’ poor attitudes, studies have shown females’ motivation toward science is almost always higher than males (Simpson & Oliver, 1985). However, positive attitude rather than motivation results in higher achievement. Weinburgh (1995) suggests that the correlation between student attitude toward science and achievement in science is moderate, but for females it is a stronger indicator of success. Attitude toward science is important to improving young females’ desires to seek science careers later in life (Kelly, 1990).

Societal expectations and norms may be another factor in the lack of women in science careers. Males are typically given a decided edge in science as an option throughout life. Science is often thought of as a “male” career. Studies have shown students’ images of a scientist are usually a white-male in a lab coat alone in a laboratory (Chambers, 1983). There are few role models of women scientists illustrated in text books which may communicate that science is not for women.

Many parents and teachers do not push females toward the sciences perpetuating the stereotype that science is for boys. “Ninety-four percent of all elementary teachers are women and their lack of confidence to teach science may be perceived by female students and project a negative image for prospective female scientist.” (Kahle & Lakes, 1983).

Stereotyping can begin early in childhood when boys are given hands-on toys that promote problem-solving and increase visual-spatial ability. Girls on the other hand are often taught to be passive and well-behaved. They are given toys that generally do not involve any hands-on or science experiences (Kahle & Lakes, 1983). It would
seem that society must change in its perceptions, attitudes and stereotypes toward males and females if females are going to be given the same advantage as males to pursue science careers.

Within the school environment, females lack many of the opportunities males receive in science classrooms which may be a deciding factor in their avoidance of science careers. Studies have consistently supported evidence that show males are asked higher-order questions, receive more praise and are afforded more opportunities to participate in class through being called on, calling out, and receiving “target student” treatment (Tobin & Garnett, 1987). Target students are those students who demand much of the teacher’s time and attention. These students, usually numbering 1-7 in a classroom, can receive proportionately more than three times the number of interactions than their classmates, and the target students in science usually tend to be male (Sadker & Sadker, 1985). Females generally tend to be asked low-order questions, are criticized for calling out in class, and are shown or told how to do science activities rather than given the opportunity to do them independently (Sadker & Sadker, 1986). When doing experiments that give students hands-on experience, boys tend to be aggressive and dominate materials. Studies have shown boys participate in more clubs related to science than girls (Kahle & Lakes, 1983). These clubs give boys more science related experiences than girls beyond the classroom.

The aforementioned factors could produce a strong advantage for males over females leading to career choices in science. Females may develop negative self-images about themselves in science as they perceive themselves as less than equal
when they are not treated as equals in questioning and classroom participation. They may not develop a desire for a strong understanding of science if they are not prompted or provided with clubs where science experiences will be available outside the classroom.

Research suggests that student attitude toward science, science achievement and student-teacher interactions in science may affect female decisions to pursue science as a career. Therefore, it is of importance to investigate student-teacher dyadic interactions, student attitude toward science and achievement in science to see if these gender differences in science exist. This study seeks to look more closely at these areas of gender differences in science. Based on the review of the literature which will come in chapter two, the following research questions and hypotheses have been formulated.

**Research Question**

1. Do seventh grade science teachers’ interactions differ between males and females? Interactions will be categorized by type of question posed by the teacher, high level (analysis, synthesis or evaluation) or low level (application, knowledge or comprehension) and on-task (praise or work related) or off-task (criticism or non-work related) interactions.

2. Do seventh grade science teachers’ interactions between males and females occur at different rates?

3. Do males achieve at a higher rate than females when measured by grade point average?
4. Do males possess a more positive attitude toward science than females?

The following null hypotheses are predicted based on the literature review conducted in chapter two.

1. Seventh grade science teachers’ types of interactions will not differ between male and female students significantly.

2. The rate of interaction between seventh grade science teachers and male and female students will not differ significantly.

3. There will be no significant difference between grade point average of male and female students.

4. There will be no significant difference between grade point average and the type of male and female interactions with seventh grade science teachers.
CHAPTER TWO
LITERATURE REVIEW

Introduction

A review of the literature in science has revealed many areas in which gender differences exist. Research studies have found differences in students’ attitudes toward science, science achievement, and opportunities to experience science subject-matter. However, within these areas, there has been significant discussion by researchers as to how much if any difference truly exists. Despite varying views on this topic, it does appear that most research supports a view that males hold an advantage over females in science. This review will explore three major areas of this advantage; science achievement, student attitude toward science, and opportunities to experience science-subject matter.

Achievement

Most research supports evidence that boys outperform girls in general science achievement tests (Erickson & Erickson, 1984, Steinkamp & Maehr, 1984, Tobin & Garnett, 1987, Levin, Sabar & Libman, 1991). Testing on gender differences in science achievement has been done from 3rd through 12th grade in studies. The 1992 NAEP study revealed boys had higher test scores on standardized science achievement tests than girls at ages nine, thirteen and seventeen (Meece & Jones, 1996). A cross-cultural survey of science achievement found with very few exceptions differences between the average performance score of boys and girls were evident across 19 countries included in the study, and the differences were virtually all in the boys’ favor.
Most researchers agree the difference is not as great as once assumed. When researchers examined science areas independently, they found little difference in achievement scores in biology between males and females, but a bigger difference in physics and chemistry scores. Lee & Burkam (1996) found similar results in junior high students in physical sciences, but found girls slightly outperformed boys in life sciences. Roger Lock (1992) found no difference between boys and girls in performing science skills. Erickson & Erickson (1984) found little substantial difference in achievement tests in fourth and eighth grade, but in twelfth grade a greater differential in achievement was discovered between boys and girls. Steinkamp & Maehr (1984) found slightly different results. They reported the smallest gender difference in achievement tests between boys and girls in elementary school, followed by high school and the biggest difference in achievement tests between boys and girls at the junior high level.

Researchers have investigated few factors that might explain girls' lack of success compared to boys in science achievement. Visual-spatial ability is one area that has received much attention with a variety of results. Visual-spatial ability is an important factor in scientific thinking, especially in physical sciences. Since sex-related differences in spatial-ability in favor of boys have been consistently documented in the literature, this factor is said to give males an advantage in the study of science (Gray, 1981). Other researchers have supported, in their studies, that males are more highly developed than females in visual-spatial ability (MacCoby & Jacklin, 1974, Johnson &

Linn & Hyde (1989) found in a meta-analysis study on visual-spatial ability that gender differences in spatial ability are declining, they may not be obviously related to science or mathematics and processes revealing gender differences in spatial ability respond to training. Also, visual-spatial ability has not been proven as a prerequisite to success in science instruction (Smith & Schroeder, 1981).

Gender role perception and self-concept were also found to be related to achievement (Handley & Morse, 1984). Few other studies, however, have been conducted to find if achievement and visual-spatial ability or other factors are related.

Other possible reasons have been suggested by researchers for low achievement of females. These are society's perception of science as a masculine career, sociological behaviors, such as toy-playing which can develop visual-spatial ability in males depending on the toy, and experiences gained by individuals in and out of the school classroom related to science.

Some researchers believe schools have more to do with science achievement than gender differences. Young and Fraser (1994) found school affects to account for a greater variance in physics achievement than gender differences. They believe this factor supports the need for home and school affect to be researched more closely when looking at achievement. Furthermore, they suggest many researchers leave home and school affects out of their studies on gender differences and science achievement which makes their results misleading. “Unless researchers use the Hierarchical Linear Model for hierarchical data, as students nested in schools are, their
results are almost certainly going to be of dubious quality with faulty statistical tests and poor control of students and school level variables.” (Young & Fraser, 1994).

**Student Attitude**

A multitude of research has been conducted on student attitude toward science, but few researchers define and separate attitude toward science from opinion, interest and motivation toward science within the body of their research. Simpson and colleagues (1994) defined attitude as “a predisposition to respond positively or negatively to things, people, places, events or ideas.” (pg. 212)

Much research indicates that boys hold a more positive attitude toward general science in fourth through twelfth grade. (Weinburgh, 1995, Simpson & Oliver, 1985, Linn & Hyde, 1989). These findings appear to occur in many countries. Kotte (1992) researched ten nations and found males out performed females in science achievement and held more positive science attitudes, although the gap has decreased somewhat over the years. Schibeli (1984) looked at specific areas in science and reported that girls show a more positive attitude toward biology, and boys showed a more positive attitude toward physics and chemistry. Weinburgh (1995) in a review of the literature on students’ attitudes towards science found girls to have slightly more positive attitudes toward science in high performance students. Boys had slightly more positive attitudes toward science in average and lower performance students.

Researchers have indicated differences among grade levels in attitudes as well. Kahle and Lakes (1983) reported, “Although at age nine girls responded that science does not make them feel ‘successful’ most of their feelings were positive and
comparable to nine-year-old boys. Handley and Morse (1984) stated that as girls and boys became older they indicated acceptance of science as a male dominated career more so than in fourth grade. In their meta-analysis study, Linn & Hyde (1989) found little difference in males and females interest in science in the elementary grades. After the elementary years, research points to a gradual shift in attitude among boys and girls. This shift begins to appear in the junior high years when adolescents are defining their male/female roles. Gender roles may influence females away from science careers caused by their perception of them as being masculine while they are defining who they are as women (Handley & Morse, 1984). Kahle and Lakes (1983) add additional insight from their review of the NAEP survey on attitudes toward science, “... by ages 13 and 17, girls stated that not only did science fail to instill feelings of 'confidence', 'success' or 'curiosity', but that it also made them feel 'stupid'. Linn & Hyde (1989) report similar results in their study.

In addition to these findings, overall male and female attitudes toward science decrease as the number of years in school increases (Yaegar & Penick, 1986). Kahle and Lakes reported that negative attitudes continue to grow as students get older as shown in 13 and 17 year old responses to the NAEP study (1976-77) they reviewed. Simpson and Oliver (1985) support this earlier study. They found attitudes declined each year in their study profiling grades 6-10 on attitude toward science.

There appear to be many possible indicators causing females to have a less positive attitude than males in general science. Girls’ attitudes toward science, science classes, and science careers are the result of their educational experience and activities as well
as other social and cultural factors. The encouragement (or discouragement) they receive at home and at school, their perception of science classes, activities, and careers as masculine, their lack of extracurricular activities, and their narrow view of science all contribute to their perception of science as something relatively useless in everyday life and an unlikely future career choice (Kahle & Lakes, 1983).

Simpson & Oliver (1990) found the strongest influences on science attitude were the school, particularly the classroom. Also, attitudes of students' friends toward science correlated highly positively toward their attitudes toward science. Shepardson & Pizzinni (1994) found the learning situation to affect student attitude toward science. Their learning situations included; text-book-worksheet activities, traditional laboratory activities, and problem solving activities using the search, solve, create, and share inquiry method (SSCS). They found the SSCS model promoted the most positive perception of science activities of the three tested in this study. Therefore, they say learning situations that are perceived positively by girls may contribute to their development of a positive attitude, as well as improved achievement. Similar findings with learning situation have been corroborated by other researchers (Kulm, 1980, Talton & Simpson, 1987).

Teachers possibly can effect negative attitudes, too. “Ninety-four percent of all elementary teachers are women and their lack of confidence in teaching science may be perceived by female students and project a negative image for a prospective female scientist.” (Kahle & Lakes, 1983). Girls often receive negative messages about science from important females, many times this includes female elementary teachers
Teachers generally feel boys are stronger in science than girls, especially in physical science. If teachers believe students are of the same ability in science, they may still treat them differently. These teacher beliefs and attitudes can affect behavior in science (Kahle, Rennine, et al., 1993).

The stereotyping of a scientist as a male career could also affect students' attitude toward science. In a 1983 Draw-A-Scientist Test (DAST), researchers found only 28 female scientists were drawn by 4800 children (49 percent were females) who took the test. All 28 female scientists were drawn by females. This study found 4th and 5th grade students categorizing scientists as typically males wearing glasses with facial hair working alone in a laboratory type setting. Evidence of symbols of research, knowledge, technology and relevant captions might be present (Chambers, 1983).

Boylan, Hill and Wallace (1992) feel the Draw-A-Scientist test is too superficial. It forces the test-taker into making decisions on their drawing, and subjects will generally fall back to stereotyping the scientist they draw. They conducted the interview-about-instances (IAI) procedure which tests students' conceptions of scientists and science. This procedure uses illustrations of scientists that deal with appearance, work place, work tasks and employment/gender. Students are shown illustrations by interviewers and asked questions about the illustrations. Their responses to the questions determine their perceptions on scientists and the field of science. They felt their data provided richer, deeper and more useful information about students' conceptions of science and scientists than the surface draw test reveal. They found students had a deeper understanding of who scientists were and what they did after conducting their
Some research indicates that attitude can be important to success in science (Simpson & Oliver, 1988, Shrigley, et al., 1988, Wienburgh, 1995, Handley & Morse, 1984). In separate studies, Simpson & Oliver (1988) and Harty, Beall & Samuel (1986) found positive attitude toward science as a predictor to possible science achievement. Wienburgh (1995) said data suggests that, in general, the correlation between attitude toward science and achievement in science is moderate. The correlation is somewhat stronger for girls than boys, indicating that a positive attitude is more necessary for girls to achieve high scores. Other studies have concluded this positive relationship between attitude and achievement (Schibeki & Riley, 1986, Talton & Simpson, 1987, Koballaf, Shrigley, & Simpson, 1988). Also, female attitudes toward more careers in science as being appropriate correlated positively with their achievement in science (Handley & Morse, 1984). Kelly (1981) said attitudinal factors are the contributing factor to lack of women in science. As of 1994, women made up only 16 percent of the scientists and engineers in this country (Vetter, 1994). In physical sciences and engineering, they are even less represented. Only 10.7 percent of chemistry, 4.7 percent of physics and astronomy and 3.1 percent of engineering jobs in this country are held by women (Bush, 1991). However, Steinkamp & Maehr (1983) found that there is insufficient evidence to link gender differences in attitude toward science to science achievement.

Opportunities

Research documents a third general area in science, opportunities to experience
science subject-matter, where there may be a gender difference affecting female success in science and career disposition later in life. Several studies find boys receive more experiences outside the classroom related to science than girls (Lee & Burkam, 1996, Kahle & Lakes, 1983, Catsambis, 1995). These experiences may include visiting museums, science clubs, boys scouts, or playing with toys relevant to gaining science experiences (models, erector or lego sets, electronics, science kits, etc.). Simpson & Oliver (1985) conclude that boys higher interest in science leads to more exposure to science in the form of reading, television, experiments, games, etc., which could equate to higher scores on science achievement tests.

Many researchers claim low parental and teacher expectations of women as scientists could cause young females to avoid these experiences because of the stereotype of science as a masculine profession (Kahle & Lakes, 1983, Tracy, 1990, Lee & Burkam, 1996). This lack of experiences by women in subject matter could effect their attitude and achievement. Levin, Sabar & Libman (1991) found these lack of experiences in science may lead to a lack of scientific understanding which could affect achievement or performance which may cause self-confidence, interest and attitude to wane. Kahle & Lakes (1983) draw similar conclusions. Responses to NAEP items they reviewed toward science indicate that lack of experiences in science leads to lack of understanding of science which contributes to negative attitudes toward science. Their study shows nine-year-old girls have as much interest in science related activities as nine-year-old boys, but they are just not experiencing them as much as boys at this level.
Within school, research indicates boys receive more opportunities to experience science as well (Meece, et al., 1982, Oakes, 1990, Shepardson & Pizzinni, 1992, Jones & Wheatley, 1990). Boys manipulate equipment more than females in the science classroom (Tobin & Garnett, 1987). This dominance could occur in group lab work. Tobin & Garnett (1987) found when students were grouped equally, the achievement was equal. However, when groups had more boys than girls, the males dominated activities and were more successful. When females were in larger numbers than males in groups, males still performed better than females. In these cases, they found the male directed more attention to themselves or dominated the equipment and left the female out of the experience. They suggest the importance of manipulating equipment can lead to positive experiences and further understanding which might lead to positive attitudes.

Research finds males have more teacher-student interactions than females (Irvine, 1985, Sadker & Sadker, 1986, Jones & Wheatley, 1990). In fact, overall males receive more attention than females from kindergarten through college (Sadker & Sadker, 1985). Also, males are eight times as likely to call out compared to females (Sadker & Sadker, 1985). When call outs occur, Sadker & Sadker (1985) found boys call-out answers were generally accepted, and girls call-out answers were generally remediated. They were told to raise their hand to respond to questions.

Many times these interactions are dominated by “target students”. Target students are those students that answer the majority of the questions in class and demand much of the teacher’s attention. Sadker & Sadker (1985) report that these students can
receive proportionately more than three times the number of interactions as their classmates. The majority of target students tend to be males (Tobin & Garnett, 1987).

When other classroom interactions were observed, boys were found to receive more praise and criticism than females. Irvine (1985) found that regardless of ability, boys tend to demand more attention with their active, assertive, independent personalities. High achieving boys tend to dominate discussions, speak out and demand attention. Low achieving males were found to misbehave and challenge the teacher for attention. In a segregated classroom with boys and girls split up, Sadker & Sadker (1984) found the teacher spent more time on the boys’ side of the room attending to their needs. However, Parakin (1967) found that high-ability students regardless of gender had more interactions with teachers than low-ability students.

A number of studies show that males receive more high-level questions (analysis, synthesis or evaluation) than females (Hall, 1982, Tobin & Garnett, 1987, Shepardson & Pizzinni, 1992). Tobin & Garnett (1987) found that males respond to teacher questions overall more than females. When females had an opportunity to answer they answered more predominately low-level (knowledge, comprehension or application) questions (Barba & Cardinale, 1991).

It can be suggested from research that generally girls are complimented on their form and neatness of work (Hall, 1992), shown how to do science activities or the activities are just done for them (Tobin & Garnett, 1987), and raise their hand more to respond to questions in science classrooms (Barba & Cardinale, 1991). These factors could affect female students in science. Barba & Cardinale (1991) found the
frequency and type of teacher interactions with students affected the student levels of achievement and perceived goals. Irvine (1985) suggests this lack of attention could send a message that males are more important because female teachers are giving a disproportionate amount of feedback to males. This differential treatment by teachers could affect students' achievement, self-concept, aspirations and behaviors. However, active classroom participation was not found to be a necessary indicator of higher achievement in Gallagher's study (1976).

Summary

The review of the literature on gender differences is conflicting at times. However, in general it supports a male advantage in student attitude toward science, achievement in general science, with an even greater advantage in physical science, and more opportunities to experience science subject-matter in and out of the classroom. The purpose of this study is to investigate student-teacher interactions, student achievement, and student attitude toward science to see if a gender bias exists in science classrooms.
CHAPTER THREE

PROJECT DESIGN

This chapter presents an overview of the study to be undertaken, general information about the population to be studied and the instrument and procedures used to collect and analyze the data. The data were based on three general areas: 1) student achievement based on grade point average in science, 2) student attitude toward science and 3) student-teacher interactions.

The purpose of this study was to investigate seventh grade science classrooms to find if a gender bias exists. Teacher-student interactions were observed and recorded, science achievement was measured, and a student attitude toward science survey was administered. The science grades of the students in the study were provided by their teachers for the second semester of the 1996-97 academic year. The student attitude toward science survey is a 5-point Likert scale survey developed by Robert L. Shrigley in 1968 and updated in 1991 by Misiti, Shrigley & Hanson. The survey consisted of 13 questions and was administered by the teachers in the study.

Population/Subjects

The subjects for this study consisted of approximately 250 seventh grade students from a predominately middle class junior high school (grades 6-8) in the city of Rancho Cucamonga, California. The student population for the seventh grade students of this school is 51% female and 49% male. The racial breakdown is 44% Caucasian, 31% Hispanic, 12% African-American and 13% other minorities. The other minorities are mostly students of Asian descent. Four teachers took part in the
study; three female and one male. The teachers have an average of 9.3 years of teaching experience, with a range of two to twenty-one years of experience. The teachers volunteered for the study and were aware that the study was being conducted to observe student-teacher interactions in science. Each teacher teaches two science classes a day. Both of the teachers’ classes were used in this study.

Methodology

The methodology used to carry out this study included observations of student-teacher interactions, a student attitude toward science survey and student achievement as measured by grade point average.

Student-Teacher Interaction Observations

Student-teacher interactions were observed by use of video recording equipment in each classroom. Each of the eight classes in the four classrooms were video-taped on two separate days within a three week period. These taping sessions lasted forty minutes. The first and last five minutes of each session were not used for data collection. This method was used to avoid skewed data pertaining to this point. The lessons observed were teacher-directed lessons. No sessions were used that included testing or the absence of the regular classroom teacher.

The author charted observations between student and teacher using the form in Table 1 (p. 22) for each session. Only individual interactions were charted during observations. These interactions were classified into four categories; high-level questions, low-level questions, on-task interactions, and off-task interactions. The interactions were recorded by sex of student and category. Each category was defined
as follows for classifying purposes:

**high-level questions**: Questions that required student analysis, synthesis or evaluation of subject matter.

**low-level questions**: Questions that required student comprehension, knowledge or application of subject matter.

**on-task interactions**: Any interaction occurring between the teacher and student that involved praise related to work or the work itself.

**off-task interactions**: Any interaction occurring between teacher and student that involved criticism or was not related to the work.

### Table 1

*Student-Teacher Interaction Observation Recording Sheet*

<table>
<thead>
<tr>
<th>School:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom:</td>
<td>Session:</td>
</tr>
<tr>
<td>Teacher Gender:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Gender</th>
<th>Questions</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

---

**Student Achievement-Grade Point Average**

Teachers in the survey provided the student’s science grades on all test subjects for the second semester of the academic year 1996-97. Teachers reported the grades to the author who recorded them in male and female categories. Pluses
and minuses were dropped from grades. For example, a grade of B- would be changed to a B, and a grade of C+ would be changed to a C. Grades were then converted to numbers using a four point system in Table 2.

### Table 2

#### Science Grade Conversion Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Point value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4 points</td>
</tr>
<tr>
<td>B</td>
<td>3 points</td>
</tr>
<tr>
<td>C</td>
<td>2 points</td>
</tr>
<tr>
<td>D</td>
<td>1 points</td>
</tr>
<tr>
<td>F</td>
<td>0 points</td>
</tr>
</tbody>
</table>

Student Attitude Toward Science Survey

The student attitude toward science survey was compiled using 13 out of a possible 23 questions from a science attitude survey designed and tested by Misiti, Shrigley, & Hanson (1990). This test was restructured from a previous survey designed by Robert L. Shrigley (1968). This survey went through rigorous testing and suggests some degree of validity. The trial statements were carefully written and tested. The reading level of the statements was checked. Known groups testing, cross-cultural data, high item-total correlations and test for evaluative quality suggest a valid scale (Misiti, et. al., 1990).

The survey was administered by each teacher in their two classes. All students completed the survey individually answering the questions using a 5-point Likert scale. Appendix A includes a complete student attitude toward science survey identical to the one administered in the study.
Data Collection

There were three parts to the data collection. The first part involved video recording each of the eight classes for two sessions. These sessions were charted for type of student-teacher interaction and sex of the student. The second part involved collecting student grade point average for science in each of the eight classrooms observed. The grades will be converted to numbers using a four point scale illustrated previously in Table 2 (p. 23). The grades will be divided into two categories by gender and a grade point average for each sex will be determined. The last part involved administering the science attitude survey. This survey measured student attitude toward science.

Student-Teacher Interaction Observations

The two observed sessions for each of the eight classrooms were coded using the form from Table 1 (p. 22). These 16 forms were combined to create one master chart. A chi-square was then administered on this information to check for significant difference between gender in type of question asked of students by teachers, on-task/off-task interactions, and total interactions between students and teachers.

Student Achievement-Grade Point Average

Teachers reported second semester grades for the 1996-97 academic year to the author for all students in the study. These grades were changed to a number using the point scale in Table 2 (p. 23). All grades were compiled into two categories; male or female. Then, a grade point average was calculated for each gender.
The science attitude survey was administered to all students in the eight classes by the respective teachers. The survey consisted of 13 questions. The students responded to the statements through the use of a 5-point Likert scale. The scale ranged from strongly disagree to strongly agree. The test took students less than 30 minutes to complete. The author recorded each student's results according to gender on a composite chart. Scores were calculated by adding up all the circled responses and dividing the total achieved by the number of questions (13). The greatest possible score would be a 65. The lowest possible score would be a 13. Students who average between 1-2 would hold negative attitudes toward science. Students who average between 2.1 and 2.8 would hold slightly negative attitudes. Those who score in the with an average of 2.9 to 3.1 would have neutral attitudes toward science. Students who averaged would 3.2 to 3.9 would hold slightly positive attitudes toward science. Students who averaged 4.0 to 5.0 would hold very positive attitudes toward science.

The directions for scoring the scale were used according to Table 3.

**Table 3**

*Scoring for Student Attitude Survey*

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Statement</td>
<td>5 points</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Positive Statement</td>
<td>1 point</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

An attitude for each sex and a school attitude was compiled using this information.
CHAPTER FOUR

RESULTS

General Observations

Teacher-student interactions were video recorded for all eight classes (two lessons in each class). The use of the video recorder proved quite valuable. Many classes were well paced. When questions were asked or interactions occurred that were difficult to define, the tape was rewound and reviewed again for precise analysis. Some researchers may argue that the presence of video recording equipment in the classroom may cause the teacher or students to not exhibit typical behavior. However, the author was satisfied that after a brief settling period with the video camera, the classroom behavior was quite typical of an ordinary day.

Teachers performed demonstrations, led whole group discussions and guided individual work. Students, in small groups, performed experiments. Classes in which students performed experiments or completed individual work tended to have few questions asked. The majority of the student-teacher interactions were on or off-task related interactions. In teacher led demonstrations and whole group discussions, the majority of interactions between teacher and students were in the form of questions. These activities contained very few on or off-task interactions. There were a lot of different activities witnessed during the observations. However, there was never a good blend of both questioning and on-task/off-task interactions in any one classroom session observed.
Student-Teacher Interactions

Level of Question

The four teachers in eight classes (16 sessions) asked a total of 317 questions.

Eighty-one percent of the questions teachers asked were identified as low-level questions and 19% were identified as high-level questions. Males were asked 54% of the low-level questions and 62% of the high-level questions. Females were asked 46% of the low-level questions and 38% of the high-level questions. These differences were not significant as seen in Table 4.

Table 4
Contingency Table for Level of Question

<table>
<thead>
<tr>
<th>Questions</th>
<th>Male Students</th>
<th>Female Students</th>
<th>Total Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Level</td>
<td>140</td>
<td>117</td>
<td>257</td>
</tr>
<tr>
<td>High-Level</td>
<td>37</td>
<td>23</td>
<td>60</td>
</tr>
<tr>
<td>Total Number</td>
<td>177</td>
<td>140</td>
<td>317</td>
</tr>
</tbody>
</table>

Chi Square = 1.01; < .50

On-Task/ Off-Task Interactions

Teachers had 324 on or off-task interactions with students. Fifty-nine percent of these interactions were with males and 41% were with females. Males were involved in 54% of the on-task interactions and 69% of the off-task interactions. Females had 46% of the on-task interactions with teachers and 31% of the off-task interactions. These differences were significant at the .05 level as shown in the contingency table in Table 5 (p.28).
### Table 5
*Contingency Table for On-Task and Off-Task Interactions*

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Male Students</th>
<th>Female Students</th>
<th>Total Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Task</td>
<td>125</td>
<td>105</td>
<td>230</td>
</tr>
<tr>
<td>Off-Task</td>
<td>65</td>
<td>29</td>
<td>94</td>
</tr>
<tr>
<td>Total Number</td>
<td>190</td>
<td>134</td>
<td>324</td>
</tr>
</tbody>
</table>

Chi Square = 4.14; p < .05

**Total Interactions**

There were a total of 641 student-teacher interactions observed in the 16 sessions. Of those interactions, 57% involved male students and 43% involved female students. Fifty-six percent of the total questions asked by teachers and 59% of the total on-task and off-task interactions were made with males. Females were engaged in 44% of the total questions asked and were involved in 41% of the total on-task or off-task interactions. There was no significant difference as shown in Table 6.

### Table 6
*Contingency Table for Total Interactions*

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Male Students</th>
<th>Female Students</th>
<th>Total Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions</td>
<td>190</td>
<td>134</td>
<td>324</td>
</tr>
<tr>
<td>On/Off-Task</td>
<td>177</td>
<td>140</td>
<td>319</td>
</tr>
<tr>
<td>Total Number</td>
<td>367</td>
<td>274</td>
<td>641</td>
</tr>
</tbody>
</table>

Chi Square = 1.53; p < .25
Science Achievement

The four teachers used in this study reported the second semester grades in science for each student in their two classes for the academic year 1996-97. These grades were converted to a point system (see Table 2, p. 23). A grade point average was determined for each teacher’s two classes combined by gender. Teacher two’s males (35 students) achieved the highest grade point average among the four classes with a 3.31. This is the equivalent of a mid-range B. The lowest male grade point average was 2.26 in teacher four’s classes (27 students). This would equate to a low C. Overall, 126 male students compiled a 2.74 grade point average. This is the equivalent of a high C. Teacher two (32 students) also had the highest female grade point average for a class with a 3.56. This would equate to a B. The lowest female grade point average was 2.71 in teacher four’s classes (24 students). This is the equivalent of a high C. Overall, the 128 female students’ grade point average was 3.12. This would equate to a lower-range B. Females outperformed males by 0.38 in grade point average in the second semester. In fact, in every teacher’s classes, girls outperformed boys in achievement when measured by grade point average. Table 7 (p. 30) illustrates this information.
Table 7
Student Grade Point Average by Gender

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Male Students</th>
<th>Grade Point Average</th>
<th>Female Students</th>
<th>Grade Point Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35</td>
<td>2.71</td>
<td>35</td>
<td>3.06</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>3.31</td>
<td>32</td>
<td>3.56</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>2.50</td>
<td>37</td>
<td>3.05</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
<td>2.26</td>
<td>24</td>
<td>2.71</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>2.74</td>
<td>128</td>
<td>3.12</td>
</tr>
</tbody>
</table>

Student Attitude Toward Science Survey

Ninety-nine male and 97 female students participated in the student attitude toward science survey. Fewer students than in the original population were used in this section. There were two factors that caused this phenomenon. One, surveys that did not identify a gender were discarded. Two, several students were absent on the day the survey was administered. The highest individual score by a male student was 58 out of a possible 65 (4.5 average). This score suggests a very positive attitude toward science. The lowest individual score by a male student was 17 (1.3 average). This score suggests the student holds a very negative attitude toward science. Overall, the 99 males who took the test averaged a 3.1. This suggests a neutral attitude toward science because a 3 equates to the unsure response. The highest female score on the survey was a 57 (4.4 average). This score suggests a very positive attitude toward science. The lowest female score recorded was a 15 (1.2 average). This score suggests a very negative attitude toward science. Overall, the 97 female students averaged 2.8 on the survey. This suggests that the female students in this study held
slightly less than positive attitudes toward science. However, they are not far behind their male counterparts. When scores were broken down by teachers’ classes, males held higher attitudes toward science than females in all classes except one. Table 8 illustrates a breakdown of each teacher’s students’ attitudes toward science by gender.

Table 8
Student Attitude Toward Science Survey Results by Gender

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Male Survey</th>
<th>Female Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>3.4</td>
</tr>
<tr>
<td>2</td>
<td>33</td>
<td>3.1</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>2.7</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>3.2</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Additional Observations

Many additional observations important to the area of gender bias in science were observed during the recording of student-teacher interactions. These behaviors were watched in a second viewing and should be noted at this time.

Students were observed who received a significant share of the student-teacher interactions. These students have been identified in the literature as target students (Sadker & Sadker, 1985, Barba & Cardinale, 1991). Students are classified as target students when they receive more than three interactions with the teacher during a class period. These students received their attention through calling out responses or requests or by raising their hands. Both methods were effective because teachers accepted their answers. The majority of these students were males.
Male students were observed being more aggressive in the science classes. They demanded more attention during individual work by getting up from their seat and going to the teacher. If they stayed in their seat, they would make noise or hand signals for the teacher to assist them. Linn & Hyde (1989) have also reported on male’s aggressive behavior in science classes.

Males had more call outs during classroom observations than females. These call outs were generally accepted. The call outs came in the form of answers to questions, comments or questions pertaining to assignments. Call outs in science class by males has been well documented in research (Sadker & Sadker, 1986, Tobin & Garnett, 1987, Jones & Wheatley, 1990). These video-taped lessons could be used to further and more accurately investigate these areas of gender bias in science in a later study.
CHAPTER FIVE

DISCUSSION

Interpretation

This study examined specific areas of science that may suggest a gender bias in student-teacher interactions, achievement and attitude toward science. Based on the results of this study, which are consistent with research, it could be suggested that a gender bias still exists. Males received more overall student-teacher interactions than females in this study although the difference was not significant.

Males received more questions of both the high-level and low-level type. These findings are similar to those of other researchers (Tobin & Garnett, 1987, Barba & Cardinale, 1991). In this study, girls received one high-level question for every five low-level question. This type of questioning could hurt girls' feelings of self worth and confidence in science if continued over the years. Irvine (1985) states that a perceived lack of attention could be a message that males are more important because teachers are giving a inappropriate amount of feedback to males.

On-task and off-task interactions were found to be significantly different between males and females in this study. This proved to be especially true in off-task interactions. Males received almost 70% of this type of interaction. This was by far their greatest advantage between females in all types of interactions studied. The types of off-task interactions dealt with criticism and discussion of subject matter not related to work. This type of interaction occurred most often when boys called out responses. This behavior enabled boys to speak and receive feedback most of the time without
using the conventional method of raising one's hand. This practice was accepted by all teachers observed. While few females called out, the male students often did. Few teachers observed were able to ignore this practice for an entire session. Meanwhile, most girls observed, waited patiently with their hand up waiting to be called. One girl had her hand raised the entire observation and was only called upon twice. It can be presumed she might become frustrated towards science if this practice is a daily routine.

Sadker & Sadker (1986) bring up an important point about student-teacher interactions. The most valuable teacher resource in a classroom is the teacher's attention. Boys are receiving that attention any way they can. Even if it results in negative feedback. Girls are receiving a message that to raise your hand and sit quietly will not always be rewarded. Unfortunately, studies find when girls call out, their responses are not as readily accepted. They are instructed to raise their hand (Sadker & Sadker, 1986).

Limitations of Student-Teacher Interactions of Study

Student-teacher interactions could have been studied for a longer duration. By extending the number of sessions observed, several things could have been accomplished. Teacher and students could have become more comfortable with the video equipment in their rooms. A number of different teaching techniques could have been observed that might have given a better picture of the interactions occurring in the classrooms. Two observations may not have been an adequate sample from which to accurately conduct this study.
Effects on Grade Point Average

Females held a higher grade point average than males in every class and overall in the seventh grade population studied. Other researchers have found similar results, usually these results are found in life sciences (Becker, 1989, Locke, 1990, Lee & Burkam, 1995). Most research uses some type of science achievement test to compare male and female science achievement. This study used grade point average in its assessment. This type of achievement assessment is considerably different from a test. A test is usually done in one day. All students scores are judged against a norm. The material on an achievement test usually covers all areas of the science curriculum.

Grade point average scores will have a variety of factors that determine their outcome. Grades are determined over a longer duration of time, using numerous scoring techniques and are decided by different teachers who may hold biases toward students. Students may be studying a topic that is or is not interesting to them. This may effect their motivation to do well in science. There are also home and school factors during the semester that may influence a students grade in science for any particular semester.

When looking at grades as a measurement for achievement, one explanation for girls' higher grade point average might be linked to motivation. Motivation, and not necessarily attitude, could have been the force behind female success in achievement. Simpson & Oliver (1985) found girls were more significantly motivated to achieve in science than boys in all grades 6-10.
Student Attitude Toward Science

This study found boys to have a slightly more positive attitude toward science than girls. Boys were found to have neither positive nor negative attitudes toward science. Girls’ attitudes toward science were slightly negative. This study resembles others that have studied attitude in that most all find males with more positive attitudes than females (Simpson & Oliver, 1985, Simpson & Oliver, 1990, Weinburgh, 1995). It is also similar because most studies find students to have less positive attitudes toward science and that their attitudes continue to wane as years in school increase (Simpson & Oliver, 1985).

Attitude toward science appears to be an important factor in success in science. How students feel toward science and their ability to succeed in science are strong predictors of later science achievement (Simpson & Oliver, 1990). Weinburgh (1995) also states that in all cases a positive attitude results in higher achievement.

The fact that females in this study held a higher grade point average than males does not prove a gender bias is non-existent. This study compares to many previous studies in its findings. Males received a greater proportion of student-teacher interactions, and they have more positive attitudes toward science than females. These factors could lead to more science experiences and exposure. This could predict science success in the future. Female achievement in this study could be linked to motivation to succeed in science (in the form of positive grades). This success should not dispel female’s unequal treatment in student-teacher interactions which may effect attitude toward science. This attitude may influence success later in their science
future.

Conclusion

Two broad conclusions can be drawn from this study. One, more research needs to be conducted on females in science on a continuing basis. Studies should be conducted that explore gender differences in science and what factors lead to our lack of women in the field of science. Research needs to be ongoing to test for improvement in the many areas where gender differences have been found. These findings should investigate why and how improvements have been made. Finally, pilot studies need to be conducted that attempt to reduce the gender differences in science through planned methods in the classrooms. This type of research is essential if change is going to take place and education attempts to equalize its science education.

Two, despite significant differences not being found, it does appear a gender bias exists in science classrooms in this study. Females received less student-teacher interactions than males. However, they still were able to achieve at a higher rate than males. This may be explained because of their motivation. Also, an achievement test may have yielded different results.

Males held more positive attitudes toward science than females. These more positive attitudes and continually more student-teacher interactions may allow males to overcome this achievement later in life. As students in middle school advance to high school, advanced science courses are electives. Students who hold positive attitudes and feel confident in science will be more likely to select these courses. Male students are more likely to select these courses because they generally have more positive
attitudes and usually hold an advantage in student-teacher interactions in the early years of education. This will build their self-worth and confidence in science. These advanced science courses are usually necessary if a student attempts to pursue a career in the field of science. Student attitude toward science and student-teacher interactions are two areas in science where improvement is necessary if we are to increase the number of women selecting science as a career.

Implications

Female students are not receiving an equal amount of student-teacher interactions in science. This lack of attention could lead to negative attitudes toward science. It is this attitude that could predict future success or lack of it later in their science lives. This lack of success in science may explain one reason why women are under-represented in the field of science.

Educators must become aware of this gender bias and make changes in science classrooms to better facilitate equal science learning for all students. There are many methods that teachers can use to facilitate equal learning opportunities.

Teachers must first look at their own attitudes towards science. Teachers who hold a negative attitude toward science are likely to avoid science instruction. These teachers are sending a negative message. Since the majority of elementary teachers are female, they may also be sending a negative message to young female students about the female role in science. Teachers tend to believe boys are better in science than girls (Kahle & Parker, 1993). If these beliefs enter the classroom, they may effect teaching habits (i.e. expectations, questioning and student-teacher interactions). One
way to improve equality in science is to deliver positive female role models. Female teachers can be that role model by regularly attending to science with an enthusiastic attitude.

Within the classroom, many methods can be used by teachers to balance their science teaching. Teachers should ask both genders equal types of questions (high-level and low-level). Use of wait-time is one method that makes this possible (Rowe, 1996). When grouping students, teachers should put students in same sex groups or in equal numbers. Teachers must work hard to instill a comfortable, non-threatening environment in the classroom (Inglehart & Brown, 1989).

Science instruction needs to include female examples in the textbook and should relate to daily experiences of all students so that they see its relevance. Science is often delivered through experiences that relate directly to the male experience. Stereotypes need to be avoided during science instruction. Equipment must be accessible to all students. Males tend to become aggressive during experiments. It is important to provide equal opportunities. Girls should be selected for teacher led demonstrations at an equal rate to males.

Finally, clubs, groups and out of class experiences need to be made available for female students. They should be encouraged to participate in these experiences. It is early experience and exposure that is essential to success in science. Levin, et.al. (1991) explained that a lack of readiness (from not receiving early exposure and experiences) may effect their ability to perform. The lack of ability to perform successfully may cause self-confidence, interest and ability to wane.
In summary, while this study did not provide conclusive evidence that a gender bias exists, it did substantiate many claims made in earlier research. Males received proportionately larger amounts of student-teacher interactions, especially in regards to off-task interactions and high-level questions, and they held slightly more positive attitudes toward science. These student-teacher interactions may lead to more positive attitudes in science. These factors may lead to later success in science, and the decision to choose a career in the field of science.
**APPENDIX A: STUDENT ATTITUDE TOWARD SCIENCE SURVEY**

Please, circle your gender.  
Male  Female

Circle one number for each question that best answers that question.

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Getting science books from the library is a drag.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Science films bore me to death.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I dislike watching science specials on television.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I hate science class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Working with science equipment makes me feel important.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Science is one of my favorite subjects.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Sharing science facts I know makes me feel great.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I hate to study science out of doors.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I like to make science drawings.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I enjoy using math in science experiments.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I cannot wait until science class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I wish we did not have science class so often.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
13. Doing science projects at home is fun.
BIBLIOGRAPHY


