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ABSTRACT

This study describes a program designed to increase participation and involvement of female students in physical science classrooms and laboratories. The setting for the study is a high school in a suburban middle class community adjacent to a metropolitan area in the Midwest. Evidence for the existence of the problem includes student involvement checklists, teacher log to focus on general observations of student involvement throughout the quarter, and student survey to identify the perceptions of the students as to their level of involvement in the classroom and laboratory. Analysis of probable cause data revealed that female under involvement in science has many possible causes. Teachers interact more often and in more detail with male students who tend to be more aggressive. Female students have a more difficult transition through adolescence than male students. Science as a discipline discourages females. Society undervalues the role of women and sends mixed messages to females. To further add to the problem, there is an overall denial of gender biases. A review of solution strategies resulted in three categories for intervention: teacher instruction to increase awareness of gender bias, modification of teacher behavior to eliminate gender inequities, and instructional strategies using cooperative learning to improve participation and reduce competitive behavior. Post intervention data indicated an increase in classroom participation by the targeted female students in physical science. (Contains 25 references.) (Author/ASK)

INCREASING PARTICIPATION OF FEMALE STUDENTS IN PHYSICAL SCIENCE CLASS

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Acknowledgements and Dedication

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This study describes a program designed to increase participation and involvement of female students in physical science classroom and laboratories. The setting for the study is a high school in a suburban middle class community adjacent to a metropolitan area in the Midwest. Evidence for the existence of the problem includes student involvement checklists, teacher log to focus on general observations of student involvement throughout the quarter, and student survey to identify the perceptions of the students as to their level of involvement in the classroom and laboratory.

Analysis of probable cause data revealed that female under involvement in science has many possible causes. Teachers interact more often and in more detail with male students who tend to be more aggressive. Female students have a more difficult transition through adolescence than male students. Science as a discipline discourages females. Society undervalues the role of women and sends mixed messages to females. To further add to the problem, there is an overall denial of gender biases.

A review of solution strategies resulted in three categories for intervention: teacher instruction to increase awareness of gender biases, modification of teacher behavior to eliminate gender inequities, and instructional strategies using cooperative learning to improve participation and reduce competitive behavior.

Post intervention data indicated an increase in classroom participation by the targeted female students in physical science.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted physical science class are 10th grade female students who exhibit a lack of involvement in the classroom and laboratory participation. Uninvolvement is defined by failure of the females to volunteer in classroom interactions involved in both lecture/discussion and laboratory group work. Evidence for the existence of such a problem includes student involvement checklist, and teacher observations.

Immediate Problem Context

All information about the site involved in the following research is taken from the 1999 school report card.

The site is a comprehensive high school in a high school district containing grades nine through twelve. The school has an enrollment of 1,873 students. The average class size is 21.2. Ethnic background of the students is as follows: 82.6% White, 8.6% Hispanic, 4.8% Asian/Pacific Islander, 3.7% Black, 0.3% Native American. The student population is made of 11.8% low income, 5.4% limited-English proficient, and has a drop out rate of 6.8%. Student attendance has an average of 91.3% with 0.9% of the student body chronically truant (School Report Card, 1999).

There are 143 teachers and 17 teacher aides at the site; 52% are female, 48% are male. Ethnic background of the teaching staff is as follows: 98.7% White, 0.9% Hispanic, 0.4% Asian/Pacific Islander, 0.0% Black, 0.0% Native American. The teachers have an average of 17.4 years of teaching experience, 24.1% of the teachers have a bachelor's degree and 75.9% of the teachers have a master's degree or above. The pupil-teacher ratio is 17.3:1 (School Report Card, 1999).

The site is located on an 80-acre campus. The three-story brick building was opened in 1959. It houses a variety of classrooms and shops, including wood, auto, industrial and technology, and a print shop. The site also has a library/media center, large auditorium, and a multi-purpose room. Science labs include a greenhouse, biology, chemistry, physics, physical science, and an animal lab. Physical education and athletic facilities include two gymnasiums, lighted stadium, athletic fields, tennis courts and running tracks. These facilities serve a wide variety of student sports teams as well as a drama department, music department, and a number of extra-curricular clubs and activities including Students for a Better Environment, Speech Team, Math Team, Science Club, Multicultural Club, Key Club, and Student Council.

The graduation requirements, updated in 1998, are strong in the areas of English, speech, reading, science, mathematics, social studies, physical education/health, and computer literacy. The curriculum and assessment program is tied to the Illinois Learning Standards. Curriculum ranges from special education classes in core courses, vocational programs, college preparatory courses, honors level offerings, as well as Advanced Placement (AP) courses offered in 12 subjects. There is a 2 year science requirement; 1 year biological science and 1 year of a physical science. College bound

students are encouraged to take chemistry and physics beyond biology and physical science. Other course offerings in the science department include Anatomy & Physiology, Horticulture, AP Chemistry, Animal Lab Studies, and Principles of Technology. Of the graduates, 86% attend college with an average ACT score of 22.8. Curriculum is designed to fit the needs of the student body and community (School Report Card, 1999).

Surrounding Community

The population of the site is 22,279 people, of which approximately two thirds are blue collar. The site is located in a high school district containing two schools, both of which are located in suburban communities. Median family income is $41,316. The community is comprised of mostly single-family homes with two large apartment complexes. Average home value is $109,600. The ethnic makeup of the community is predominantly white with a recent influx of Hispanic and Asian/Pacific Islanders.

The district consists of two high schools serving a 24 square-mile area that includes 33,000 residences and businesses in the western suburbs of a large Midwestern city. Property taxes generated from an assessed value of 1.9 billion help fund a 40 million dollar budget. Operating expenditure per pupil is $10,228. Average administrator salary is $105,780. The district is run by a school board of seven elected members from the community. The district has one superintendent. Each school within the district has a director of curriculum, a principal, and three assistant principals. The district represents a typical suburban high-school district in Middle America and may reflect the existence of the problem (School Report Card, 1999).

National Context of the Problem

The problem of gender equality in education has generated concern at the national level for decades (Sadker,1999). Title IX of the 1992 Educational Amendments addressed the concern of gender equity in classrooms by making it illegal to treat students differently or separately on the basis of gender (AAUW, 1992). In 1992, the American Association of University Women (AAUW) releases its ground breaking study, How Schools Shortchange Girls, showing that gender bias does exist in American classrooms.

Sadker and Sadker have researched gender equity in the classroom for over 20 years and have pointed out inequities that occur in the classroom (Marshall & Reinhartz, 1997). Verbal interactions among students and teachers have been studied in elementary, secondary, and college classrooms in a variety of settings and classrooms. In all cases, girls received fewer academic contacts, are asked lower level questions, and are provided less feedback and encouragement than boys (Sadker & Sadker, 1994). With the days of girls' home economics and boys' shop classes gone, many educators believe they are gender blind, but the biases are still there and they are subtle (Sadker, 1999). According to Sadker, "Teacher education and staff development programs do little to prepare teachers to see the subtle, unintentional but damaging gender biases that still characterizes classrooms" (Sadker, 1999, p. 23).

The subtlety of gender bias is not the only reason for persistence of inequality. America has a false sense of accomplishment (Sadker, 1999). Since the 1992 report by AAUW, overall girls' test scores and enrollments have risen in math and science (AAUW, 1999). However, in high school, boys are still more likely than girls to take the three core science classes: biology, chemistry and physics (AAUW, 1999). This trend is

carried over into college and career choices (Sadker, 1999). Even though women now receive 55% of all bachelor's degrees and 55% of all master's degrees, (American Teacher, 1999) the majority of females major in liberal and fine arts where men make up a majority of the sciences (Sadker, 1999). Among full-time workers, women with college degrees make $20,000 less than men with college degrees (Sadker, 1999). Today's female students are not being prepared for careers in the 21st century that require technical skills (American Teacher, 1999). "In career preparation programs, the technical and engineering fields are overwhelmingly male while girls cluster in traditional female, lower paying occupations" (American Teacher, 1999, p. 4).

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

In order to document the lack female student involvement in class, students completed a survey as to their perceptions of their level of participation in class and laboratory situations, and the researcher observed students using a behavioral checklist.

Three classes of physical science were observed and surveyed, totaling 184 students. A student survey was developed by the researcher (Appendix A) to gather information as to the students' perceptions of their own level of involvement. The students were asked to report on what they felt about the frequency in which they raised their hand to participate in class as well as how actively involved they viewed themselves in both the classroom and laboratory settings. Students were also asked about the amount of time they spent in laboratory using the lab equipment compared to the amount of time they spent recording information. Lastly, the students were asked to reflect about their level of involvement in group work. A summary of the results is presented in Table 1.

Table 1

Students' Perceptions as to their Levels of Involvement in Classroom and Laboratory

	Strongly Disagree	Disagree Somewhat	Total Disagree	Agree Somewhat	Agree Strongly	Total Agree
In class, I am actively involved and participate; I raise my hand whenever I know an answer.	Girls 11.9% Boys 6.4%	Girls 33% Boys 16%	Girls 44.9% Boys 22.4%	Girls 42.9% Boys 51.6%	Girls 11.9% Boys 25%	Girls 54.8% Boys 76.6%
I share the workload in lab 50/50.	Girls 0% Boys 3%	Girls 2.1% Boys 3%	Girls 2.1% Boys 6%	Girls 50% Boys 61.8%	Girls 47.6% Boys 32.2%	Girls 97.6% Boys 94%
In lab, I spend equal time recording data and using equipment.	Girls 2.4% Boys 3%	Girls 7.1% Boys 16.1%	Girls 9.5% Boys 19.1%	Girls 66.6% Boys 71.3%	Girls 23.9% Boys 9.6%	Girls 90.5% Boys 80.9%
In group work, I am actively involved and participate.	Girls 0% Boys 0%	Girls 2.4% Boys 16.1%	Girls 2.4% Boys 16.1%	Girls 61.9% Boys 45.2%	Girls 35.7% Boys 38.7%	Girls 97.6% Boys 83.9%

Percentages are out of the total number of students that were surveyed. Please note that 44.9% of girls surveyed disagreed with the statement that they were actively involved in class and participated by raising their hand whenever they knew an answer, unlike the boys in class. For the boys, 76.6% of boys surveyed agreed with that statement. The data also suggest girls are more comfortable in a cooperative group setting (97.6%) versus when they are isolated or stand out via raising their hand (54.8%). The girls, almost 100%, think that they share the workload; the majority indicates they share the responsibility of recording data and using equipment. The data suggest the researcher use more cooperative settings and find ways to help girls feel confident about participating in class.

Students were observed in a classroom setting on 10 different occasions between September 20, 2000 and November 3, 2000. An involvement checklist was developed by the researcher (Appendix B) to monitor the number of times an individual student participated in class. The first 3 days of data collection represent typical classroom days. A summary of the results is present in Table 2.

Table 2

Three Days of Classroom Observation Checklist Monitoring Student Involvement

Day	Number of Student Interactions	
Day 1	33 total	6 with girls
		27 with boys
Day 2	43 total	11 with girls
		32 with boys
Day 3	36 total	4 with girls
		32 with boys

The data show that even though boys makeup roughly half of the student population, they are clearly responsible for the majority of the interactions in the classroom. These interactions are either calling out answers, or being called on to respond. In most cases boys in class are the students that yell out answers or have their hands raised the majority of the time. The data suggest that the researcher use classroom techniques to elicit more responses from girl students, and eliminate gender inequities.

Probable Causes

The literature review reveals the following probable causes of girls' lack of involvement and overall gender gap in science classes: teachers, societal influences, and science itself as a discipline. The first part of this literature review addresses the behavior of teachers and instructional strategies. The next section explains societal influences. The last part concentrates on science itself and how it has traditionally discouraged participation of girls.

Teachers

The literature suggests several causes for girls' lack of involvement in science classes and an overall gender gap in science classes. According to Marshall and Reinhartz (1997) girls' interest in math and science declines between the ages of 9 and 14, and these declines can be traced to "pedagogical strategies common in traditional science classrooms" (p. 334). Teacher interactions play a major role in providing gender equity in the classroom. The literature documents that teachers interact more with boys. They call on boys more often to answer questions and their interactions with boys are more detailed and call for higher order thinking (AAUW, 1992; Campbell & Sanders, 1997; Davis, 1999; Martin & Newcomer, 1999; Matthews, Brinkley & Crisp, 1997; Sadker, 1999; Streitmatter, 1998). The research over the last 2 decades finds that classroom interactions put "males in the spotlight and relegate females to the sidelines" (Sadker, 1999, p. 24). Teachers give males more attention and make them the center of instruction; this increased teacher attention contributes to enhance student performance (Sadker, 1999).

According to the Sadkers (1995) girls are less prepared for future academics because they receive fewer academic contacts, are asked lower level questions, are provided with less constructive feedback and encouragement than boys. Teachers reinforce boys for general responses more than they do girls (Marshall & Reinhartz, 1997). Rothenberg (1995) finds that boys are given more detailed and constructive criticism of their work, and are treated more tolerably than girls during outbursts of temper.

The subtle biases begin in preschool years and undermine the self-esteem and career choices of females, and continue throughout their educational careers (Davis, 1999). In a research study done by Mathew et al. (1997) in a grade 5 classroom, after 2 days of classroom observations, the researchers knew three boys' names and only one girl's name. In this study, another incident of importance occurred when a female student was waiting to participate but was interrupted by a male student, upon vocalizing her feelings the teacher tried to comfort the girl by replying "Boys will be Boys" (Matthew et al., 1997, p. 6).

The gender biases in the classroom have decreased over the last ten years, however the biases still exist; often times biases are subtle and not intended (Adams, 1998; Brown University, 1996; Davis, 1999; Martin & Newcomer, 1999; Matthews et al., 1997; Peterson & Bainbridge, 1999). Adams (1998) says that teachers often exhibit higher expectations for males than they do for females; they expect the male students to be better problem solvers and encourage males to engage in problem solving activities. Davis (1999) suggests that these different expectations are "grounded in the assumptions and beliefs that society has about gender differences" (p. 15).

The literature indicates that gender bias is generally either ignored or denied. There tends to be poor teacher preparation in the area of gender bias, and even those institutions that do provide some training in gender equity spend a very small amount of time devoted to the subject (Campbell & Sanders, 1997; Sadker, 1999). Title IX of the United States Code is the federal law passed in 1972 that prohibits sex discrimination in education; its provisions have not been actively enforced or pursued (AAUW, 1992; AAUW, 1999).

Teachers are often unaware that the problem exists, or they view gender equity as a non-topic. Teachers cannot believe they might inadvertently be showing biased behaviors (Campbell & Sanders, 1997; Davis, 1999; Marshall & Reinhartz, 1997; Peterson & Bainbridge, 1999). " For the most part, teachers do not believe that they treat male and female students differently" (Davis, 1999, p. 13). Some teachers attribute the gender gap to personality and ability (Peterson & Bainbridge, 1999). Bailey (1996) points out two harmful assumptions. First, some educators believe that gender equity targets only girls. Second, they believe if the situation improves for girls then boys will lose.

Societal Influences

The gender gap and gender stereotyping is further perpetuated by society and parents (Adams, 1998; Bailey, 1996; Bailey & Campbell, 1999; Blum, 1999; Marshall & Reinhartz, 1997; Matthews et al., 1997; Rop, 1998; Sadker, 1999; Sims, 1997). Sexism is built into our societal system and pervades the values of our culture. Because of this there is a "social resistance to feminism, female concerns, and even gender studies" (Sadker, 1999, p. 26). Women have traditionally held and continue to hold the lower paying jobs

and are exploited by society. Society also places a higher value on the traditional male role; the role of the female is viewed as less important (Bailey & Campbell, 1999; Grogan, 1999; Martin & Newcomer, 1999; Rothenberg, 1995).

In our society, being called a girl is a classic insult for boys to hurl at each other. Girls feel this devaluing of women as they move through adolescence; girls suffer from lower self-esteem (AAUW, 1992; Marshall & Reinhartz, 1997; Rop, 1998; Sadker, 1999). In its 1992 study, AAUW finds "Large-scale empirical studies, public-opinion polls and in-depth clinical studies following individual girls through school all report significant declines in girls' self-esteem and self-confidence as they move from childhood to early adolescence" (p. 19). Only 29% of high school girls reported they are "happy the way I am," in contrast from 60% in elementary school (AAUW, 1992).

Girls lose confidence in early adolescence (Hornblower, 1998). Girls feel more pressure from society and pop culture to fit in (Bailey, 1996; Rop, 1998; Rothenberg, 1995). Odea and Abraham (1999) found that self-confidence was the highest in males after puberty but lowest in females after puberty suggesting that puberty may have opposite effects on males and females. Rothenberg (1995) reports finding that adolescent girls are twice as likely to be depressed as boys and links depression in girls to negative feelings about their body and appearance. He also further suggests that the self-image problem in girls is tied to the "perfect girl" or "nice girl" syndrome; "around the age of 10, many middle-class girls have internalized the messages and expectations they have received into the ideal of the "perfect girl" who is pretty, kind, and obedient, and never has bad thoughts and feelings" (p. 2).

This low self-esteem is far reaching. Girls and women in our society have an extrinsic sense of self-worth (Adams, 1998; Brown University, 1996). Females tend to fix blame internally, whereas men place responsibilities outside themselves; women tend to attribute success externally and men tend to attribute success internally. For example, if a male student has a good test grade, he is more likely to attribute it to his ability, whereas, a woman is more likely to attribute the high grade to luck or an easy test. In the case of a low grade, the male is more likely to attribute it to and unfair test or poor preparation by the teacher, whereas, women are more likely to believe they are unintelligent. Societal biases continue after our education. Women are still under represented in industrial, computer, and engineering careers (AAUW, 1999; Bailey & Campbell, 1999; Grogan, 1999). Even in the field of education where women make up 83% of the teachers, they only comprise 33% of the administrators (Grogan, 1999). The AAUW (2000) reports that girls still consider a narrower set of career opportunities than do boys. " Only 6 percent of women are in non-traditional careers. In fact, women cluster in only 20 of the more than 400 job categories, and 2 out of 3 minimum-wage earners are women" (AAUW.org, 2000).

Science Itself

Science, itself, as a discipline is a possible cause. Science has traditionally discouraged participation of women and as a result has fewer women (Adams, 1998; Brown University, 1996; Martin & Newcomer, 1999; Rop, 1997). Although both men and women students both leave science, (Brown University, 1996) a higher percentage of women leave science. The gender disparity continues, particularly in the physical sciences (Rop, 1997). Women earn 34% of the doctoral degrees in biology, 21% in

chemistry, 9% in physics, and 9% in engineering (Rop, 1997). Science classes have traditionally been highly competitive and not very accommodating to a variety of learning styles. Test scores are often low and the instructor "grades on a curve." Students who get discouraged early on will not consider science as a possible career, especially female students (Martin & Newcomer, 1999; Rop, 1997). According to AAUW (2000), even girls who did well in math and science were less likely to pursue careers in these fields. Compounding this problem is the overloaded cases of school counselors, many of whom have caseloads of up to 300 students. Given these high numbers, counselors do not have the time to have meaningful interactions in helping students to make career choices (AAUW.org, 2000).

In summary, the issues pertaining have been identified: the actions and behaviors of the classroom teacher, societal influences, and science itself as a discipline. The author will address possible solutions to these probable causes in chapter 3.

CHAPTER 3

POSSIBLE SOLUTION STRATEGIES

Literature Review

The possible strategies discussed in this review of literature reflect only those strategies that can be undertaken within the structure of a high school classroom. The strategies can be divided into three categories: things that can be done by this researcher within the classroom including instructional strategies, societal problems that students can be made aware of to minimize the effect of gender biases, and the approach to science itself as a discipline.

Teachers

Often, teachers are unaware of the inequities they perpetuate (AAUW, 1999; Campbell & Sanders, 1997). Higher institutions could address this problem if those universities that participate in teacher certification require methods courses in gender equity (Campbell & Sanders, 1997). Campbell and Sanders report (1997, p. 72) that of professors surveyed, 91% agreed or strongly agreed that gender equity is an important social issue, and 83% either agreed or strongly agreed that gender equity should be taught in teacher education programs. According to Brown University (1996, p. 10) role models should be presented during teacher training by employing women graduate and undergraduate teaching assistants.

Classroom teachers determine the environment they create. This classroom environment speaks volumes to the students sending them a message of equity or inequity. If a classroom teacher is fair, equity is the norm, not the exception (Martin & Newcomer, 1999; Matthews, Brinkley & Crisp, 1997). Fair teachers recognize students for their individual attributes, not their gender (Matthews et al., 1997). In order to give all students equal educational opportunities, "gender equity must become the norm in the classroom rather than the exception" (Martin & Newcomer, 1999, p. 3). Sadker and Sadker (1994) suggest this can be accomplished by sharing the goal of equity with the students in the classroom. Since students, too, need to be aware of gender biases, Davis (1999) suggests students examine textbooks and supplementary materials used in the class to find examples of gender bias.

Teachers have to acknowledge the gendered nature of schooling and be aware of their own gender biases when they are establishing the climate of their classroom (Bailey, 1996; Marshall & Reinhartz, 1997). We as teachers must take a careful look at our own practices. This can be accomplished by examining instructional behavior perhaps by videotaping, or have a student or colleague collect data to identify incidences of gender bias and discuss strategies to change (Bailey, 1996; Brown University, 1996; Davis, 1999; Marshall & Reinhartz, 1997).

Marshall and Reinhartz (1997) suggest teachers document whether they act differently with boys than with girls; and continue to document as they make changes towards improving their methods with boys and girls. When the classroom climate is encouraging and supportive, all students are willing to take more risks and grow intellectually. As students' levels of participation increases, so does their confidence

level (Marshall & Reinhartz, 1997). American Association of University Women (AAUW, 1992) reports that their research suggests that female students need to be actively encouraged to participate in large-motor activities such as laboratory activities. This means that teachers may have to donate extra time to elicit participation from their female students, especially in science. Rop's (1997) research reports that boys will automatically fill out forms for Advanced Placement Chemistry even though they do not belong in those classes, whereas girls do not believe they can do it unless you tell them they can, and even then there is hesitancy. The research suggests teachers should encourage and support both genders (AAUW, 1992; Brown University, 1996; Hornblower, 1998; Marshall & Reinhartz, 1997; Martin & Newcomer, 1999; Rop, 1997). Brown University (1996) cautions educators "Be aware that women will be more likely than men to perceive their performance as less satisfactory then it is in reality, and they are more likely than men to attribute this supposed unsatisfactory performance to themselves" (p. 11).

Classroom teachers can learn from the literature on all girl environments (Bailey, 1996; Brown University, 1996; Streitmatter, 1998). Streitmatter's (1998) findings of an all female physics class suggest teachers create a non-competitive cooperative atmosphere in which to learn science; and same sex lab partners to help eliminate the boys manipulation of the equipment, and the girls as the scribers.

Society

This author cannot change the influences of society, but one can heighten the awareness of biases among students in a classroom. This awareness takes on a wide range of tasks. Students need to be aware that girls receive "conflicting messages about their

worth and place in our culture from schools, television, and the movies" (Rothenberg, 1995, p. 3). Classroom material can contain a balanced mix of characters in traditional and non-traditional roles. Classroom teachers can model both traditional and non-traditional roles for men and women. If girls are urged to join ice-hockey teams, boys should be encouraged to write poetry without being labeled a "sissy." Adults "can enhance gender-neutral self esteem by suggesting that a daughter help fix a leaky pipe or a son whip up an omelet" (Hornblower, 1998, p. 92). Adult role models can alleviate gender stereotyping by being aware of the destructive nature of stereotyping on all children (Adams, 1998; Hornblower, 1998; Rothenberg, 1995).

Science as a Discipline

Science teachers themselves have a poor reputation. Many adults have science phobias, some of which have been caused by the history of science teachers' methods of grading and assessing (Adams, 1998; Brown University, 1996; Davis, 1999). Traditionally, some science classes have been known as the weed-out classes, especially chemistry. Low grades in these types of classes produce high science anxiety (Brown University, 1996). Brown University (1996) suggests eliminating the curve to eliminate competition, explain the grading system before, allow pass/fail option, and follow up poor exam performance with a teacher/student conference. Teachers should also vary the exam structure (Adams, 1998; Brown University, 1996).

To eliminate gender inequities in the classroom, the research discusses classroom methods to make things fairer. In teaching science, teachers need to reorganize scope and sequence that builds (Brown University, 1996; Rop, 1997). Rop (1997) suggests science teachers look at the big picture first, to relate how everything fits

together. Students, girls especially, have a strong desire to know why they are learning about things and how it is connected to the real world (AAUW, 2000; Brown University, 1996).

To generate interest in science, science should be hands on and problem solving. Students should be provided with open ended, student designed labs to provide research (Bailey & Campbell, 1999; Brown University, 1996; Rop, 1997). Brown University, (1996, p. 7-8) suggests that providing students with a sense of ownership of the lab may help to motivate active participation and "which may help them gain more confidence through experience." An open-ended structure also helps to stress the process of solving a problem, an opportunity not available through cookbook style labs that lead students to one possible answer. Science teachers need to make science real world and show all students how it is important and relevant to their lives, including challenging students' ideas about gender-appropriate careers (AAUW, 2000; Bailey, 1996; Brown University, 1996).

In the science classroom, gender biases are reduced if there is a strong female presence (Marshall & Reinhartz, 1997; Rop, 1997; Rothenberg, 1995). In all sciences, girls need to see that their contributions are valued. In upper level sciences, girls need to be recruited to balance the gender mix (Rop, 1997). "When girls have opportunities to take leadership roles, gender bias in the classroom and in society is reduced" (Marshall & Reinhartz, 1997, p. 337). Science teachers need to actively provide female role models, in person or in print, including female scientists and contributions of women to science (American Teacher, 1999; Brown University, 1996; Marshall & Reinhartz, 1997; Rop, 1997; Sims, 1997). It is only when girls are provided with a rich background of female

role models are they able to picture themselves in science careers and enable them to succeed in fields once considered off limits.

As classroom teachers, we must not allow stereotyping (Bailey, 1996; Brown University, 1996; Martin & Newcomer, 1999). Teachers must monitor language and materials. They must actively look for materials that feature girls and women. "It is crucial to gender equity that both male and female students see themselves positively in the materials they study" (Martin & Newcomer, 1999, p. 11). Science classrooms benefit when teachers recognize the variety of learning styles and use varied instructional methods, not just lecture, but a cooperative and collaborative approach (Brown University, 1996; Davis, 1999; Hornblower, 1998). Brown University (1996) notes that these varied methods are good classroom teaching and benefit all students. The cooperative approach requires a better sense of community and increases social skills and generates more interest among all students.

Science teachers need to divide attention equally between male and female students (Brown University, 1997; Davis, 1999; Hornblower, 1998; Marshall & Reinhartz, 1997; Matthews et al., 1997). According to Hornblower (1998), successful science teachers do not allow a small group to monopolize classroom discussions. Hornblower (1998) suggests that in any classroom, four to seven individuals tend to dominate the class; this calls for teachers to actively involve all students. Marshall and Reinhartz (1997) suggest teachers devise a method to ensure that every student is actively involved in his or her learning.

The strategies discussed in this chapter involve strategies to help alleviate gender biases by improving teaching to all students in the classroom. The strategies discussed

include changing the approach of the teacher, informing the students of the biases found in society, and changing the traditional approach of science itself.

Project Objectives and Processes

As a result of teacher instruction to increase student awareness of gender inequities, and implementation of cooperative learning activities, from September 2000 to January 2001, the female students from the targeted physical science classes will increase their level of classroom participation, as measured by teacher anecdotal records and student participation surveys.

In order to accomplish the project objective, the following processes are necessary:

1. Direct classroom instruction of gender biases and how biases harm the educational environment for everybody.
2. Sharing data analysis of student participation data to demonstrate the actual level of student involvement with the physical science students.
3. Cooperative group settings will be developed to increase female student participation.
4. Researcher will develop a method of calling on students to ensure equitable involvement of students.

Project Action Plan

Data to document the existence of the problem will begin the week of September 18, 2000. A student checklist will be used to document 10 separate classes. Students will complete a survey to identify their perceptions as to their level of involvement in classroom and laboratory settings. The involvement checklist will be used to monitor student/teacher interactions in class, these interactions include calling on a student because they volunteered, calling on a student without them volunteering, or a student

calling out without being called upon. Data collection will be completed by November 3, 2000.

Analysis of data will be shared with the classes to increase student awareness of gender inequities. The researcher will discuss possible interventions to elicit classroom participation that is equitable. Classroom activities using cooperative setting will be developed by the researcher to ensure participation of each member of the classroom.

Methods of Assessment

In January 2001, students will reflect on the interventions used during the second quarter and list "pluses," "minuses," and things they found "interesting" (PMI). A second student survey will be completed to identify the students' perceptions as to their level of involvement after the intervention strategies. In addition, anecdotal records regarding the success of the cooperative activities will be kept by the researcher.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to increase the level of classroom participation of female students from the targeted physical science classes. The following strategies were used to achieve the desired changes: development of cooperative group settings, direct instruction of how gender biases are harmful, presentation of pre-data with the students to show the actual level of student participation, and a method of calling on students to insure equitable involvement developed by the researcher.

The data from the student survey suggested that girls were more comfortable in a group setting (97.6%) versus when they were isolated or stand out via raising their hand (54.8%). Cooperative groups were used for classroom activities beginning the second grading quarter. The groups varied from lesson to lesson, and the number of students in a group varied from 2 to 4. These groups were set up randomly and were used for a variety of classroom activities including: Jig-sawing parts of the text, taking notes, reviewing the chapter, problem sets, and included laboratory write-ups. These cooperative activities were used at least once a week. A sample modified lesson can be found in Appendix C.

Students received direct instruction regarding gender biases during the first week of the second marking period. The researcher presented information from the literature review in chapter 2. The researcher also presented the analyzed classroom data collected

during the first marking period, (See Table 1, Table 2) as to students' perceptions of their level of involvement in the classroom and their actual level of involvement by gender.

During the class period, the class discussed possible strategies for the students, the class, and the researcher. The targeted classes suggested the following classroom techniques to achieve our goal of an equitable classroom: call on students instead of waiting for students to volunteer, call on a girl then a boy then a girl...., call on all students before calling on someone twice, use name cards to insure randomness, remind students periodically of our classroom goal. Throughout the second marking quarter, all of the previously listed strategies were used to insure equitable participation.

At the end of the second marking quarter students completed a reflection in the form of a table listing pluses, minuses, interesting, (PMI) in response to the prompt "Our classroom goal was to insure equitable participation. During the second quarter we used cooperative activities, and a variety of ways to help randomness of participation. Consider these interventions and reflect about those things you found as pluses, minuses, and interesting." Students also completed a second survey as to their perceptions of the level of classroom and laboratory participation. The researcher had planned on collecting a second set of involvement checklist data, but the strategies used to insure randomness of participation, virtually eliminated the feasibility of such a checklist. If every student is called upon or in the case of a cooperative grouping, every cooperative group is called upon to participate, such a participation checklist is meaningless. Throughout the entire process, the researcher kept anecdotal records.

Presentation and Analyses of Results

In order to assess the effects of cooperative learning and the student's feelings about random and equal participation, students completed a PMI reflection. The resulting data was compiled and is set forth in Table 3. A total of 178 student responses were analyzed.

Table 3

Students' reflection to intervention strategies

	Girls positive comments	***Girls negative comments***	***Boys positive comments***	***Boys negative comments***	***Total (+)***	***Total (--)***
Cooperative groups perceived as positive	97.9%	2.1%	96.3%	3.7%	97.2%	2.8%
Calling on everyone or calling on randomly	92.8%	7.2%	66.6%	33.4%	80.89%	19.2%

(97 girls), (81 boys)

Of the 97 girls and 81 boys who responded, students had a wide variety of comments and responses. Comments from their PMIs pertaining to the interventions were the only responses tallied. Percentages are out of a total number of students who were surveyed. Nearly all students prefer to work in a cooperative setting. Please note that 92.8% of the female students prefer calling on every person or to call on students randomly compared to 66.6% of the male students who preferred that strategy. Overall the majority of total students prefer both cooperative settings and interventions to insure equitable participation in class. Sixteen students, 11 girls and 5 boys, commented that the

researcher sharing data to document the existence of the problem was very valuable. After the intervention students completed a second survey as to their perceptions of their level of participation in class. A summary of these results is set forth in Table 3.

Table 3.

Students' Perceptions as to Their Levels of Involvement in Classroom and Laboratory Activities Following Interventions

	Strongly Disagree	Disagree Somewhat	Total Disagree	Agree Somewhat	Agree Strongly	Total Agree
In class, I am actively involved and participate; I raise my hand whenever I know an answer.	Girls 7.2% Boys 6.2%	Girls 20.6% Boys 12.3%	Girls 27.8% Boys 18.5%	Girls 51.5% Boys 61.8%	Girls 20.7% Boys 19.7%	Girls 72.2% Boys 81.5%
I share the workload in lab 50/50.	Girls 0% Boys 2.2%	Girls 2.1% Boys 7.4%	Girls 2.1% Boys 9.6%	Girls 41.2% Boys 74.1%	Girls 56.7% Boys 16.3%	Girls 97.9% Boys 90.4%
In lab, I spend equal time recording data and using equipment.	Girls 0% Boys 0%	Girls 5.2% Boys 12.3%	Girls 5.2% Boys 12.3%	Girls 53.6% Boys 77.8%	Girls 41.2% Boys 9.9%	Girls 94.8% Boys 87.8%
In group work, I am actively involved and participate.	Girls 0% Boys 0%	Girls 0% Boys 2.5%	Girls 0% Boys 2.5%	Girls 59.8% Boys 72.8%	Girls 50.2% Boys 24.7%	Girls 100% Boys 97.5%

After the interventions, 72.1% of the girls feel they actively participate in class compared to 54.8% before the intervention. For boys, 97.5% agree that they are actively involved in group-work and participate compared to 83.9% before the intervention.

Analysis of anecdotal records showed the following trends. When note cards with students' names on them were used to call on students during classroom discussions, students were more attentive in general. As the marking period progressed, and cooperative classroom activities had been used many times; some groups would reassign the roles. In such cases it was often the females of the class who would step into the

leadership role. Five times during the intervention, cooperative groups were used to work on problem sets. One member from each group was selected to put a problem on the board after the group had worked through the problem. This was a very efficient method to solve the problems, requiring less direct instruction. Throughout the intervention, students became more willing to take risks in groups.

On a more personal note, this researcher found it very disturbing to see how seldom the female members of the class were being involved in classroom discussions before the intervention. The research tells that the societal influences are so much a part of the socialization of both our males, and our females; making the males more assertive and aggressive in class, and our females take the less assertive role. Being a woman science major as well as a volunteer fire-fighter, the researcher had lived through many occasions of gender biases in classroom situations. Often times in classes, especially the physical sciences such as chemistry and physics, female students are "invisible." While taking physics in college, there was a professor who did not notice the women in class asking for assistance, nor did he ask women to participate. This researcher is very sensitive to the problem of gender equity, yet the data collected shows that males in her classes were involved twice as often as female students. How could this researcher allow the female students in her classes to become "invisible" and unheard in class knowing the pain those female students feel when they are ignored?

The gender roles in our society are burned into our very fiber, and the results are long ranged. Boys are socialized to be aggressive and seek attention, and girls are socialized to not make waves, and be the "good girl." The boys should be commended for being aggressive enough to go after the education and opportunities they want, but at the

same time, female students should also be encouraged to participate and demand equal time.

Conclusions and Recommendations

Based on the presentation and analysis of the data from student surveys, PMIs, and anecdotal records, the female students showed an increase in classroom participation. Both boys and girls benefited; girls participated more in class, and boys participated more in group-work. This increase in classroom participation could be due to any of the interventions. The researcher cannot isolate a single intervention that was directly responsible for increased participation. A combination of the intervention strategies appears to have influenced participation.

According to the students' reflections, cooperative activities made them feel more comfortable and they found working with the peers more fun. With the reminder of the goal of an equitable classroom, students recognized the benefits to all in the learning environment where biases are overcome. In such cases students who would have monopolized the classroom discussion tended to monitor their behavior to allow others to participate as shown by the anecdotal records. Modification of teacher behavior appears to have had the greatest impact. The teacher is responsible for describing the problem and making sure the problem is known. Once the problem was known and discussed, the students helped to identify strategies to involve all members of the classroom. When students are part of the solution they feel greater ownership and greater satisfaction when the goal is reached. Developing methods for modifying teacher behavior to call on all students not only changed the researcher's behavior but also heightened student awareness of the teacher's methods and their desire to have equitable participation.

This researcher found the greatest success in achieving equity was directly involving the students through first, direct instruction of the significance of biases and second, creating a shared goal of all students being equally involved. This strategy requires the teacher to have a thorough understanding of the developmental level of their students as well as a good rapport. This strategy is also very time consuming. Students' voices need to be heard; and as a class, methods need to be developed to overcome inequities. If students are part of the solution, they are more likely to be positively involved.

The easiest of solutions were the methods developed to call on students randomly using their names on note cards, or to call on a girl then a boy then a girl....., or to call on every student or group member. These methods require very little preparation and can be done by any teacher desiring a more equitable classroom.

One of the biggest obstacles in overcoming gender inequities is the unwillingness to admit that it exists. Many teachers deny that it happens within their own classroom. This statement cannot be made until a teacher has performed a self-study, or perhaps can team-teach or peer coach with another member of the faculty. Two teachers working together can gather data on the number of interactions that occur during a typical class period. This needs to be done in areas of math and science where female students are not enrolling in the same numbers as the male students. Above all, teachers need to keep in mind that what is good for girls, does not mean it is harming boys.

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APPENDICES

Appendix A

Directions: Please complete the following survey. *All* information is strictly anonymous, so please answer honestly and remember, do not sign your name.

For questions 1-4 circle your response.

1. I am a *male / female.*
2. My English teacher is a *male / female* and most of the time *males / females / equal amount* answer in class.
3. My math teacher is a *male / female* and most of the time *males / females / equal amount* answer in class.
4. In this class, who answers more questions? *Males / females / equal time devoted*

For questions 5-8 indicate your response by circling your choice.

5. In physical science, I am actively involved in classroom discussions. I raise my hand to answer a question whenever I think I know the answer.
   a. I strongly disagree b. I disagree c. I agree d. I strongly agree
6. In physical science, I am actively involved in laboratory situations and share the workload 50/50.
   a. I strongly disagree b. I disagree c. I agree d. I strongly agree
7. When doing a lab in physical science, I spend equal amounts of time recording data and using the lab equipment
   a. I strongly disagree b. I disagree c. I agree d. I strongly agree
8. In group-work in physical science, I am always actively involved and contribute to the group.
   a. I strongly disagree b. I disagree c. I agree d. I strongly agree

In the future, I am interested in the following career choice(s):

_____

_____

_____

_____

Appendix B

Student involvement checklist to monitor volunteering of students and classroom interactions. Three physical science classes monitored for ten lessons of lecture/discussion and ten laboratory activities. During the observations, in both classroom and laboratory, I will be the recorder of data. The lab observation will include at least three complete observations of every lab team in a lab period.

	CLASSROOM				LABORATORY		
Student name	Called on because volunteered	Called on without volunteering	Calls out to answer	Asks a question in class	Using equipment	Recording data	Asks a question in lab

Appendix C

Physical Science: Volcano Frame
Directions: In your assigned groups use the resources available along with your textbook to complete the frame.

Volcano & Sketch	How Formed	Famous Volcanoes & last eruptions	Hazardous Events

Appendix D

Dear Parent(s) and Student,

As part of my graduate work, I am involved in a research project to ensure equitable involvement and participation of all students in physical science. Included in my project will be analysis of data I collect from the class.

Throughout the first semester, students will take a survey to identify the perceptions of students as to their level of involvement in the classroom and laboratory. During the analysis of the data, no names will be used and all information will be anonymous. In class, we will learn about gender biases and how they harm the educational environment for all students.

Please sign and return the form below.

Thank You,

Megan Graham

I agree to allow my student _____ to be included in the data analysis process.
Please print

I do not agree to allow my student _____ to be included in the data analysis process.
Please print

Signature of student_____

Signature of parent _____

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Sign here→ please

Signature: Megan Graham

Printed Name/Position/Title: Student/FBMP

Organization/Address: Saint Xavier University
Attention: Esther Mosak
3700 West 103rd Street
Chicago, IL 60655

Telephone: 708-802-6214

FAX: 708-802-6208

E-Mail Address: mosak@sxu.edu

Date:

THANK YOU

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Appendix E

SAINT·XAVIER·UNIVERSITY

Field-Based Master's Program

Saint Xavier University and SkyLight
Field-Based Master's Program

To: School Administrators

From: Program Research Staff

Date: June, 2000

Candidates for the degree of Master of Arts in Teaching and Leadership are required to identify a local educational issue and to design a project to address that issue, with a view to improving educational practice. The candidate listed below has designed an action research project and summarized that design in the attached preliminary abstract. You are encouraged to review this document and share any questions or comments you might have with the degree candidate. Members of the program staff are also available should you have further questions.

Please indicate, on the form provided, that you are aware and approve of the purpose and scope of the proposed project. The form may be returned to the candidate who will forward it to the university. Our best wishes for a successful school year, and we look forward to meeting you at the Research Exhibitions.

Sincerely,

Barbara Mabry
Instructor
Saint Xavier University

Esther Mosak
Executive Director, Off-Campus Programs,
School of Education
708-802-6214

Degree Candidate: *Megan Graham*

I have been made aware of the purpose and scope of the candidate's Action Research Project, and I approve of its implementation.

Carlene Horgan 8/31/00

Signature of School Official Date