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GENDER DIFFERENCES IN AN ELEMENTARY SCHOOL
LEARNING ENVIRONMENT: A STUDY ON HOW GIRLS LEARN
SCIENCE IN COLLABORATIVE LEARNING GROUPS

By

YVETTE FRANK GREENSPAN

A Dissertation submitted to the
Department of Curriculum and Instruction
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

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To my father, Al, who taught me the value of hard work and to my mother, Florence, who taught me that obstacles can be overcome through determination.

To my husband, Richard, for his continued love and support in helping me to fulfill my dream and to my son, Ian, and my sons-in-law, Kevin and William, who are learning that a woman deserves equal recognition in all things. Finally, to my daughters, Loran and Alyssa who have been taught to expect it.
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ABSTRACT

Girls are marked by low self-confidence manifested through gender discrimination during the early years of socialization and culturalization (AAUW, 1998). The nature of gender bias affects all girls in their studies of science and mathematics, particularly in minority groups, during their school years. It has been found that girls generally do not aspire in either mathematical or science-oriented careers because of such issues as overt and subtle stereotyping, inadequate confidence in ability, and discouragement in scientific competence.

Grounded on constructivism, a theoretical framework, this inquiry employs fourth generation evaluation, a twelve-step evaluative process (Guba & Lincoln, 1989). The focus is to discover through qualitative research how fifth grade girls learn science in a co-sexual collaborative learning group, as they engage in hands-on, minds-on experiments. The emphasis is centered on one Hispanic girl in an effort to understand her beliefs, attitudes, and behavior as she becomes a stakeholder with other members of her six person collaborative learning group. The intent is to determine if cultural and social factors impact the learning of scientific concepts based on observations from videotapes, interviews, and
student opinion questionnaires. QSR NUD*IST 4, a computer software program, is utilized to help categorize and index data.

Among the findings, there is evidence that clearly indicates girls' attitudes toward science are altered as they interact with other girls and boys in a collaborative learning group. Observations also indicate that cultural and social factors affect girls' performance as they explore and discover scientific concepts with other girls and boys.

Based upon what I have uncovered utilizing qualitative research and confirmed according to current literature, there seems to be an appreciable impact on the way girls appear to learn science. Rooted in the data, the results seem to mirror the conclusions of previous studies, which indicate girls are generally conscious about their interrelationships with boys, affecting their self-perception and how others perceive them. Implications and discussion are highlighted in the study.
CHAPTER 1
OVERVIEW OF THE STUDY

"Understanding the millennium requires looking past the male milestones of traditional history to see the shape of women's lives"

(Davis & Conway, 1999, p. 80).

Introduction

According to recent research, girls have a declining sense of self and many display low self-confidence during the adolescent years (AAUW, 1998). Although we have come a long way in promoting science learning for girls, statistics inform us that girls continue to lag behind in enrollment for high school classes in biology, chemistry, computer literacy and physical science (AAUW, 1998). Could this problem be a result of girls' experiences with other girls and boys incurred at an early stage in their science learning?

For this study, qualitative research is the method of inquiry to investigate how fifth grade girls from diverse cultural backgrounds learn science content in collaborative learning groups with other girls and boys in a positive environment, a classroom setting, which is conducive to discovery and exploration. As an investigative approach, it permits the researcher to reflect on girls' attitudes and beliefs as they interact in a given situation with their peers.
Emphasizing science process skills in hands-on, minds-on activities, girls’ and boys’ attitudes toward science are investigated, interaction with each other are taken into account, and observations on how girls accept their roles as members of collaborative learning groups are researched. The premise is that implementing collaborative group learning builds middle girls’ self-confidence, creates leadership qualities and motivates them to learn science (Bruce, 1993; Johnson & Johnson, 1991; Kale, 1989; Tobin, 1996; Tobin, Kale & Friseur, 1990).

The following tentative questions are the framework for this research study with the intended objective of providing some latitude in understanding behaviors and attitudes of one group of girls and boys as they engage in science discourse.  

- How do girls, as stakeholders in collaborative learning groups, engage in learning science?  
- How do girls interact with others in collaborative groups?  

Through this research, proposed results and conclusions will hopefully shed light on whether there are differences in the way that girls learn science as compared to boys and the possible impact on the future science education of girls.

My Pilot Study

A Need for Pedagogical Reform

The intent of my pilot study was to target how students with diverse cultural backgrounds learn and achieve science knowledge. It is well documented that both girls and boys from all ethnic groups learn differently based on their cultural
and social experiences (AAUW, 1998; Gipps, 1996; Tobias, 1993). Teachers, thus, need to constantly reevaluate their teaching techniques and provide alternative strategies for all students by presenting a wide array of opportunities for them to learn (Grennon-Brooks & Brooks, 1993; Shapiro, 1994). Science as an inquiry-based process lending itself to asking questions and applying critical thinking skills to solve problems is a linchpin for active learning (National Research Council, 1996). In Shapiro’s (1994) view, when knowledge and contributions that the learner brings to science learning are valued, it allows both the teacher and the learner to develop more engaging approaches in their efforts to teach and learn.

In the early 1990s, Miami-Dade County, Florida, a county comprised of culturally diverse students, realized that pedagogical reform was essential in providing a sound, equitable education for all its students. This paradigm shift led educators to facilitate systemic reform in the areas of mathematics and science (Miami-Dade County, 1994).

In 1994, the county received a 15 million-dollar grant, the Urban Systemic Initiative (USI), from the National Science Foundation (NSF). Scheduled over a five-year period, the goal was to reorganize the education system by urging all schools in the county to work cooperatively to improve students’ learning in mathematics, science and technology (Miami-Dade County, 1994; http://www.dade.k12.fl.us/usi/). Forty-eight teacher consultants from 99 schools, representing six regions of the District, were initially recruited and selected to strengthen content and instruction, extend school improvement processes, align
policies to promote equity and excellence, and expand community connections to link mathematics and science learning to the real world. The three key goals were to improve scientific and mathematical literacy for all children, prepare all students to live with economic independence and personal satisfaction, and enable a significantly greater number of children to consider and pursue careers in mathematics, science and technology (Miami-Dade County, 1994).

As a Miami-Dade County teacher and USI teacher consultant, I was chosen to help implement the goals of the Urban Systemic Initiative. I participated by preparing and planning teacher workshops, modeling lessons for elementary school teachers, instructing science on Saturday to students in libraries and public malls, and developing science evenings at my school for parents and children. Prior to being selected as a USI teacher consultant, I had established simple group learning that was center-based for the teaching and learning of science. As a semi-traditional teacher, I lectured occasionally and used the textbook as the ultimate resource of knowledge.

Once I embarked as a USI teacher consultant, I began to question the teaching techniques I had previously incorporated into my classroom instruction. Specifically, I began to consider alternative methods for educating my students in science. Tobin, Butler Kahle & Fraser (1990) reiterate von Glasersfeld's prediction concerning the changing role of teachers in the classroom, "The teacher's role will no longer be to dispense 'truth' but rather to help and guide the student in the conceptual organization of certain areas of experience" (p. 7).
Consequently, I provided additional opportunities for collaborative group
learning, which allowed the students to take a more active role in acquiring
knowledge. I realized it was their responsibility to solve a problem, and I became
more of a source of information rather than a wherewithal of knowledge. I
learned to explore many avenues to invent curriculum outside of the textbook
and created units of study based on many sources. Because I had the
opportunity to work directly with mentor scientists and conduct scientific research
in the field (in conjunction with my doctoral studies program at Florida State
University) I began to integrate newly learned science concepts into my
classroom curriculum. Grounded on my research in the field, I developed units of
study according to the curriculum guidelines mandated by Miami-Dade County
and the state of Florida.

Once I had established my role as a teacher consultant and implemented new
pedagogical techniques, I began to observe the behavior of my students in
collaborative learning groups. What I observed inspired me to develop a
research study on how they learn science.

Initial Research

The first group of students for my pilot study was 25 third graders, comprised of
60% Hispanic, 24% White, 12% African American and 4% Other. There were 12
females and 13 males situated in a classroom in the main building of the school.
Five of my students were in the gifted program, four of them attended an in-
house language arts program while the other went to a nearby resource gifted
center twice weekly. One was an ESOL (English for Speakers of Other
Languages) student and another attended ESE (Exceptional Student Education) classes for three hours daily.

Because I was charting the migration of birds from other parts of the United States to the Parrot Jungle, a local nature park, I developed a curriculum for these students that focused on birds. They learned about birds' habitats, body formations, and means of communication, diet, and mating habits. By identifying numerous species, these third grade students became birding experts, and were able to identify some of the birds that migrate to Florida during the winter months. By consolidating action experiments and collaborative learning, their vocabulary became more sophisticated and they displayed greater enthusiasm for learning science (Greenspan, 1999).

Eventually, these students pursued the study of aerodynamics as it related to birds and humans. Additionally, I included physical science topics exploring the essentials of the water cycle and its relationship to weather during the year. The children's views toward weather concepts changed significantly during the year, allowing them to make better predictions about weather patterns.

The second group of students investigated for the pilot study was fifth graders, 19 girls and 12 boys. Eight of my students were gifted, with five students attending an in-house gifted program and three attending a nearby resource gifted center twice weekly. I had one student in Exceptional Student Education (ESE) and one attended classes in English for Speakers of Other Languages. Since I had been a third grade teacher in the same school for eight years, nine of the fifth graders had previously been students of mine. The class
consisted of 67% Hispanic, 23% White, 10% African American and 0% Other. I centered their curriculum on the nature of science by recognizing and identifying sequential designs in nature.

I chose to explore the social behavior of squirrel monkeys at the Monkey Jungle, a nature center located in South Florida, as part of the science requirements for my doctoral studies. Not only did I learn the science, but my students did too by discovering nature and linking scientific patterns observed in life. By studying plant and animal cells and watching primates in a natural habitat, my students eventually were able to visualize and some were able to delineate symmetrical patterns of primates’ travel routes, eating habits, vocalizations, diet preferences and social behavior. By incorporating a constructivist approach to learning through collaborative learning groups, these students learned to recognize and identify sequential designs in nature (Greenspan, 1999).

Together we became a community of learners (Tobin & Tippins, 1993) bonded together as stakeholders and committed toward the purpose of understanding how patterns are linked to nature. Eventually, all of us learned to accept the responsibility of solving a problem through social discourse. However, some of the students lacked life experiences and maturity to fully understand that the nature of science is basically a set of interconnected pieces forming a whole. But they began to search toward an understanding of what is nature and, particularly, they gained some insight and a limited awareness into the nature of science (Greenspan, 1999).
The general purpose of my pilot study was to integrate group learning into my curriculum with a focus on student learning and understanding rather than on science content (Tobin et al., 1990). I also emphasized hands-on, minds-on activities. Initially, I established cooperative learning groups with the intention of forming collaborative learning groups as the children progressed and matured. Cooperative learning delineates jobs for each individual in the group which helps young children organize themselves; i.e. manager, assistant manager, recorder, reporter, materials manager, member-at-large (Johnson & Johnson, 1991). These jobs help to fuse the process toward collaborative learning, which inspires students to share experiences and strengthens critical thinking skills (Grennon-Brooks & Brooks, 1993; Linn & Burbules, 1993). A cooperative learning group divides a task into parts with each member completing one part of the whole project, while a collaborative learning group has two or more students jointly solving a single solution for a problem. Thus, a collaborative group arouses natural curiosity, encourages shared communication, and optimizes science learning (Linn & Burbules, 1993).

In my case, I encouraged the students to always assign jobs even in collaborative learning groups because it helped them to stay on task, it provided needed structure for their age level, and diminished conflict among those who were argumentative and aggressive. Throughout, the goal was to have students successfully collaborate with other students by communicating ideas and helping other group members understand that any and all ideas contribute to the goal of the group (Linn & Burbules, 1993).
Conclusions of Pilot Study

To assess my pilot study, it was evident that I had to include observations of my students at the moment of learning. After receiving permission from Florida State University's Institutional Review Board (Human Subjects Committee), I began to videotape students learning science with the intention of allowing them to view the film and see themselves at work. Videotaping can "identify intended messages, and solicit structured feedback regarding the congruency of ...nonverbal behaviors" (Branbury & Herbert, 1992, p. 37). Both parents and students signed a letter granting permission for the process to begin.

As I reviewed the videotape, I looked for patterns of behavior in their body language and spoken words. I examined non-verbal gestures such as facial expressions like smiling and non-smiling, and I observed hand gestures as an indication of active or non-active participation (Dixon, 1995). I noted such subtle gestures as a smile, a grin or a nod and I recorded overt gestures like light slapping and overt verbal reprimands, such as "keep quiet," "you should do it my way," and "he/she won't let me do...."

Additionally, I listened for key words and phrases in their conversations to determine if there was any repetitive behavior. I focused on their verbal comments expressed as they worked in collaborative learning groups, such as "I want to be the leader (manager, assistant manager)," "I think.....," "I don't think," "I must.....," "I should...."

I also developed a written questionnaire, given at the end of the year, which asked for students' opinions about learning science within collaborative learning
groups. I indexed and coded key words and phrases into categories, such as 'like,' 'does not like,' and 'it's okay' that they wrote in the questionnaire.

Finally, I interpreted all the data according to the fourth generation evaluation (Guba & Lincoln, 1989) and attempted to draw conclusions based on my observations and experiences with the children.

As a result, I found that girls verbally expressed their opinion more openly as they worked in groups, stating "I like" or "I don't like" more often than boys did. Boys generally did not use these terms as frequently and acted first by touching and manipulating objects for the experiment before they verbally expressed an opinion. I also noted that girls requested to be manager/assistant manager of the group more times than boys did. Most of the time, other members of the group allowed the girls to be in these leadership positions when they asked for the job. However, in some instances, especially in fifth grade, girls were not chosen to be in leadership type jobs by their peers, they did not request the job or when they wanted it, they were not even allowed to manage the team.

In analyzing the results of the questionnaire, both sexes agreed that they preferred to work in teams but in third grade, the sexual makeup of the group did not matter to either the girls or the boys. On the other hand, in the fifth grade, girls preferred to work in groups of girls whereas boys did not care if they worked with just boys or girls.

Furthermore, toward the middle of the year, I had the students draw illustrations of what they perceived a scientist to be (Barman, 1997), based on their experiences and knowledge of science. I studied their drawings and
compared them for similarities and differences in their sketches and detailed illustrations. In this case, I found that both girls and boys perceive scientists to be older males with frazzled hairdos, dressed in white laboratory coats and surrounded by scientific instruments, such as microscopes, magnifiers and glass beakers.

During the research with both classes, I noticed that girls behaved differently in collaborative learning groups than boys. In the third grade, I observed that girls first review the task at hand and then immediately proceed to get the job done. They took the initiative and forced other group members to participate. Boys, however, had difficulty getting on task and appeared to talk about other things unrelated to the project. Also, the girls were more verbal and attempted to bring closure to the task, respecting the opinion of all members of the group. They were generally interested in presenting the best possible work to the class, wanting to be assured of an excellent grade. To the chagrin of the girls, the boys acted nonchalant about their possible grade. In fact, when the boys led the groups, the camaraderie among members was much less because the boys displayed a laissez-faire attitude in sharing ideas and knowledge with their peers.

In the fifth grade class, I noticed that as the year progressed, girls became more passive when they worked with boys in learning groups. For example, when one of the girls suggested placing a particular candy to make a pattern on the group's gingerbread house, one of the boys immediately criticized its location. Thereafter, that same girl was hesitant to make any further suggestions. In another instance, when the students were asked to design a
primate lunchbox, the girls in one group which was comprised of an equal
number of boys, sat motionless, and did not participate. In other activities, when
girls showed signs of aggressiveness and attempted to be in charge, the boys
would laugh or make condescending remarks.

Some of the girls appeared to enjoy learning science more when they worked
with other girls. However, when the group was comprised of girls and boys, many
girls appeared submissive and eagerly accepted the boys' opinion as valid
without considering their own. Some girls even took a 'backseat' role and did not
attempt to participate in the activity. Those who appeared to take an active role
in solving problems were increasingly 'put-down' by the boys in the group who
attempted and usually succeeded in dominating the girls by calling them 'bossy.'

In response to the question if there were any conflicts in the group, most of the
girls agreed that conflicts arose in selecting who was to be manager or materials
manager, the most popular positions in the group. Invariably, when the groups
were formulated, I noticed that the boys spoke the loudest and became the
manager or materials manager simply because they were the rowdiest. It
appeared that the girls accepted what the boys expected of them and submitted
to domination with only a feeble attempt to dispel the boys' authority.

In conjunction with my conclusions, Kenway; Blackmore, Willis & Rennie
(1996) also observed girls' attitudes and expectations of themselves. The
authors believe that gender justice must be achieved by understanding what
actually happens in schools and they found that educators are more interested in
changing girls and altering their learning environments rather than valuing girls.
for what they accomplish. By noting the emotional dimensions of feminist pedagogy in several activities that attempt to build on girls' self esteem, Kenway et al. further discovered that the expectations of girls were low, thus causing a resistance to participate. In other words, any attempts to enhance self-confidence in girls offered no challenges to spark their interest because the activity itself positioned girls into the same old identities and expectations.

Based on my limited results and indicators that I observed with students in the above-mentioned grades, my interest was heightened to pursue further investigation. Recent research indicates that there are some studies that investigate girls' achievement in science and how attitudes affect their science learning. The Sisters in Science Program (Richardson & Livingston, 1999), an after-school program established for fourth grade females to employ hands-on activities in a constructivist framework, was conceived to increase girls' achievement, attitude, interest, and awareness in science in order to encourage them to eventually pursue a science-oriented career. While their results are inconclusive regarding girls' increased science achievement, they do report positive data that conclude girls have an increased interest and better attitude toward science.

My study has been developed to go one step beyond by comparing girls and boys as they work together. It is centered on whether there are differences in the way that girls learn when they engage in science discourse with boys and other girls in collaborative learning groups, and if there are particular forces or circumstances that might affect that learning. My investigation not only examines
girls' attitudes toward science and science concepts but it also explores how both girls and boys working together in collaborative learning groups view science and how it may affect their learning.

The Study

Description of the Study

It is the intent of this investigation to propose that the cognitive styles of girls and boys are distinct (Head, 1996). Assuming this premise, it is suggested that girls and boys learn science differently based on social and cultural influences. Following this conclusion, this study also explores how the constructivist teacher can provide a more equitable educational setting for the benefit of both girls and boys.

It should be noted that in the pilot study, results were based on data compiled from observations and a questionnaire given at the end of the school year. Conclusions were based upon ‘most’ type statements and judgements were made about the students learning science. However, in this study, I plan to expand the findings by utilizing qualitative data from the text on what girls say in action as they collaborate with other girls and boys in their learning groups. The specific methodology will be further described in Chapter Three.

Specifically, the problem to be researched focuses on whether there are differences in the way that girls learn science as compared to boys and if there are intangible forces that affect that learning. The study is conducted with fifth grade students, located in an isolated portable unit at the far-west end of the
school, in a coeducational learning environment during the 1999-2000 school year. As a class, students investigate animal and plant cells, electricity and magnetism and forces of motion, topics that are representative of the fifth grade curriculum.

The group in the study consists of six prior students from my previous third grade class and an overall ethnic configuration of 65% Hispanic, 21% White, 9% African American and 5% Other. There are 35 students in my classroom, with 14 females and 21 males. Two, one female and one male, are students in the Exceptional Student Education program (ESE), one female attends English for Speakers of Other Languages (ESOL), and another male attends weekly speech therapy. Seven attend the language arts in-house gifted program. Additionally, twelve students have been identified as having scored in the lowest 25% (lowest quarter percentile) in reading on the Stanford Achievement Test and, consequently, attend a daily specialized reading laboratory for remediation.

The school is located in an urban community situated behind the University of Miami, Miami, Florida. This is a lower to middle class neighborhood and the school has 604 students, including eight in a handicapped Exceptional Student Education program for Pre-Kindergarten and 23 in a regular Pre-Kindergarten. The population of the school body consists of 56.5% Hispanic, 29.4% White, 11.7% African American and 2.4% Other. Twenty-eight percent of the student body receives a lunch package, which entitles them to eat either at a free or reduced rate. Even though the administration has changed six times during the past 12 years, causing multiple changes in the daily workings of the school, the
Parent Teacher Association remains an integral ingredient for continuity. Consequently, parents often volunteer their time and expertise by helping teachers and children in the classrooms or by organizing social and fundraising events.

Relevance of the Problem

According to the American Association of University Women (1995), gender refers to "different sets of expectations and limitations imposed by society on girls and boys simply because they are female or male" (p. 5). I intend to explore how girls learn and discover science concepts as they work with boys and other girls in collaborative learning groups. Studies indicate that early experiences affect girls' learning in the classroom, influencing their enthusiasm for science education (Mann, 1994; Tobin, 1996) and these early experiences have long term consequences on how they achieve in later life (AAUW, 1995). The problem impacts them both socially and economically.

In reviewing this research problem, it is important to understand the epistemological perspective on how girls initially understand the nature of knowledge and how they begin to develop the process of knowing. The premise of this overview suggests that when girls and boys begin learning about life, they learn about it through natural curiosity in order to make sense of their world. As early as the 1920s, Piaget argued that the young human mind was best described in terms of complex cognitive structures. Piaget concluded from close observations of infants and prudent questioning of children that cognitive
development proceeds through various stages, each involving entirely different
cognitive schemes (Bransford, Brown, & Cocking, 1999).

As development progresses, children learn to organize what they observe into
some form of order. Indeed the norms and cues of society, both social and
cultural, further prepare them in understanding what is right and wrong. Also,
they obtain cues from the people within their domain, who are influential role
models, and who elicit and summon the children to behave in a certain fashion.

Many factors cause girls to conduct themselves in the way they do. Bransford
et al. (1999) further remark,

Although a great deal of children's learning is self-motivated and self-directed,
other people play major roles as guides in fostering the development of
learning in children. Such guides include other children as well as adults...so,
too, can powerful tools and cultural artifacts, notably television, books,
videos... (p. 70).

Therefore, we can assume that societal and cultural forces affect the nature of
learning and the development of the process of knowing for girls. Girls
themselves remark that their identity is strained and is sometimes a skeptical
negotiation between their 'real' self and the abstract stylizations of girlhood that
society defines and promotes (Haag, 1999).

Girls enter into the classroom with certain preconceived notions about
science and scientific concepts (AAUW, 1999; Haggerty, 1996; Head, 1996;
Jarvis, 1996). Not only have their parents, peers and society's conditions
influenced them, but they have also had certain experiences that affect their
learning. These, in turn, help to determine how they will behave in the classroom whether they are learning alone, with partner-pairs or in collaborative learning groups.

Many studies indicate that gender issues exist throughout society from early language acquisition to pervasive cultural interactions and environmental experiences (AAUW, 1995; Haag, 1999; Lipson, 1998; Stefanos, 1997). Subtle messages in advertisements, contradictions and inconsistencies in society's expectations of girls' behavior, and the obvious existence of constant stress to compete in a male-dominated society influences the demeanor and conduct of girls in school and at home. Sexism is evident in every aspect of school life (Gipps, 1996; Mann, 1994; Pinar, Reynolds, Slattery, & Taubman, 1995).

A report by the American Association of University Women (AAUW), How Schools Shortchange Girls, (1995) affirmed that:

.... girls do not receive equitable amounts of teacher attention, that they are less apt than boys to see themselves reflected in the materials they study, and that they often are not expected or encouraged to pursue higher-level mathematics and science courses (p.147).

The study also reflected that young peoples' self-esteem drops during adolescence and that the loss of self-confidence is more dramatic and long-lasting for girls than for boys. This is particularly so in areas of science and mathematics. Hafner (1999) discusses the gap between the sexes in learning science and mathematics:
As puberty takes hold, girls begin to lose the self-confidence that once helped them excel in math and science. "Lots of them love math and science," Ms. Bennett [creator of Girls' Middle School, Oakland, CA.] said, "but something happens to them where they start to pull away" (p. D7).

Furthermore, because girls lack the self-confidence needed to achieve during these school years, it affects their long-term goals and impacts them in later years. Not only are there unequal opportunities in the classroom but such conditions are also perpetuated in the business world. The gap persists from higher education to the workplace. It is estimated that unless changes are made by the year 2000, most jobs created for women will be low paying positions even though women comprise half the workforce (Keller, 1997; Meadows, 1998).

In that regard, the latest studies indicate that 63 million women are working (Glasheen & Crowley, 1999), and are earning less than men with the same job while continuing to be employed in service jobs with less pay and marginal benefits. Earning about 76 cents for every dollar that a man procures, women represent 70% of adults with incomes below the poverty level (Furchtgott-Roth, 1999). It was noted that only three women now head a Fortune 500 company (Glasheen & Crowley, 1999) with only 75% of these Fortune 500 employing at least one woman corporate officer. Only 12 percent of all doctoral degrees in engineering are women with just 22 percent employed as scientists and engineers (Hafner, 1999). Would these studies indicate otherwise if girls were treated differently and provided with equitable opportunities in the classroom?
Girls also suffer from sexual harassment, which feminist curriculum theorists began to investigate in the late 1980s (Pinar et al., 1995). Studies indicate that sexual harassment begins as early as the elementary school years (AAUW, 1995; Orenstein, 1994). It is estimated that 27% of the girls in middle school have had sexual intercourse by the age of 14. Mann (1994) suggests that young adolescent boys place intense sexual pressures on adolescent girls, causing them to fight back. Haag (1999) reports that "...girls perceive 'normal' sexual relations, sexual risks, and sexual violence as existing on a continuum" (p. 17).

Gender expectations shape the school climate not only in the curriculum but also in the way that peers and teachers view girls. Girls' plight is overwhelming from conventional images portrayed in textbooks and standardized testing (AAUW, 1995; Willingham & Cole, 1997), to discouraging school achievement with negative feedback, and various forms of ridicule encountered with regard to social and ethnic stereotyping (Haag, 1999). "High achieving girls of all races and ethnicities also report having been taunted as 'overachievers,' sellouts, or 'teacher's pets.' Some girls recall incidents where their intellectual, academic, and sexual identities were critiqued simultaneously and mutually" (Haag, 1999, p. 59).

As a classroom teacher viewing the situation on a daily basis, the problem of girls learning science is of particular concern. Recent studies indicate that girls lag behind boys in science and mathematics tests, and as they grow up to become women, barriers continue to hinder them in midcareer and in technical fields (Glasheen & Crowley, 1999). According to Ford (1999), women are a
disproportionate amount of students who are part-time and over the age of 24. Additionally, they are grossly underrepresented in computer science, engineering and the physical sciences, which are majors in colleges that lead to high wage jobs. Girls tend to gravitate toward word processing classes while boys enroll in higher-level computer classes. In career preparation programs, males are overwhelmingly enrolled in technical and engineering fields while girls cluster in traditionally female, lower paying occupations.

As women in the workplace, biases exist that portray women as less hardworking, tough and valuable on the job than men (Glasheen & Crowley, 1999). The same authors contend that midlife women by the age of 55 with established careers earn only 69 cents for every dollar a man earns. Seeking a big promotion they generally do not get what they strive to achieve. Promotions for women in general occur only when they are ‘overripe’ and have demonstrated they can do the next job whereas a man is promoted when they are ‘hungry’ but not when they are ready.

Women are also pressured to choose between raising a family and having a career. With 72% of women with children under the age of 18 working, handling work and family life is difficult and demanding.

Not only are girls compromised in the workplace, but their abilities are questioned in school settings through a constant stream of stereotyping and discrimination. Girls are discouraged from continuing in areas of science and mathematics by attitudes of peers, parents, teachers, and society as a whole.
Sexism and harassment are equally evident, impacting girls negatively and establishing poor self-esteem.

Through the results of this study, I hope to understand how girls learn science with boys and other girls and develop the notion that preconceived attitudes affect learning. By discerning such information, it is my intention to propose approaches to better educate girls in science at the elementary school level, which will equip them to compete equitably as they enter the new millennium.

**Summary**

Systemic reform has evolved to include a paradigm shift in education, which is designed to ensure equity for all students in the areas of science and mathematics. This investigation proposes that societal and cultural forces affect the nature of learning for girls at an early age, reflecting and impacting them in science learning in the classroom. These forces are crucial to influencing their early development years and future endeavors. The school environment is a prototype of society, a mini culture that represents the larger one, emitting mixed messages of stereotyping, discrimination, and conventional jargon (Haag, 1999; Mann, 1994). Examining how girls work with other girls and boys in collaborative learning groups, exploring their interactions as they engage in learning, and observing their attitudes toward science will hopefully provide insight into how girls value themselves within the learning group as well as in the culture of the classroom.

By implementing the principles of constructivism, this study will give girls greater opportunities to express their knowledge and take control of their own
learning. As a result, it is the intent to observe girls' roles in the classroom and ultimately to achieve a transformation of both girls' and boys' attitudes and behaviors toward each other. Hopefully, the research will answer some questions related to the plight of girls as they learn science and create further query for thought.
CHAPTER 2
CRITICAL ISSUES FACING GIRLS

"As Americans, we all want a good education for our children. But at the same time, we shouldn't ask our daughters to take a backseat to our sons in our nation's classrooms" (Lange, 1997, p. 16).

Introduction

A number of important studies (Haag, 1999; Mann, 1994; Orenstein, 1994) affirm that girls face gender bias and discrimination everyday. The American Association of University Women (AAUW) (1998) report that there is a continuing cultural, social and economic gap between females and males. Gender is described by Mason (1995) as "an image or perception that is developed due to assumptions and stereotypes manifested in societal experiences and mores" (p. 9). For purposes of this paper, it is essential to review relevant research that demonstrates the existence of a gender bias, which affects girls' behavior and is causing the gap between women and men to widen.

Common to modern thought, sex and gender identities are defined differently. The first relates to biological factors, referred to as male and female, which normally remain intact throughout life. The latter, designated as masculine and
feminine, refers to societal and cultural factors, which may change over the
course of time. Both are essential in explaining how one behaves (Wilber, 1997).

In order to comprehend the full impact of the aforementioned gender gap, it is
necessary to briefly explain how females historically have been viewed by
society. This will be followed by a review of the latest studies that support the
notion that socialization and cultural factors impact girls' development, especially
during the adolescent years.

In keeping with the problem addressed in Chapter One, which indicates that
extenuating factors may affect how elementary girls learn science in the
classroom as they interact with other girls and boys, the influence of the
educational environment on girls' attitude toward science will also be discussed.
A review of recent research notes that the academic experience does in fact
impact girls' perceptions about themselves (AAUW, 1995, 1998; Haag, 1999;
Mann, 1994; Orenstein, 1994). Such areas as pedagogical practices, curriculum
content, and standardized assessment practices will be addressed, which, when
combined together, act as a force that ultimately influences girls' behavior,
enhances their self-worth, and alters their attitudes toward science and learning.

Finally, there will be a brief explanation about qualitative research, the
method of investigation utilized in this research project. It focuses on meaning in
context and requires data collection techniques and instruments that are
sensitive to underlying meaning when analyzing and interpreting results
(Merriam, 1998). The fundamental purpose of qualitative research is to produce
knowledge, assuming "that meaning is embedded in people's experiences and
that this meaning is mediated through the investigator's own perceptions" (Merriam, 1998, p. 6). Under those conditions and for purposes of this study, qualitative research appears to be a viable approach to gather evidence about how girls learn science in a natural setting. The benefits of qualitative research as an investigative tool will be discussed in the latter part of this chapter.

A Look at Girls

A Biological Perspective on Females

Historically, the study of girls and women has evolved from many different perspectives, some examining the anatomical differences between men and women while others investigating anthropological and socio-cultural aspects, leading to the view that in part both may affect girls' behavior. In order to understand the complete picture of how girls act and react in a given situation, one must take into account each viewpoint to determine if this does indeed define girls' behavior as well as confirm that past convictions help to clarify their present behavior.

Comparing the physiological nature of men and women, Bateson (1994), a cultural anthropologist, found that the larger size of the connector between the two hemispheres of the brain may indicate why women are more intuitive than men thus allowing them to complete several tasks simultaneously. Still others believe that hormones, which generate the cycles of the reproductive organs affect behavior. These hormones, causing girls to conduct themselves in a
certain manner, determine metabolism and moods, which ultimately control the functions of other systems in the body (Sagan, 1998).

Over the years, anthropologists have also studied the origins of women's behavior from Eve's creation in the Bible to observations of similarities found in the behavior of primates that possibly help to explain how girls act or respond to life's experiences. Many scientists concur that chimpanzees learn skills through observation and imitation and that they communicate through a complex pattern of signals, facial expression and vocalizations defined as language (Angier, 1999; Partan & Marler, 1999). This has prompted many to believe that chimpanzees may think and act similarly to humans. Further, some investigations suggest that in communication and genetic make-up, primates are our closest relatives, especially chimpanzees (Angier, 1999; Partan & Marler, 1999; Wade, 1999) while others propose that primates can think by placing objects in sequential order (Wade, 1998). In other words, anthropologists submit that both girls and boys may respond to their environment because of their anthropological makeup, perhaps derived from a connection to their early ancestors in the primate world.

Gibbons (1998) even affirms that humans genetically share 98.5% DNA with their primate cousins, the chimpanzees. She also indicates that mitochondria, cellular organelles of DNA, further link humans and apes. Even certain subspecies of chimpanzees are infected with different strains of HIV-like viruses, a disease carried by man, leading to the belief that one particular chimpanzee subspecies may be the source of human HIV-1 infections (Cohen, 1999).
Gibbons (1998) likewise confirms that many traits found in female primates are obvious in female humans.

This means that a very small portion of human DNA is responsible for the traits that make us human, and that a handful of genes somehow confer everything from an upright gait to the ability to recite poetry and compose music (p. 1432).

In addition, by observing chimpanzees in their natural habitat, Goodall (1998) notes that chimpanzees elicit humanlike behavior such as tool making, tool use, and close bonds with family members. As with humans, she confirms that social interactions prevail among both female and male chimpanzees as they display affection, happiness, sadness, kindness and benevolence. Possibly through continued observation, we may learn that behaviors displayed in the primate world will assist us in better understanding social interaction in human society.

On the other hand, socioculturalists believe that the differences in girls' behavior stem from cultural influences (Davis, 1995; Ladson-Billings, 1994; Mason, 1995). They believe that subtle and overt stereotyping is manifested in every aspect of life, beginning even at birth with pink and blue nurseries. They agree with Koballa (1996) that convincing advertisements on billboards, hypnotic cliches on radio and television programming, and impressive worldwide legislative and political policies control the social context of females by the very nature of persuasion espoused through highly credible, attractive and powerful sources.
Several relevant educationally based studies have also contributed to clarifying girls' behavior and achievement in the classroom. During the 1960s and 1970s, the plight of girls was based on the belief that discrimination was indeed evident and that girls were not given ample opportunities to learn while in school. In the 1980s, researchers believed that there were differences in abilities between the sexes and that girls and boys used their abilities in different ways (Head, 1996; Wilder, 1997). Recently, it was recognized that there are barriers to girls' learning in the classroom suggested by examining the results of standardized achievement tests, dropout rates and careers selected by women (AAUW, 1995, 1998). These issues will be detailed when the impact of gender bias in science is discussed in the second part of this chapter.

**Important Influences on the Socialization of Girls**

In spite of changes in women's roles in society, many girls continue to follow into traditional patterns of behavior that affect achievement and performance in the classroom. Discussion of the socialization of girls is indeed pertinent toward understanding the objective of this research which examines if there are any prevailing learning differences in girls because of existing societal attitudes.

The American Association for University Women (AAUW) reported that girls' perception of self is lower compared to their male counterparts (AAUW, 1995). Tobin (1996) denotes it as an invisible part of belonging to a culture:

> Neither the female who has to deal with this cultural baggage nor those who construct females as they do might be aware specifically of what is happening. The construction of self and non-self are a part of the daily
routines of individuals in any social setting, a part of normal life within a
cultural setting (p. 121).

During socialization, girls are expected to behave in a certain way. Stereotyping
is defined as conventionalized ideas or societal expectations of appropriate
behavior (Kahle, 1990). These behaviors are acquired through social learning
and cognitive development. In social learning "imitation is motivated by fear of
separation from a love object" (Frieze, Parsons, Johnson, Ruble & Zellman,
1978, p. 116). A child imitates her parent because of expected reinforcements
and a need to be assured that that parent will love her. The authors further
confirm that in cognitive development, children imitate models of the same sex
because they desire a positive self-image and want to learn behaviors that are
judged appropriate for them. In both cases, they concur that children are
rewarded for appropriate behavior, which helps them understand who they are in
the context of their perception of themselves.

The resulting behaviors formalize into a base of values, a system as it were,
used to guide action throughout life. Primarily, a girl will observe behaviors and
attitudes of people in her environment and learn to value them for herself. From
those observations, she will imitate some behaviors and avoid inappropriate
ones, developing guidelines on how to behave in given situations in the future
(Frieze et al., 1978).

Frieze et al. (1978) subsequently remark that "stereotypes and
generalizations along the dimensions of power, competence, prestige, strength,
and size are among the earliest to develop" (p. 129). When a girl observes
negative or positive feedback from any of these valued characteristics, it affects her perceived role in society and, therefore, her behavior and attitude. Difficult to change, these attitudes of self-image may become less rigid under certain circumstances but will not be replaced altogether.

Traditional roles for women have placed girls as caretakers and homemakers. From an early age, these stereotypes flourish through role modeling and parental reinforcement. According to Friere et al. (1978), “a child’s conception of his world, both physical and social, comes about through the child’s structuring of incoming information into cognitive schemata and then generalizing these schemata to new situations” (p. 123).

The Impact of Cultural Influences on the Development of Girls
Not only does the impact of socialization affect girls’ perception of themselves and their subsequent behavior but cultural expectations manifested through gender stereotyping are equally influential in their development. What they learn in their culture may affect how they behave and how they act out their role as a female. Since the intent of this investigation is to observe fifth grade girls in small collaborative groups, as they learn science with other girls and boys, it is essential to examine cultural issues. Affecting the learning process, a mini culture develops in the classroom as students interact in small groups; i.e., they naturally behave according to the cues and norms of the larger culture (Gipps, 1996).

During girls’ period of development, psychological forces developed in their cultural context also impact them with regard to how they feel about themselves.
and how they will perform in school. Frieze et al. (1978) note that the role of culture dictates categories and generalizations in girls, thus causing conflict and ambivalence about who they are. Orenstein (1994) further notes that psychologically girls have reduced expectations and less confidence in themselves and their abilities than boys have as they emerge from the teen years. This may be caused by how others in the culture perceive them.

Pervasive throughout American culture, gender stereotyping may be subtle or overt causing girls to discern their successes and failures differently than boys. In that regard Fennema (1993) states that males and females are equally intelligent but socialization and culturalization lead them to behave differently.

In an investigation examining the interaction patterns of girls and boys with teachers, gender stereotyping is apparent. Kahle (1989) asserts that girls believe they are successful science learners because they work hard. Some even think they are lucky in guessing an answer. Many believe they are not smart. Kahle concludes,

... boys and girls experience different learning conditions and have different learning opportunities. Teachers who practice directed intervention, who provide opportunities to work in laboratories and with equipment, who develop quantitative and spatial skills, and who transform society's sex-role stereotypes will advantage both girls and boys (p. 40).

Tobias (1993), too, verifies that when girls achieve poorly, they attribute it to lack of ability, which is based on cultural expectations. But, when boys execute poorly, boys presume it is because they have not dispensed their best effort.
In the same regard, when they perform well, girls believe it is based on luck while boys on the other hand, think they succeed because of their ability. In other words, the culture dictates how girls behave when they compete against boys and how they should act just because they are girls.

Other studies which focus on cultural bias indicate that girls are cognitively handicapped, learning differently than boys (Tobias, 1993).

Boys tend to use deductive, rigorous, structured, and axiomatic thinking.

Girls use inductive, experiential, creative, and intuitive thinking and are more influenced by their cultural environment (Woodrow Wilson Gender Equity in Mathematics and Science Congress, 1993, p. 101).

Nonetheless, it has been confirmed that girls receive less attention in classes than boys do. In studies, teachers respond more to the aggressive, demanding needs of boys than to the passive, submissive behavior of girls (Sadker & Sadker, 1994).

Moreover, gender stereotyping prevails within minority groups and diverse populations of society (AAUW, 1998; Pickard, 1995; Sadker & Sadker, 1994). Some patriarchal cultures, encouraging conventional roles, send subtle messages to girls, which inhibit and prevent them from making life choices. Hispanic girls particularly face many societal obstacles, including deficient language skills (AAUW, 1998). AAUW further declares that compared to other minorities, their teen birth rate has not declined despite rising sexual experience among fifteen-year-olds. "Many [pregnancy prevention programs] are not geared to address the needs or cultural strengths of Hispanics, although that
group is overrepresented in the teen pregnancy statistics” (AAUW, 1998, p. 69).

Additionally, in 1995, 30% Hispanic females, ages 16-24, dropped out of school and when returning for a degree were not able to pass the high school equivalency test (Cain, 1999). It has also been revealed that between the ages of nine and fifteen, academic confidence, belief in one's talents, and a sense of personal importance plummets more for Hispanic girls than white or African American girls (Orenstein, 1994).

African American girls confront a similar dilemma. Black females view their academic achievements as less valuable than black males in spite of better performance. Ladson-Billings (1994) states that one out of two African American children are poor, five times as likely as white children to be dependent on welfare and become pregnant during the teen years, and three times as likely to live in substandard housing headed by a female. She further concludes that African American girls generally attend poor schools with few resources, resulting in feelings that they will be consigned to low-caste jobs in the future because of their race and status. Therefore, while in school, these black females have little motivation to excel (AAUW, 1995) and are more pessimistic about both teachers and schoolwork than other girls (Orenstein, 1994).

The Adolescent Years

The problem addressed in this paper deals with observing attitudes and behaviors of elementary school girls as they learn in a classroom setting with other girls and boys and how extenuating factors influence the learning process as they engage in science discourse. The premise implies that such behaviors at
the elementary level may indeed affect girls as they develop during the crucial adolescent years. Many agree that these teen years appear to be both the most important cycle of development for girls and the period of time when their self-esteem declines at a steady rate (AAUW, 1998; Mann, 1994). In understanding these years of growth it is important to briefly discuss what happens to girls during that time when their space is invaded, their body is threatened, and they become an object of ridicule and benign neglect (Mann, 1994).

Adolescence:

... spans the period of time from puberty — often generalized as beginning around age 12 — to incorporation of an adult identity, which occurs somewhere between the late teens into the 20's. This period of psychological life... abounds with a rate of internal change not experienced since one's early childhood and not to be experienced in adulthood (Muisener, 1994, p.58).

Pipher (1994) describes puberty:

... as a biological process while adolescence is defined as the social and personal experience of that process. But even puberty is influenced by culture... The point is that girls enter adolescence earlier than they did forty years ago (p. 53).

A study of 3,000 children, grades 4-10, conducted by the AAUW, "showed that young peoples' self-esteem drops during adolescence and that this loss is more dramatic and long-lasting for girls than boys, especially in areas of math and science" (Today UTD, 1997, p. 11). Nuckols, Porcher, & Toft (1994) note,
Even for children who are maturing adequately, adolescence is a time of contradictions. These are years when we are stuck between dependence and autonomy, between childhood and adulthood. We are expected to act like adults, even as we're required to raise our hands before we go to the bathroom (p. 52).

AAUW (1998) also remarks that girls have a more declining sense of themselves, which inhibits their actions and abilities. Girls who are held back a grade are most likely to drop out of school than boys who are held back. Once they become dropouts, they are less likely to return and complete school. Added to their plight, statistics indicate that one in four adolescent girls show signs of depression, do not get needed health care, and have a higher rate of criminality as substance abusers when compared to boys (AAUW, 1995; D.A.R.E. America, 1997).

Ironically, substance abuse does not affect girls more than boys or boys more than girls. There appears to be no direct correlation by gender, noting that in recent years girls have closed the gender gap as substance abusers. A recent study, *Substance Abuse and the American Woman*, concludes that both girls and boys are equally likely to smoke, drink alcohol, and use illegal drugs (National Center on Addiction and Substance Abuse, 1996). Results also indicate that more college women smoke than men, females drink alcohol as much as males, and both sexes are now using drugs, alcohol and tobacco at the same early age. In other words, "today's daughters are 15 times likelier than their mothers to begin using illegal drugs by age 15" (Reid, 1996, p. 1).
All of these factors are possible indicators of the development of poor self-image and diminished self-confidence in girls (Orenstein, 1994). According to research conducted by the Commonwealth Fund in 1997, AAUW (1998) notes, “Adolescents’ responses to questions related to mental and physical health indicate that the adolescent years are a far more negative time for girls’ health than for boys” (p. 64). Targeted as the beginning decline of self-esteem, the adolescent years are a crucial period of social development when substance abuse may be an indication of low self-esteem. However, that self-image may also perpetuate itself and affect girls’ performance in school, causing lower achievement (AAUW, 1998; Mann, 1994; Orenstein, 1994). Pipher (1994) corroborates, “Girls’ emotional immaturity makes it hard for them to hold onto their true selves as they experience the incredible adolescence in the 1990s” (p. 58). She further comments:

There is an enormous gap between the surface structure of behaviors and the deep structure of meaning. Surface structure is what is visible to the naked eye—awkwardness, energy, anger, moodiness and restlessness. Deep structure is the internal work—the struggle to find a self, the attempt to integrate the past and present and to find a place in the larger culture. Surface behaviors convey little of the struggle within and in fact are often designed to obscure that struggle (p. 53).

Therefore, it appears that the socialization of girls and the culture that dictates their female role are integrated into a complex network that impacts their performance in school, their life choices, and their view of life. This integral
network, then, creates girls who develop low self-esteem, which is exacerbated by the tensions and strains of the adolescent years, further diminishing their self-image and diffusing their confidence to pursue careers in mathematics, science and technology.

The Educational Community

Gender Bias in Science Education

Gender bias appears to be most prevalent in science education. Studies indicate that girls do not matriculate as much as boys in secondary science courses or pursue careers in engineering, technology, and higher order science content areas (AAUW, 1998; MacDonald, 1995; Mason, 1995). A report by AAUW (1998) concludes, "Unequal treatment and more subtle forms of classroom bias still discourage the achievement of girls and minorities, particularly in mathematics, science, and technology" (p.46). In reality, girls are less likely than boys to study physics and physics related courses (AAUW, 1998; Davis, 1995).

Attitudes in the early years about what girls should do and how they should behave affect their later years. Research has shown that these early experiences influence their choice of education while at the same time, society's beliefs alter girls' own convictions about science (Fennema, 1993). Girls perceive scientists and science as a masculine-oriented field, which inadvertently, causes them to choose other subjects to study (Barman, 1997). A study in 1977, noted human personality and behavioral traits:
A normal healthy competent male tended to be seen as independent, objective, unemotional, dominant, competitive, active, skilled in business, self-confident, ambitious, frequently...having a liking for mathematics and science.... a normal female was considered to be submissive, easily influenced, not adventurous, dependent, subjective, excitable in a crisis, conceited and to have a dislike for mathematics and science (Harding, 1996, p. 7).

Based on gender stereotyping, most girls then do not choose to enter into science-oriented fields, resulting in females possessing a lesser status in society, which diminishes lower self-image. The language style of science may be a contributing factor. Tannen (1996) purports that language and gender are related through a lens of sex and class linked patterns. She claims that there is pervasive miscommunication among females and males caused by cultural and stylistic differences which impact girls’ behavior and perceptions. In conjunction with Tannen’s viewpoint, others reveal that girls do not take ownership of the subject of science, leading to a weaker identification with science and resulting in a lack of commitment to continue learning it in later years.

It may be that girls are achieving in subjects like science and/or mathematics but not really engaging with them; achievement as opposed to ‘ownership’ will not offer the motivation required to overcome social and cultural pressures and to break norms (Gipps, 1996, p. 267).

Girls learn to withhold opinions, defer to boys, submerge honest feelings, and hide their intelligence (AAUW, 1998; Mann, 1994; Orenstein, 1994; Sadker...
Sadker, 1994). Thus girls learn to believe that they are emotional, irrational, and illogical individuals who do not have the ability to succeed or even pursue careers in the 'masculine' fields of mathematics and science.

The Impact of the National Science Education Standards on Girls

Because this research examines how girls learn science as they collaborate with other girls and boys, it would be remiss not to discuss the impact of the National Science Education Standards, which serve as the basis of instruction for this investigation. Due to recent studies, the educational community has become cognizant that girls and minorities appear to be shortchanged as they grow and learn in the classroom, particularly in science (AAUW, 1995, 1998). Therefore, educators have begun to recognize that changes in the practice of teaching must coincide with the needs of girls, and they have initiated and developed appropriate standards to meet those needs.

In recent years, the nation has proceeded in its efforts to improve science education and create a set of standards to effect schools nationwide. The National Science Education Standards (National Research Council, 1996) provide, promote, and encourage equal education for all students to learn science. Written by a multiethnic group, the science standards "emphasize a new way of teaching and learning about science that reflects how science itself is done, emphasizing inquiry as a way of achieving knowledge and understanding about the world" (National Research Council, p. ix.). Research indicates that the inquiry method is most beneficial for girls to learn science (Head, 1996; Jarvis, 1996; Kahle, 1989; Tobin, 1996).
The goals of the Standards include providing all students, when given the opportunity to actively engage in the process, with challenging science learning experiences that ideally achieve an understanding of science. Recognizing the essential role of teachers, the Standards specify that teachers facilitate students to learn science in a positive, collaborative fashion that encourages inquiry, discourse, and shared responsibility. The Standards claim that students learn science by ‘doing’ in order to develop an understanding of what science is and its impact on them within the realm of their culture. Aimed at establishing a high level of science literacy in the United States and improving science education through systemic reform, the Standards also include educating students and teachers, policymakers, teacher education programs in colleges and universities, textbook publishers, science museums, businesses, and scientists.

Supporting the notion that teachers are inherently essential in the learning process, the Standards provide clear implications that teachers have to help change science curriculum, alter teaching methods, and reevaluate assessment practices. By becoming active in the process, the Standards claim that teachers will benefit those girls and boys who traditionally have not received encouragement and opportunity to pursue science (National Research Council, 1996).

*How Teachers Affect Girls in a Learning Environment*

Since the National Science Education Standards specify the role of teachers in supporting and encouraging girls to learn science, it is necessary to explore recent findings on how teachers do, in fact, impact girls’ performance and
achievement in a learning environment. Marks (2000) in an interview with Sanders, who set out to quantify the impact of teachers on student achievement, concedes, “Teacher effectiveness is 10 to 20 times as significant as the effects of other things” (p. 16). Sanders concludes that a single ineffective teacher can thwart the progress of a child for at least four years (Marks, 2000).

There have been many studies that have investigated the impact of teacher influence on students’ learning. Some have investigated teachers’ perceptions and attitudes toward girls and science, while others examined interaction patterns between teachers and students (Kahle, 1989), and teaching practices (Haggerty, 1996; Tobin, 1996). Teacher input also affects children’s views about science (Head, 1996; Jarvis, 1996). Yet another group of educators examined teacher pedagogy and the effect that teachers have on learning (Dagher, 1991; Haggerty, 1996; Kreinberg & Lewis, 1996). Haggerty (1996) concludes that the practice of teaching reflects the personal value system of the teacher tempered with conflicting beliefs about science. She believes, ultimately, that a personal value system affects students’ understanding of science concepts.

Furthermore, both girls and boys themselves need to understand there are different learning strategies for different tasks, and they must learn to choose the appropriate one to use. Gipps (1996) further declares, “This resonates with what we know about meta-cognition: that pupils need to be aware of and to monitor, ‘to regulate’, their own process of learning. The emphasis...is on the pupil as conscious decision-maker” (p. 266).
For purposes of this research, studies related to teachers' perceptions and attitudes toward girls and science, teacher-student interaction and teaching practices will be addressed.

Haggerty (1996) investigated the development of student teachers' perceptions of science by focusing on student teachers and their views on science and science teaching. She learned that student teachers viewed science as objective and masculine and affirmed that "stereotyped perceptions of science limit the appeal of science for many, especially for girls and women" (p. 24). In other words, she concurred that science is not a knowledge that girls can use as a conceptual lens when they view the world. Harding (1996) also corroborated that the misconception of science as a masculine, male-dominated subject remains indelible upon girls' view of science, thus alienating them from studying science or pursuing it as a career.

Kahle (1989), on the other hand, concentrated on the interaction patterns between students and teachers and students and students. She studied the teaching techniques of two teachers, a male and female, in an Australian high school. She determined that an inquiry model provided an excellent environment for girls to learn science but it also reinforced gender stereotyping because of the teaching style of the individual teacher. She confirms, "Their different roles as change agents interacted with their teaching strategies and styles to produce very different classroom climates for girls and for boys" (p. 39).

While using a teaching style preferred by girls and boys who had previously not demonstrated any desire to learn science, Kahle (1989) further observed that
the male teacher transmitted cultural cues which, according to her findings, enforced gender differences and encouraged male students to pursue the study of science. Although Kahle expected the inquiry model to be satisfactory for both sexes to learn, she noted it did not promote a positive climate for either females or males and had some shortcomings based on the individual teacher’s style of teaching. She found that the male teacher did not demonstrate the characteristics or attributes that was needed to build a supportive classroom climate for girls and boys whereas, the female teacher revealed many teaching behaviors that did promote equitable education. However, the female teacher also reinforced certain behaviors and reproduced some sex-role stereotypes that hindered girls from learning in an environment that was conducive to learning free of gender stereotyping.

Kahle’s (1989) findings appear to confirm “that the behaviors and relationships [between teachers and students and students and students] which lead to a sexist environment are much more complex than those which are easily identified” (p. 36). She further indicates that covert rather than overt interactions play a more significant role in learning. These findings provide an important reference for my research because by examining student-student interactions, I hope to further highlight the premise that there may be underlying and extenuating factors, such as social and cultural issues, which affect girls who learn science with other girls and boys.

Furthermore, similar studies investigate teacher-student interaction and its impact on girls learning science. Many educators conclude that frequency,
duration, and content interactions between teachers and students help to 
develop different perceptions of abilities and relationships about academic 
subjects (Bullock, 1997; Chambers & Andre, 1997; Murphy, 1996). AAUW (1995) 
verifies that more male students receive attention from their teachers than girls 
do because they demand it. They further remark that the content of teachers' 
comments and its execution (praise, accept, challenge, remediate or criticize) 
expectations of teachers can be powerful stimulants to girls’ success” (p. 112). 

In the practice of teaching, many teachers believe and portray science in a 
gender-biased manner. Ask any student or teacher what they believe is the 
image of a scientist and inevitably it will be a Caucasian, elderly man dressed in 
a white coat with glasses and a frazzled hairdo (Barman, 1997). Even drawings 
created by students portray images of scientists similarly, possibly indicating that 
students hold science as a male-oriented career (Kahle, 1990). These cultural 
barriers, transferred pedagogically to girls, appear to embody masculinity and 
make science and science learning more difficult and less accessible for girls. 

Likewise, evidence indicates that girls tend to be generally passive in the 
classroom, selecting coursework that emphasizes social relationships and verbal 
skills (Orenstein, 1994; Sadker & Sadker, 1994). By the same token, boys 
generally are encouraged to play with science-oriented toys like electrical 
gadgets whereas most girls are unfamiliar with tinkering and building blocks, 
causing them to become disinterested and bored when such activities are 
presented in the science classroom (Murphy, 1996). As a consequence,
differences are apparent between female and male academic preferences, which demonstrate wide gaps in spatial skills and attitudes in science and mathematics (AAUW, 1998; Mason, 1995; Reyes & Padilla, 1992).

Girls appeared to work fundamentally from human needs, dealing predominantly with issues. They were often cautious in their entry to a situation, wanting to know how, why and whom it was for.... they were constantly seeking to keep the implications of the whole in view, and for some this complexity became intolerable to the point where they capitulated (Harding, 1996, p. 117).

Both Harding (1996) and Head (1996) vouch that girls are more thoughtful, concise and precise in answering questions than when boys answer questions. In other words, teachers must take the time to listen to girls and wait for them to respond.

With regard to the practice of teaching, there have also been inquiries into specialized programs that prepare teachers about gender differences (Kahle, 1996) and those that view the benefits of single-sexed educational settings designed with a male and female teacher (Kruse, 1996). Kruse supposes that providing girls with an all-girls learning environment develops their self-esteem and, at the same time, gives boys an opportunity to understand gender issues and attitudes. Although not the answer to the problem, single-sexed schools may benefit girls by giving them the chance to learn and develop on their own terms, regardless of the pressures placed on them in a male-dominated classroom. Kruse emphasizes that "The aim here is equal rights and equal worth for girls..."
and boys, so that they can meet and experience equal and mutual appreciation and respect” (p. 189).

Finally, in order to narrow the gender gap in science education, changes must be made in the way that teachers approach the learning of science. Some believe that providing a socially constructed atmosphere with collaborative learning groups ensures opportunities for both sexes to discuss their knowledge and opinions (Haag, 1999; Mann, 1994; Tobin, 1993). It "promotes social skills, self-esteem, discussion, testing, inferring and giving informed conclusions, thus providing a classroom atmosphere which is preferred by most girls and many boys” (Jarvis, 1996, p. 37). This inquiry and problem solving approach also assures girls the freedom to participate and begin at the same level as boys in helping to make choices and partake in reaching a solution to a problem. Mann (1994) reiterates:

Young girls... are socialized to be dependent, and they receive more protection and more assistance in doing tasks from their parents and teachers. As a result of this social reinforcement, ... when children enter school girls tend to be more dependent on others and boys tend to be more self-reliant (p. 105).

In terms of learning science, if given the opportunity, girls will most likely feel more competent and more inclined to work on a task and persist at it until it is mastered. Thus, as indicated in the studies mentioned above, teachers’ perceptions and attitudes, teacher-student interaction, and teaching practices
affect girls’ learning, impacting their behavior and beliefs toward school and particularly science learning.

**Gender Bias in Curriculum**

AAUW (1995) reports that:

The formal curriculum is the central message-giving instrument of the school. It creates images of self and the world for all students. The curriculum can strengthen or decrease student motivation for engagement, effort, growth, and development through the messages it delivers to students about themselves and the world (p. 105).

Curriculum content and textbooks also transmit societal values and cultural stereotyping to young readers, affecting the way that girls learn. Interest in gender issues in the 1970s, particularly as it impacted girls, produced evidence that suggested there is a pattern of subtle messages in storybooks, basal readers and science textbooks which is revealed to girls through texts, examples, illustrations and thematic material.

Later investigations reported that women comprise only one percent of some texts, trivializing and distorting their roles in society (AAUW, 1995). In 1984, the National Foundation for the Improvement of Education categorized six common forms of gender bias in instructional materials: “exclusion of girls, stereotyping of members of both sexes, subordination or degradation of girls, isolation of materials on women, superficiality of attention to contemporary issues or social problems, and cultural inaccuracy” (AAUW, 1995, p. 109).
Even with extensive federal research and a committed effort to reduce gender bias in textbooks, hidden language messages continue to encourage traditional female roles. Absent are the inclusion of women as scholars, developers of history and initiators of events (AAUW, 1995). Included are subtle language biases that purport traditional teaching and focus primarily on symbols created by men (Pinar et al., 1995). Double standards, condescension and tokenism are common (AAUW, 1995; Orenstein, 1994; Sadker & Sadker, 1994). Because girls continue to be characterized and illustrated in books as submissive and conforming, they learn to mirror these images in real life.

One of the hidden messages of storybooks and textbooks is to teach girls about culture. In many instances, girl characters are portrayed as caring, non-aggressive, and passive participants. Just examine the stereotypical characterizations represented in such fairy tales as Cinderella, Alice in Wonderland and Snow White. Basal readers, too, depict girls in the traditional homemaker role, concerned with the task of keeping a happy, united family. Even though today’s textbook publishers have made a greater effort to include women, many do not portray girls as breadwinners, leaders, and policymakers (AAUW, 1998). AAUW confirms, “The enhanced ability of such texts to stir girls’ imagination and accurately reflect their perceptions of the world they inhabit lays a better groundwork for their attainment of higher standards” (p. 52).

Basic science textbooks either present or subtly encourage science as a male-oriented subject which may be meaningless and incomprehensible to young girls (Harding, 1996). Including such concepts as aerodynamics and
simple engineering activities is difficult for minority girls because of their limited experiences in those areas (Ladson-Billings, 1994).

Furthermore, certain language in science textbooks continues to advocate the Eurocentric traditions and the white, male Christian dominance (Giroux, 1991). Girls and minorities are expected to perform difficult and intricate experiments, which contain context, vocabulary and idioms unfamiliar and confusing to them. Many times, illustrations and pictures within those texts advocate a middle or upper class setting that is both impractical and far from the reach of girls (Harding, 1996).

Finally, we can see that subtle messages are delivered to girls in curriculum content, storybooks, basal readers and science textbooks by omitting girls as influential figures in society and portraying them in traditional female roles. Certainly it affects girls' learning causing some educators like Giroux & McLaren (1989) to emphasize that a curriculum should respect the diversity of all students. They believe it should be based on the principles of trust, sharing and commitment with the intent of improving the quality of human life.

**Gender Bias in Assessment Practices**

As a whole, assessment provides criteria and feedback for judging what a student knows and how it is applied to everyday life. It has been well documented that some assessment practices generate gender-biased messages to girls, specifically in standardized tests (AAUW, 1998). Recent studies have managed to educate the public about shortcomings in tests in terms of gender, race, and class found in language, illustrations, and other hidden areas (AAUW,
Standardized tests are given to youngsters from early childhood through post college with test scores impacting their future. Interestingly, in the early grades, girls outperform boys on standardized tests but steadily decrease by the time of high school. They perceive assessment tasks and problems differently, under the same circumstances:

Girls tend to value the circumstances in which assessment tasks are set and take account of them when constructing meaning in the task. They do not abstract issues from their context. Conversely, as a group, boys tend to consider issues in isolation and judge the content and context to be irrelevant.

This latter approach generally is assumed to be the norm in both assessment and classroom practice in science (Murphy, 1996, p. 111).

By high school, girls score lower on the Stanford Assessment Test (SAT) and the American College Testing Program (ACT), tests essential for college admission, particularly in mathematics and science. Due in part to these test scores, Sadker & Sadker (1994) relate, "While females are more likely to attend community colleges, they are less likely to find themselves at the most highly selective schools" (p. 167). Thus, females, because of these examination results, have less opportunity than males to enter the college of their choice.

Sadker & Sadker (1994) further describe the results of the Preliminary Scholastic Assessment Test (PSAT), a test used to select winners for the National Merit Scholarships and state scholarships.
The PSAT is the first national peek into the future. For girls it is a frightening preview. Boys score so much higher than girls do on the PSAT that two out of three Merit semifinalists are male. PSAT results are like a fire bell in the night, and the developer of the test, the Educational Testing Service (ETS), knows it...it rigs the scoring in an attempt to reduce the gender gap. ETS giving twice the weight to verbal performance, traditionally an area of female strength...All this effort still does not result in equal male and female performance. While eighteen thousand boys reach the highest PSAT categories, only eight thousand girls attain them (p. 139).

Not only are girls shortchanged on college admission tests but if they choose to enter graduate school, they are also faced with cultural discrimination. Girls score lower in both the mathematics and verbal sections on tests for admission to graduate programs (Sadker & Sadker, 1994). In some of these tests, the number of references of females is limited or both of the sexes are portrayed in preconceived and stereotypical roles (AAUW, 1998).

Assessment tests must be developmentally appropriate, must be set in contexts that are familiar to the students, must not require reading skills or vocabulary that are inappropriate to the student’s grade level, and must be as free from bias as possible (National Research Council, 1996, p. 84).

Some studies focus on qualitative testing in science for assessing girls, thereby eliminating the cultural bias that exists in quantitative assessment. Sadler (1998) made some very enlightening suggestions on assessing students’ knowledge while studying student conceptions in science and learning. He found that
multiple choice tests, constructed from qualitative investigation of students’ conceptions of science, could be reliable and valid for assessing alternative ideas. He noted that:

.... The probability of choosing scientific answers surprisingly decreases with student ability before it rises to unity with high-level students. In this instrument one that attempts to test for student alternative conceptions [misconceptions], it appears that students at moderate levels of ability actually retreat from the scientific explanation. Students of moderate ability often find alternative conceptions increasingly attractive. The difference between the ability level of students who are guessing at answers and those who have mastered the concept can be thought of as a parameter that is related to the length of time it takes to learn the concept (p. 289).

Moreover, Sadler (1998) resolved that in order to eliminate gender bias in assessment, distractor-based multiple-choice tests should be created to help teachers diagnose student conceptions and measure conceptual change. He also suggested revising standardized tests by incorporating these distractors, conflicting views of students’ ideas versus scientific views, to fairly reflect the results. Using Project STAR curriculum which encourages students to construct their own knowledge about astronomy, test items were designed by searching for literature that researched children’s alternative conceptions of astronomy and also through students’ interviews and open-ended tests. They found that for some students prior ideas on astronomy were strengthened while for others ideas were abandoned for alternative conceptions that were more appealing.
To conclude, Sadler (1998) presumed that including nonmonotonic psychometric models, a measurement of mental processes elicited through testing, would be beneficial to girls for science assessment. Such models would include easy-to-score tests that emphasize conceptual understanding. He also confirmed that test results used by standards and curriculum developers should be the baseline for understanding science for any given grade level.

In that regard, Sanders, Koch & Urso (1997) clarify that traditional forms of testing can place girls at a disadvantage, especially when methods and content capitalize on skills boys are more likely to have than girls. From their studies, they concluded that females are better course takers than they are test takers. They suggest that gender differences in achievement may not be real but due to the testing process and not an indication of girls' lesser abilities.

Additionally, girls do not prefer competitive timed-test situations or tests that require decontextualized bits of memorized information. Boys tend to do better than girls with test items whose content and context favor male interests, refer less to women, or present women in stereotypical roles. Girls have more success with real-life application problems in mathematics, science, and technology and perform better with process skill questions rather than content-based ones (Sanders et al., 1997). Head (1996) notes “that males tend to be more hasty and impulsive in test situations while females exercise more care and deliberation” (p. 62).

In conclusion, qualitative assessment appears to be the most beneficial means of providing a reasonable judgment of girls' knowledge because it allows
girls to be reflective and non-competitive. It affords them an opportunity to espouse knowledge according to their own context. However, like standardized assessment, it too may be subjective and biased because interpreting its results can be strongly influenced by the values, beliefs and opinions of the evaluator. Teachers as interpreters and administrators of tests make judgments about the appropriateness of science content, observe student interest, and note the effectiveness of specific science activities (National Research Council, 1996). In the long run, it would appear that qualitative assessment considers girls’ style of learning more appropriately than quantitative assessment. Certainly, achieving equitable test taking tactics will point the way toward a narrowing of the gender gap.

**Method of Inquiry**

Not only does it appear that qualitative assessment considers girls’ style of learning but qualitative research also appears to generate a better understanding about women’s relationships and interactions with others (Olesen, 1994). For purposes of this investigation, the qualitative inquiry, an informing and guiding approach, is utilized to understand how girls learn science as they interact and engage in science discourse with other girls and boys. Denzin & Lincoln (1998) state that:

> Qualitative research is multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make
sense of, or interpret phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials—case study, personal experience, introspective, life story, interview, observational, historical, interactions and visual texts—the described routine and problematic moments and meanings in individuals' lives (p. 3).

In an educational environment, there are multiple benefits to utilizing qualitative research because it takes into account the human element. Typically, the researcher is the primary instrument for data collection and analysis, and the fieldwork occurs in a natural setting. It also employs an inductive research strategy (Merriam, 1998). In these three examples, concepts, models and theories are derived from educational, developmental, and cognitive psychology as well as sociology because data are collected from interviews, observations, and document analysis (Merriam, 1998; Newman & Benz, 1998).

Qualitative research is defined "as the basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways" (Guba & Lincoln, 1994, p. 105). On that basis, the following questions guide the context of this study.

Grounded on three interconnected queries, a method of inquiry asks the ontological, epistemological and methodological questions (Guba & Lincoln, 1994). The ontological question asks what is the form and nature of reality while the epistemological question examines what is the nature of the relationship between the knower and what can be known. The methodological question
surveys how the inquirer seeks out whatever she believes can be known (Guba & Lincoln, 1989, 1994) and will be further discussed in Chapter Three.

First, the ontological question warrants a brief explanation. It is defined as the "branch of metaphysics that investigates the nature of being and of the first principles, or categories involved" (Barnhart, 1963, p. 847). Ontology, then, asks what is or what is the nature of reality? According to Guba & Lincoln (1989), ontology is the study of what there is that can be known. In other words, to define ontology, one must consider that which exists in reality. As the researcher, I approach the world with a certain set of ideas based on my gender, class, racial, and cultural perspectives (Denzin & Lincoln, 1998) which may ultimately impact the research process. But this study also takes into consideration the nature of reality of the girls being researched and what exists within their realm of learning. In other words, how do they perceive the nature of science based on their gender, race and culture?

Second, epistemology is a study of the methods and grounds for knowledge, or a coming to understand the process of knowing. It is "the branch of philosophy which investigates the origin, nature, methods, and limits of human knowing" (Barnhart, 1963, p. 405). It asks how can we be sure that we know what we know. It is interactive, linking the inquirer to the inquiry (Guba & Lincoln, 1989) specifying "a set of questions that are then examined (methodology, analysis) in specific ways" (Denzin & Lincoln, 1998, p. 23).

In the case of this research, these are some of the following tentative questions to be asked: Ontologically, I ask: How do girls perceive the nature of
science based on their gender, race, and culture? Epistemologically, I ask: How do girls go through the process of learning science? Methodologically, I ask: Are there any behavior patterns observed in girls learning science as they engage in science discourse with other girls and boys? In other words, how do girls learn science when they are confronted with cultural and social issues inherent in their personalities and those of other girls and boys? How does it impact girls' understanding of scientific concepts, if at all?

Qualitative research also focuses on one subject, or one unit investigated over a period of time (Janesick, 1984; Newman & Benz, 1998; Yin, 1984). The researcher reflects on data and discovers patterns, which result in theoretical impressions built on prior hunches that produce new ideas and new concepts. These are then incorporated and explored (Richards & Richards, 1994).

Specifically, in this case, a small group of girls and boys are observed in a natural classroom setting as they hypothesize, discuss, and draw conclusions about fifth grade scientific concepts. From that vantage, the researcher watches students engage in science discourse and then looks for patterns of behavior that might affect learning. Thus, qualitative data is gathered and collected through detailed descriptions of situations, events, people, interactions, and observed behaviors. The researcher accumulates direct quotations from the participants and derives data related to their attitudes, beliefs and thoughts (Patton, 1990).

We can see that qualitative research allows the investigator to think reflectively, historically and biographically (Denzin & Lincoln, 1998), requiring data collection that is sensitive to an underlying meaning derived from interviews,
observations and analysis (Merriam, 1998). Merriam also attests that “qualitative researchers are interested in understanding the meaning people have constructed, that is how they make sense of their world and the experiences they have in the world” (p. 6). Theory is built from these observations as well as intuitive understandings. In that regard, qualitative research provides the best means of exploring, describing, discovering, and reflecting about how girls learn science in small collaborative learning groups with other girls and boys.

**Summary**

A review of relevant literature indicates that a gender bias exists within our culture. Societal norms and cultural cues inadvertently perpetuate a patriarchal society that affects girls everyday. From the moment of birth, many researchers have indicated that girls are compromised and exploited by society, demanding certain behavior from them in schools, at home, and at work.

Encouraged to learn by rules set by the power of man, girls may lose a sense of worth and fulfillment, contributing to a declining sense of self and low self-image and ultimately affecting their learning. Educators can address the needs of all learners by becoming cognizant during childrens’ early stages of development that girls learn differently than boys.

Similarly, studies indicate that girls are particularly deficient in science, apparently resulting from teacher attitude and expectation, curriculum stereotyping, and cultural bias in standardized tests. These forces impact
negatively on girls' self-confidence, helping to destroy an essential motivating tool needed to succeed in learning science concepts.

For this study, qualitative research is the method of inquiry chosen to investigate how girls learn science in a classroom setting as they engage in science discourse with other girls and boys. As an investigative approach, it affords the researcher the opportunity to reflect on girls' attitudes and beliefs as they interact in a given situation with their peers.

As the twenty-first century begins, suffice it to say that the need to effect gender equity is fundamental and rudimentary for the future of girls. Equity in education is thus a credible issue today and a concern for all people. By making a unified effort to diminish the omnipresent gender barriers of the preceding centuries, girls will develop the self-assurance to advance and proceed as positive contributors to society.
CHAPTER 3
METHODOLOGY

"The methodological question is answered by adherents of the constructivist paradigm by asserting that the inquiry must be carried out in a way that will expose the constructions of the variety of concerned parties, open each to critique in terms of other constructions, and provide the opportunity for revised or entirely new constructions to emerge—a hermeneutic methodology" (Guba & Lincoln, 1989, p. 89).

Introduction

According to Guba & Lincoln (1989), "methodology is best understood as the overall strategy for resolving the complete set of choices or options available to the inquirer" (p. 183). In this study, I propose to utilize qualitative research, which ensures that the researcher, eliciting information from all stakeholders, is the main instrument of data collection and analysis. The primary goal of qualitative research is to gain understanding and meaning from these data and to analyze it inductively (Merriam, 1998). Based on the constructivist paradigm, a theoretical framework, and implemented through fourth generation evaluation, qualitative research, for this investigation, provides the inquirer with opportunities to
discover how girls learn science as they engage in science activities with other
girls and boys, examining how extenuating circumstances affect that learning.

**Descriptive Plan**

Based on the data collected about girls' behavior in my pilot study, as presented
in Chapter One of this paper, I observed three girls and three boys, ages 10 and
11, in the fifth grade as they interacted and learned science together in a
collaborative learning group. Because of the culturally diverse population of my
classroom and in an attempt to represent that diversity, two Hispanic, two African
American, one White, and one Asian student participated and comprised the
collaborative learning group. During the course of the 1999-2000 school year,
the proposed time frame consisted of approximately 10 to 15 science lessons
spread over 180 school days which are established and mandated by the
Competency Based Curriculum, http://www.dcps.dade.k12.fl.us, and the
Sunshine State Standards, http://www.fim.edu/doe (see Appendix J). These
hands-on lessons, emphasizing science process skills, were taught twice weekly,
one 60-minute session and one 30-minute session, totaling about one and one
half-hours of science learning. The group met in the back of the classroom, a
portable structure located on the far-west corner of the school property, while six
additional collaborative learning groups met in the remaining space of the room
at the same time. Physical and life science content included such areas as
investigating animal and plant cells, electricity, magnetism, and forces of motion
(see Appendix J).
It is my intent to interpret and analyze the behavior and attitudes of these girls and boys by videotaping them, recording their conversations and photographing them as they collaborate in their learning group to explore and discover scientific concepts. One of the Hispanic girls, Margarite (pseudonym), my former third grade student and a participant in the pilot study, is the focus of this inquiry. The purpose is to review and observe her behavior and attitude during her participation in a collaborative learning group in third grade and compare it to her behavior and attitude in the fifth grade. I examined the evolution of Margarite's role as a stakeholder in each learning group as she enculturated into group learning. My aim is to address the following questions:

- How do girls, as stakeholders in collaborative learning groups, engage in learning science?
- How do girls interact with others in collaborative groups?

Margarite observed the videotapes of both her third and fifth grade groups learning science and was interviewed about her actions. Additionally, an attempt was made for her parents to view the videotapes to express their opinion about her behavior as she learned science with other girls and boys. All of the data was interpreted and analyzed.

Finally, all six members of the collaborative learning group answered a questionnaire (see Appendix F) submitted at the end of the school year in order to gain insight into their opinions about learning science with their peers.

As I reflect on the data collected in a real-life context, it is my intent to be open and flexible during the learning process. Because of the nature of
interviewing, an essential process for collecting information in this inquiry, it is possible that Margarite expresses an opinion that may lead to a different line of questioning, possibly altering the outcome of the interview. It is my plan to carefully listen to her to fully appreciate her motivation to behave as she interacts with other girls and boys. Equally, events, such as conflicts within the collaborative learning group or problems with the manipulatives used in learning science, may occur as the six girls and boys engage in science discourse. These events may change the lesson, resulting in altering how the lesson proceeds toward completion. Consequently, my students and I explore, discuss, understand, rethink, and redesign the study as it advances through the learning process.

Qualitative Research

Action Research

As Chapter Two explains, the method of inquiry to be utilized in this research project is qualitative research, based on a mix of designs such as action research and case study. Case study strategy is an empirical inquiry that investigates a contemporary issue within real-life context when the boundaries are not clearly defined, using multiple sources of evidence (Yin, 1984). However, Merriam (1998) originally defined it as “an intensive, holistic description and analysis of a single instance, phenomenon, or social unit” (p. 27) but later altered her beliefs by suggesting it is particularistic, descriptive and heuristic. Although similar to the case study design, my intent is to execute this investigation through action
research, defined more as spiral research, by observing how girls learn science as they interact with other girls and boys.

Action research is intrinsically bound and encompasses both methodology and methods for teaching. Kurt Lewin first coined the phrase and Collins & Spiegel (1995) described Lewin's definition:

...a spiral of circles of research that each begin with a description of what is occurring in the ‘field of action’ followed by an action plan. The movement from the field of action to the action plan requires discussion, negotiation, exploration of opportunities, assessment of possibilities, and examination of constraints. The action plan is followed by an action step, which is continuously monitored. Learning, discussing, reflecting, understanding, rethinking and replanning occur during the action and the monitoring. The final arc in the circle of research is an evaluation of the effect of the plan and action on the field of action. This evaluation in turn leads to a new action plan and the cycle of research begins anew (p. 117).

Thus, action research empowers teachers to engage in curriculum development and gives them the opportunity to improve education. Furthermore, action research is an educational innovation that intersects pedagogical awareness, research, development and evaluation, and classroom application (Berlin & White, 1998).

It is my belief that by undertaking this research, the results may lead to developing an appropriate curriculum that will better serve the needs of girls. The purpose is to also promote opportunities for girls to become co-learners.
where each is given the chance to express his/her views about science and the scientific world.

**Why Action Research**

Many teachers utilize action research to gain a better understanding of their students, and my objective is to implement action research to observe girls as they hypothesize and discover meaning in scientific concepts. Butler (1999) conducted action research with two biochemistry classes at a secondary school in order to emphasize real-life science and utilize an interdisciplinary approach. She concluded,

> I came to believe it was more important to teach students how to learn on their own than it was to teach them concepts. Was it really so important that my students didn't learn how to balance redox equations or learn to electroplate metals during this year? Not to me. The content did not mean as much as the process of learning (p. 17).

McGonigal (1999), as a teacher-researcher, also employed action research and describes the development of practices and perspectives of an elementary school teacher observing students as they collaborated to learn science content,

> Teacher-as-researcher was a dynamic format for me to learn how to develop a responsive curriculum that addressed the individual needs, concerns, and interests of a community of learners. Teacher-as-researcher was a tool for me to build a new classroom learning environment where students, teachers, and educational researchers were co-learners, co-teachers, and co-researchers (p. 16).
The benefits of practicing the dynamics of action research are described by Kielbom & Gilmer (1999) when they opine that action research also affords teachers the ability to conduct a practical inquiry in understanding contexts of study, teaching practices, and the development of their students.

**Theoretical Framework**

**Constructivism**

First, in order to understand the methodology of this project, it is important to discuss the lens, or theoretical frame, from which I view what is happening in my classroom. Based on the principles of constructivism, an epistemological perspective, it is a referent, which builds a classroom and stresses student learning (Tobin & Tippins, 1993). Guba & Lincoln (1989) summarize the methodology of the constructivist approach as being very different from that of the conventional inquirer. They affirm that the conventional investigator is linear and closed while the constructivist is "iterative, interactive, hermeneutic, at times intuitive, and most certainly open" (p. 183).

Defined as a naturalistic approach, constructivism has certain conditions. First, constructivism ensures that the evaluator is the inquiry instrument who collects data in a natural setting and focuses on educational issues that are perceived and experienced by people (Guba & Lincoln, 1989). The stakeholders of the naturalistic inquiry (students and teacher) grow and evolve into a community of learners (Tobin & Tippins, 1993) who work together, negotiate and reach consensual agreement.
Second, constructivism assumes that knowledge is built by all individuals from previous experiences and is constructed by making sense of these personal experiences in a social context (Driver, Squires, Rushworth & Wood-Robinson, 1994; Geelan, 1997; Tobin, 1993). In other words, a learner assimilates new information, reconciles, and connects it with previously constructed knowledge, which then becomes meaningful in view of a social context. Reiber (1993) remarks:

Central to constructivism is the idea that learning involves individual constructions of knowledge and occurs through the natural interaction with one’s environment or ‘culture.’ Constructivists assert that there is a direct relationship between learning and the degree to which the environment provides a rich source of engaging experiences (p. 197).

Third, tacit knowledge is another condition of constructivism in which the individual knows more than is expressed or openly communicated (Guba & Lincoln, 1989). Generally speaking, children know more than they convey in conversation. Bransford et al. (1999) confirm how children learn, “Although children learn readily in some domains, they can learn practically anything by sheer will and effort.... children lack knowledge and experience but not reasoning ability. Although young children are inexperienced, they reason facilely with the knowledge they have” (p. 100).

**The Foundations of Constructivism**

As stated, constructivism is the theoretical framework by which this research is conducted. The following three contemporary explanations serve as a guide in
understanding its foundations. They are contextual, radical and social. Geelan (1997) defines these divergent forms of constructivism and claims that each offers different thoughts about teaching and learning science. For Wilber (1985), the forms of knowledge are termed objective, subjective, and intersubjective while Kincheloe (1993), derived from the work of Habermas, defines them as technical, practical, and emancipatory.

Geelan (1997) explains that contextual constructivism is based on social influences and interactions, which he believes, do not form the complete context of the individual. For him, culture is a central force in development and learning. Notwithstanding, radical constructivists believe that knowledge is not transferred directly from the environment to persons, but is constructed actively within the mind of those individuals. He states that for a radical constructivist, "[a]ll knowledge is constructed for the purpose of enhancing survival through making experience meaningful" (p. 17). Furthermore, Geelan defines social constructivism, which is based on Solomon and Gergen's viewpoints. He relates that social constructivism is dependent on peer approval, recognizing that knowledge, through language use, occurs consensually in a social setting.

For purposes of this study, these three explanations represent the constructivist paradigm, a complex and multifaceted framework for viewing what transpires within a classroom. It is difficult to pinpoint or exactly state which one fits into this research project because each overlaps into another. Suffice it to say it appears that all three are entrenched in this inquiry model for various reasons. In that respect, contextual constructivism examines the role of culture
in learning while social constructivism elicits consensus in a social setting. In radical constructivism, knowledge is meaningfully constructed. Specifically for this study, girls and boys are observed learning science together in a collaborative learning group (social constructivism) engaging in science discourse while at the same time attempting to make sense of their new knowledge (radical constructivism) in order to build upon it. During the entire process, they are observed as they exchange cultural and societal perceptions about science (contextual constructivism).

**Establishing Collaborative Learning**

Because of the nature of constructivism in undertaking this inquiry, collaborative learning groups are implemented as a method for observing how girls learn science with other girls and boys. Establishing them in the classroom, a natural setting, lends itself to modeling a mini-culture in the classroom. Forming collaborative learning groups encourages a continuous circle of peer communication in reaching consensual agreement and optimizes students' experiences. At the same time, collaborative learning allows students to change previous ideas and beliefs and construct new and different understandings (Bruffee, 1993; Roth, 1993; Tobin & Tippins, 1993). Grennon-Brooks & Brooks (1993) concur:

> Accepting the proposition that we learn by constructing new understandings of relationships and phenomena in our world makes accepting the present structure of schooling difficult. Educators must invite students to experience the world's richness, empower them to ask their own questions and seek their
own answers, and challenge them to understand the world's complexities (p. 5).

Later in this chapter, the reader will understand that the formation of these collaborative learning groups adds credence to the methodology of fourth generation evaluation and the intent of this research.

Pertaining to this study, both girls and boys are expected to be responsible for their own learning. They are encouraged to be active participants not passive observers, listening to the dictates of a teacher. As they interact and exchange ideas to solve scientific problems in collaborative learning groups, they learn to share knowledge, build upon it and reconstruct it to a more sophisticated level. Driver et al. (1994) espouse these virtues, "Rather than seeing themselves as passive absorbers of information, pupils need to see themselves as actively engaged in constructing meaning by bringing their prior ideas to bear on new situations" (p. 7).

However, it must be noted that the girls under scrutiny each carry unique personalities, individual beliefs, and distinct perceptions about science and scientific concepts. As they participate and converse with others in their collaborative learning group, they construct new knowledge, which is based on prior experiences and cultural beliefs. When other girls and boys become a part of that learning environment, they, too, enter it with different personalities, beliefs, and judgments about science. As Matthews (1995) notes, children's ideas arise from direct sensory experiences of the world, participation in everyday social life and formal schooling. In other words, in the course of conversation, these girls
and boys create together new constructions of knowledge that become intertwined and interconnected resulting in generating a singular and unified belief.

Bransford et al. (1999) describe effective learning environments based upon recent research:

Effective learning instruction begins with what learners bring to the setting; this includes cultural practices and beliefs, as well as knowledge of academic content. A focus on the degree to which environments are learner centered is consistent with the evidence showing that learners use their current knowledge to construct new knowledge and that what they know and believe at the moment affects how they interpret new information (p. xvi).

Linn & Burbules (1993) further profess the benefits of collaborative learning, "in the course of...communication, students jointly negotiate understanding, plan complex tasks, explain things to each other, direct activities, contribute ideas, and coordinate actions with one another" (p. 92).

By providing girls with opportunities to engage in science discourse, the use of collaborative learning groups advocates accepting responsibility for learning while at the same time empowers them to seek solutions jointly with other girls and boys in their group. Bruffee (1993) promotes its worthiness:

Collaborative learning gives students practice in working together when the stakes are relatively low, so that they can work effectively together later when the stakes are high. They learn to depend on one another rather than depending exclusively on the authority of the teacher (p. 1).
For this investigation, problem solving techniques, critical thinking skills, and open communication promoted in such an environment ultimately benefits the learner and provides the tools to survive within the complex society of the future (Johnson & Johnson, 1991; Tobin, 1993).

As a result of utilizing collaborative learning groups, girls and boys have the opportunity to alter and construct new realities about science by simply exploring, discussing, investigating, hypothesizing, and inferring with each other. From that vantage point, they may choose to negotiate toward consensual agreement, thus enhancing their own learning.

**Fourth Generation Evaluation**

*Description of Fourth Generation Evaluation*

The methodology of fourth generation evaluation, a form of evaluation in which the claims, concerns, and issues of stakeholders serve as the basis for determining what information is needed, is grounded in the principle of the hermeneutic dialectic circle (Guba & Lincoln, 1989). Implemented within the methodological percepts of the constructivist paradigm, fourth generation evaluation empowers its stakeholders or participants and requires them to take into account the input of everyone in their group (Guba & Lincoln, 1989). In other words, the principles of constructivism set the stage to implement fourth generation evaluation.

For this study, fourth generation evaluation is the methodology that organizes the researcher to engage girls and other members of the hermeneutic dialectic.
circle to become committed stakeholders in the learning process. The hermeneutic dialectic circle is based on an open process of communication between stakeholders who hold certain constructions of knowledge and are willing to compromise and negotiate toward consensual agreement. In that respect, it is a mutual, empowering, and sharing process.

Throughout its course, participants exchange divergent viewpoints in order to accomplish a higher synthesis of those views (Guba & Lincoln, 1989). In that regard, girls and other participants in this investigation strive to form a collaborative view that may significantly be more sophisticated than previous viewpoints held by each member/stakeholder. Pertaining to these percepts, constructivism provides a theoretical frame for the researcher to observe and understand how girls in small collaborative learning groups learn science when they confront cultural and social issues inherent in the other girls and boys in the group.

**The Twelve Steps of Fourth Generation Evaluation**

The fourth generation evaluation is a tool that connects the constructivist paradigm to the methods of learning. It:

... is a marriage of responsive focusing — using the claims, concerns, and issues of stakeholders as the organizing elements—and constructivist methodology—aiming to develop judgmental consensus among stakeholders who earlier held different, perhaps conflicting, emic constructions (Guba & Lincoln, 1989, p. 184).

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The twelve basic steps of fourth generation evaluation are the guidelines for operating the constructivist paradigm, which is rooted in the hermeneutic dialectic circle. Although the following twelve steps are outlined and summarized sequentially, it must be noted that because of the nature of fourth generation evaluation frequent back and forth movement may occur between steps. This movement provides latitude for participants to be flexible and open-minded and at the same time, encourages them to honor the input of all stakeholders.

**Contracting**

Contracting is the first step of fourth generation evaluation. In that regard, I applied and was chosen to participate in a distance education doctoral program at Florida State University which was created through a joint effort between the University and Miami-Dade County Public Schools. Although I had some previous interest and knowledge about gender equity and the issues that girls face on a daily basis in home and at school, some of the requirements of needed coursework led me to further investigate the subject. Having conducted action research in my classroom (a requirement for one of my courses), observing children working together in collaborative learning groups, my interests were heightened and I began to openly suggest to my professors that that might be the direction of my research. We exchanged ideas and views about the possibility of pursuing a gender-oriented topic related to science learning and we soon negotiated and targeted the topic of my research.

As part of the contracting process, it was determined that my classroom would be the location of this investigation, representing a select group of 75
elementary girls and boys. Defined as a natural setting for learning, these girls and boys communicate openly, learning and teaching each other. As it proceeds, the climate develops into a mini socio-cultural environment consisting of norms and cues of a small society of individuals who work and live together cohesively.

It became obvious that what I wanted to learn about with regard to the gender issue was not specific enough and that I had to be more focused. It proved to be the most difficult task to achieve because of the amount of research already available on the subject and my own self-interests. Together with my major professor, Penny J. Gilmer, we collaborated and exchanged views and shared viewpoints. Since I had conducted a pilot study observing students in collaborative learning groups and my teaching had evolved into a constructivist framework, we agreed that implementing collaborative learning would be an essential ingredient for the study.

It was decided after much discussion that instead of attempting to observe several groups of students at the same time, the most beneficial direction would be to focus on one collaborative learning group comprised of six students, three girls and three boys. The concentration would be to observe how girls learn science, rather than any other subject, as they are engaging in hands-on science activities in small learning groups with other girls and boys. This was achievable because my students felt comfortable learning in a setting that promoted science discourse and were accustomed to collaborating with each other. I organized a tentative schedule, which enumerated the time and day of the lessons, and I also listed possible problems.
One of the major issues was to define the structure of the proposed collaborative learning group. I decided that it would be beneficial for the outcome of the study to define the ethnicity of the group based on a representation of the population of the class. Consequently, the collaborative learning group consists of two African American, two White, and two Hispanic students. At first, I considered forming the group with only four students but after much consideration and discussion with members of the hermeneutic dialectic circle, which included student input, I decided to select six students to participate. I felt that this number would provide more avid and animated science discourse, facilitating the observations I intended during the course of the investigation.

Additionally, it seemed important to include a previous student that I had taught in third grade who had been a participant in the pilot study. I chose a student who had previously demonstrated leadership qualities (Goddard, 1990; Kaye, 1998; Kerfoot, 1998) in group learning during that school year, allowing for a comparison of her current behavior and attitude toward science with others in the fifth grade group. I selected her and the other students because they represent the four different ethnicity groups of my fifth grade student population. Finally, I decided that there would be equal representation of girls and boys in the collaborative learning group in order to afford every individual the opportunity to fully share their ideas during the learning process.

Yet another problem was deciding on the optimum location for the group within the classroom. After much discussion and thought, the group was situated at the farthest space in the back of the room, as isolated as possible from their
31 peers, to allow for the privacy that they required to openly express their views. This would also permit them to have greater freedom of movement given the limited working space within the classroom. After completing these last hurdles, I embarked on my research.

**Organizing**

As the principal evaluator, I organized my research based on an evaluation that centered on how fifth grade girls learn science. I had to learn about and practice my skills as the primary instrument for data collecting, achieving it by carrying out a pilot study first with my third grade students two years prior to the project and second with my fifth grade students the succeeding school year. Through those investigations, I learned how to observe my students as they engaged in science discourse specifically listening to their conversations as they discovered scientific concepts together by manipulating science objects to solve scientific problems. My objective was to experience new situations firsthand by practicing the skills of observing and listening to my students in such situations as examining cells in microscopes, creating edible plant and animal cells, and designing series and parallel circuits. As Guba & Lincoln (1989) suggest,

> One way to throw oneself into as many new situations and environments as possible, the purpose being to gain experience and exposure. The other way is to actually practice, in a clinical or training situation, with an expert qualitative inquirer...to practice doing interviews, to practice observations of various sorts, to practice listening skills...(p. 197).
As the pilot study progressed, my students worked toward building trust with one another and I noticed that their conversations became more candid and open. That trust was eventually extended to me, the teacher. It appeared to be more obvious with the fifth graders and I based that assumption on their age, attitude and level of experience. On the other hand, from the onset of implementing collaborative learning groups, the third graders generally seemed more animated and forthright even though it took more than half a school year to achieve salient group learning with them as opposed to the fifth graders (Greenspan, 1999). As a consequence, once I established trust within the classroom setting, trust also appeared to spread between the other stakeholders involved in my research and we became more frank and straightforward in our conversations about the claims, concerns, and issues of the investigation.

**Identifying stakeholders**

Essentially, I formed a circle of stakeholders, defined as "persons or groups that are put at some risk by evaluation" (Guba & Lincoln, 1989, p. 201) with the intent of establishing an educative and open process that builds upon a more sophisticated reconstruction of knowledge. There are many persons included in my circle of stakeholders. They are:

The four members of my Dissertation Committee:

- Dr. Penny J. Gilmer, Professor of Chemistry and Major Professor
- Dr. Nancy T. Davis, Associate Professor, Department of Curriculum & Instruction
- Dr. David F. Foulk, Chairperson and Professor, Department of Curriculum & Instruction
Dr. Fred L. Petrovich, Professor of Physics

Administrators at David Fairchild Elementary Schools:

Mr. William Kinney, Principal

Mrs. Sara Martin, Assistant Principal

Teachers at David Fairchild Elementary School

The 35 students and parents of Fifth Grade, 1999-2000

Teacher's Aide

Research Assistant

University of Miami student

University of Miami Professors:

Biology, Anthropology, and Chemistry Departments

Florida State University's Institutional Review Board (The Human Subjects Committee)

Jeff Shimonski, Director, Parrot Jungle

Dr. Sian Evans, Professor and Executive Director, DuMond Conservancy, Monkey Jungle

Initially, I formalized a written contract to the Human Subjects Committee at Florida State University requesting permission to videotape students as they learned science with the intention of allowing them to observe the video and view themselves at a future date (see Appendix F). Two consent letters were additionally submitted (see Appendices D, E) for approval to be given to both parents and students requesting consent to conduct research in the classroom and observe girls and boys learning science together. Also approved by the
principal of David Fairchild Elementary School, these letters additionally granted permission to survey students' opinions about learning science. It was agreed that all information would be based upon my interpretation of the data by consolidating fourth generation evaluation techniques.

**Developing within group-joint constructions**

The hermeneutic dialectic circle is a process of communication that promotes mutual exploration and strives to reach consensus through expressing divergent viewpoints. It is circular in nature, occurring in a natural setting while utilizing qualitative methods for evaluation although quantitative strategies may be implemented, too. There is also continuous interaction among the participants, shaped and tested by negotiation. Discovery and verification are perpetually interwoven allowing other inputs to enter. The constructions of the participants are constantly changing and recycled until a joint construction is reached (Guba & Lincoln, 1989). The authors profess,

> While each respondent may have started with a somewhat different personal (emic) construction, the process is such as to expose each such personal construction to the criticism of others, and to require each respondent to take account of the constructions of others, having to come to terms with them (p. 208).

It is the intent that a hermeneutic dialectic circle, which is continuous and connected, would evolve among the girls and boys of the collaborative learning group under study, linking them toward a common goal. In the process, it is expected that my construction or previous knowledge would also be altered as
well as the students' conceptions of science content. During the course of events, I realize that I am becoming a collaborator and negotiator with them. I also realize that my role as a teacher is changing as I guide toward understanding scientific concepts. In reality, I provide some structure, such as arranging the girls and boys into a collaborative learning group in addition to providing the hands-on tools for learning to enhance their science learning. Throughout the process, I promote the curriculum mandated by Miami-Dade County schools, but as I begin to observe the students I notice they go beyond what is required of them. In other words, they show signs of learning new science knowledge that appears to be relevant to their world and expand upon it.

Throughout the early stages of the process, I notice that the more the children are given opportunities to explore and discover with each other, the more independent they become and, thus, my role changes to meet their needs. My lessons change at the moment of instruction and I am not really the teacher in the conventional way. I learn to step back and be flexible to allow them the space they need to inquire together openly, ready to accept modifications to their constructions. I encourage them to focus toward consensus. At some point, I hope they intuitively begin to reach towards acceptance of each other's viewpoints, while altering their own perceptions about science.

It must be noted that new respondents are constantly added to our hermeneutic dialectic circle. Some of the respondents may enter or reenter into the circle temporarily, adding knowledge, reconstructing it, causing a spiraling effect. For example, I am regularly a part of the circle as the primary data.
collector along with the chosen group of girls and boys who form the basis of the research. On the other hand, parents, administrators and Dissertation Committee members, university professors and others may participate in our hermeneutic dialectic circle from time to time to identify existing information or add new knowledge.

*Enlarging joint stakeholder constructions through new information/increased sophistication*

At this stage in the process of enlarging joint stakeholder constructions, I begin by just observing girls as they interact with other girls and boys, noting patterns in their behaviors and attitudes. I ask questions about that behavior and then I rethink the answer, simultaneously preparing yet another question from what I have gleaned. In other words, as the process proceeds, I am constantly interpreting what I perceive to be and realize that there is more to know.

At this point, I examine and critique other research studies, which center on girls' behavior and attitudes. I read professional reviews about the plight of girls in society. I learn about gender stereotyping, traditional societal expectations, and educational shortcomings that appear to fail girls in their pursuit of careers in science. I also gather input from other hermeneutic circles from local university professors who help judge the Annual Science Fair at David Elementary School. The input extends to include parents who participate in the three Science Evenings offered during the school year. I learn even more from the special area teachers who know my students firsthand and teach them other subjects throughout the school day.
Additionally, electronic E-mail serves as an excellent tool among all participants/stakeholders of the hermeneutic dialectic circle to disseminate information on a regular basis, express opinions openly, and share a steady stream of data. The experience broadens my views about girls, helping me to reconstruct what I previously believed about girls learning science.

**Sorting out resolved claims, concerns, and issues**

In the sixth step of fourth generation evaluation, the claims, concerns, and issues are temporarily sorted and resolved until other claims, concerns, and issues surface. In this study, some claims, concerns, and issues have been resolved while others remain unresolved.

First, the direction of the research has changed significantly from its original intent. Formerly, it was my intention to collect data about how girls learn science with the seven collaborative learning groups established in my fifth grade class. However, as data collecting progressed, it appeared that it was a task far too difficult to accomplish because I am not available every minute during the lesson to observe and listen to the discourse of each group. As the teacher, part of my responsibility is to guide the students in their quest to understand scientific concepts, and I have to be accessible to meet the needs of all the students. Therefore, after conferring with members of the hermeneutic dialectic circle, we agreed that only one collaborative learning group would be evaluated. We also agreed to employ a clinical observer from the university to record students' comments during the learning process and to help videotape the collaborative
learning group, giving me more opportunities to interact with all the students in the class.

Second, since the entire class works on an experiment at the same time, the noise level can be deafening, preventing the data collector from hearing complete conversations of the chosen group. We resolved that issue by using an Omnidirectional Dynamic Microphone by Optimus purchased at Radio Shack that has the features to pick up the sounds and comments from the girls and boys under observation. For every lesson, the microphone is placed in an unobtrusive place on the table closest to the collaborative learning group. Students are requested to disregard its presence, although that proves difficult for some of them who occasionally shout into it.

Another issue deals with the survey created to procure girls’ opinions about science learning. My aim is for girls to respond genuinely and honestly about their feelings but some of the questions appeared to be too broad and expansive. Making some minor grammatical changes and refining the questions has improved the survey but throughout the investigation, I continually focused on them to secure the best possible response from the students.

*Prioritizing unresolved items*

In an attempt to prioritize unresolved items, several are considered. Of primary concern and classified as high priority is communication between stakeholders. As a long distance learner, the hermeneutic dialectic circle interacts through electronic mail, telephone contact, and occasional meetings. Although these means of communication do allow for sharing constructions and information,
there are some disadvantages. Because eye-to-eye contact is rarely achieved except for a few scheduled meetings, it is difficult for the stakeholders to 'read' body language during discourse, an important element in interchange. Another disadvantage is not being able to have immediate and constant access to all members of the circle due to the complexities, responsibilities, and constraints of their normal activities.

Another unresolved item of high priority is the collection of data from the collaborative learning group. Finding it difficult to hear the considerable and meaningful discourse between participants of the group, a university student experimented with many different methods to record conversations, a salient issue for determining reasonable outcomes to the study. Although it may be impossible to resolve this issue, many of the stakeholders of my hermeneutic dialectic circle continue to share their views in an attempt to reach a solution.

Another notable issue is videotaping students as they begin to interact in organizing themselves in a collaborative group. Initially, they must choose a job either to be a manager, assistant manager, materials manager, recorder, reporter or member. At that stage in the process, it is vital to observe how they exchange dialogue and what process they devise to determine who performs which job. However, as the coordinator of the session for the entire class, it is impossible to be at two places at once. Trying to resolve the issue, I have employed various methods, such as peer tutoring, to solve the problem without success. In other words, videotaping the students as they begin this initial stage of group interaction remains unresolved.
Collecting information/achieving sophistication

In terms of achieving sophistication and learning more about the subject on how girls learn science, I consistently investigate existing literature to learn from other researchers. I share it with other members of the hermeneutic dialectic circle who also openly discuss their knowledge, adding further input. The result is a more practical outlook on the topic and helps me as the primary investigator to focus on the task.

In this case, during the learning process, I continually strive to accomplish a more complex understanding about girls learning science by collecting, compiling and analyzing information. As a result, I have written several papers that have been presented to other teacher-researchers and educators. The first, *Learning Science with Action Experiments, As Seen Through the Eyes of a Teacher* (Greenspan, 1998) investigates how children learn in collaborative learning groups, and the second, *A Community of Learners: Linking Scientific Patterns of Life* (Greenspan, 1999, March) addresses how children can predict, observe, and relate the formation of sequential patterns in the nature of science. Both were presented to the National Association for Research in Science Teaching (NARST) over a period of two years. The third, *Scientific Inquiry: A Journey for a Teacher and Students* (Greenspan, 1999) is a chapter published in the SERVE Monograph, which examines how my students and I evolved into a community of learners.

As each phase progresses in this research, my preconceived knowledge about the girls and boys and the dynamics of the study are constantly being
challenged and altered. I define each issue, claim, and concern as it occurs and
I notice that we became a community of co-learners. My basic premise is: I knew
what I did not know and I want to know more. The students, too, are in a
constant state of inquiry just as I am, altering previous knowledge and building
towards a more sophisticated level.

Specifically, in qualitative research, the inquirer collects data in a natural
setting over a period of time. It is my intention to collect data about how girls
learn science by listening and observing them while they work with other girls
and boys in collaborative learning groups. I observe and videotape them
interacting in small collaborative groups with other girls and boys and tape record
their conversations, transcribing them immediately following each twice-weekly
session. I also submit a midyear and end-of-the-year questionnaire to all
students. In all instances, I interpret, examine, and analyze girls' behavior and
learning patterns.

First, girls and boys are videotaped while learning physical and life science
concepts during their twice-weekly science classes with hands-on activities,
emphasizing science process skills. Action experiments are implemented to
learn science content, based on the Competency Based Curriculum,
http://www.dcps.dade.k12.fl.us, and the Sunshine State Standards,
http://www.firm.edu/doe, mandated by Miami-Dade County and the State of
Florida (see Appendix J). The students are required to manipulate objects and
engage in dialogue while trying to find solutions to scientific problems.
The goal is to note any patterns in behavior that occur between girls and boys engaged in science learning and if verbal or nonverbal interactions between them affect how girls learn science. Because there are many forms in which students interact, verbal and nonverbal language is examined. A computer qualitative software program, QSR NUD*IST 4 (Qualitative Solutions & Research Pty Limited, 1997), is utilized to help me organize the information I collect from observations completed during the school year. I videotaped girls and boys learning about plant and animal cells, electricity, magnetism, and forces of motion. I have also recorded their conversations at the moment of learning, approximately 10 hours of data. I have further submitted a mid-year questionnaire (see Appendix F) to every girl and boy in the class to gather their opinions on learning science in collaborative learning groups with other girls and boys. The dialogue and context of students' opinions has been formatted into the computer qualitative software program with the initial result of creating categories and indexing data that hopefully explore patterns into girls' behavior.

Second, there is a matter that has not been formalized within the context of the evaluation. Presently, it has been decided, after much negotiation, that a questionnaire would be an excellent approach to gain a better understanding on girls' thinking and behavior as they learn science with other girls and boys. Their opinions about the teaching and learning of science are gathered in a written survey that contains thought-provoking questions. These written questionnaires are answered by girls' and boys' to extrapolate their opinions about scientific
concepts learned in fifth grade and were submitted at the end of the first semester and at the end of the school year. The following are the questions:

- Do you like working in learning groups?
- Do you like working with girls or with boys in learning groups?
- How do you like to learn science? By yourself, with a partner, or in a group?
- What ideas did you learn about plant and animal cells? In the forces of motion? In electricity? In magnetism?
- How do you learn science best?
- Is there anything I can do to help you learn science better? (given midyear, only)
- Do you like having a special job in your learning group?
- What special job do you like the best in your learning group? Why do you like that job the best?
- Do you ever have any conflicts in your group? If so, what are they? How do you resolve your differences?

As noted previously, data are compiled, indexed, coded and interpreted with the assistance of the QSR NUD*IST 4 computer software program.

However, it is recognized that an additional survey to gather opinions of parents, if time permits, might also be crucial to understanding what their children believe to be valuable. Unfortunately, as the year progressed, it was impossible to create another questionnaire designed specifically for parents’ opinions. This would have further granted the stakeholders of the hermeneutic dialectic circle an
opportunity to develop a more sophisticated construction of knowledge about how girls learn science, allowing them to become more open to alternatives.

**Preparing the agenda for negotiation**

As Guba & Lincoln (1989) relate, preparing the agenda for negotiation consists of a series of activities outlined by the evaluator. In my case, I have defined the claims, concerns, and issues related to how girls learn science in collaborative learning groups, and I have provided valuable background information to connect different constructions. By doing so stakeholders are prepared to share and anticipate negotiation of the agenda.

**Carrying out the negotiation**

In terms of negotiation, I have observed the existence of several hermeneutic dialectic circles, which form the basis for the process of understanding how girls learn science. As the facilitator and chief mediator, I form a hermeneutic dialectic circle with my Dissertation Committee members. Another circle is built between the girls and boys of the collaborative learning group. Additional circles are created between the parents of the girls and boys under observation and administrators of the school, as well as between members of a local university. As the key stakeholder I provide a common thread that binds these circles together causing them to overlap in an effort to achieve an exchange of ideas and gain knowledge about the issues. As a result, we strive to reach consensual agreement.
**Reporting**

For purposes of this step, I submit a case study report on how girls learn science, deriving data from several sources. In reality, the case study is a construction of knowledge, furnishing the reader with a vicarious experience that concentrates on the way a particular group may confront problems holistically (Denzin & Lincoln, 1998; Merriam, 1998).

First, the results of a questionnaire expressing the opinions of girls about science learning are weighed, interpreted, and recorded. Second, the oral conversations elicited among members of the collaborative learning group as the three girls and three boys engage in solving scientific problems are transcribed, analyzed, and reported. Third, all the film from videotaping students as they interact in solving scientific problems is viewed, analyzed, and at some future date will be edited into a short video presentation. Finally, as each lesson is completed, I record my observations, feelings, and reflections into a journal. These impressions are compiled, interpreted and examined.

**Recycling**

While this investigation is ongoing, considerable new information is constantly surfacing describing differences in girls' behavior. For example, a recent report from AAUW (Haag, 1999) cited the viewpoints of adolescent girls on such issues as popularity, peer relations, sexuality, and peer hostility. The report challenged and identified a monolithic perspective of groups of girls by race and ethnicity, adding insight into how girls learn to be resilient in what they perceive to be obstacles. Based on this current research, I must always reconsider the claims,
concerns, and issues that erupt from adding new information and make it available to those in the hermeneutic dialectic circles through telephone conversations, informal meetings, and electronic mail messages. As Guba & Lincoln (1989) profess, “Fourth generation evaluations never stop; they merely pause” (p. 226).

Conclusions

In conclusion, Guba and Lincoln (1989) purport that the essence of the constructivist paradigm is the fourth generation evaluation, a twelve-step process that leads to a sound evaluative product. This process flows from the theoretical framework of constructivism to the methods that apply the essential qualities of constructivism. Although the procedure may be long and tedious, assuming a forward and sometimes backward movement, it, in reality, generates an assessment product that empowers all those that participate in its formation.

They conclude:

The reader should not fail to note the resonance between an inquiry paradigm that proposes a hermeneutic/dialectic methodology and an evaluation model that depends exactly on such a process to substantiate its claim of responsiveness. Responsive focusing calls out for a constructivist methodology, and constructivist methodology fits exactly the inquiry process needs of responsive evaluation (p. 44).
Qualifications to Utilize Fourth Generation Evaluation

Teacher's Background

As an educator for the past 25 years, I have had many experiences, which impact my professional growth as a teacher. In the early years of teaching, I was an elementary school teacher in a large urban school system followed by two years in the Peace Corps in Peru, where I developed and taught methodology courses at the college level. Upon returning to the United States, after an eight-year hiatus, I earned a Master's Degree in Bilingual Education and continued teaching at the elementary level. For the next eight years, I created and implemented a special oral-based program for teaching Spanish to Speakers of Other Languages (SSL), adapted from the Rassias Method (Dartmouth College). The process incorporated the schoolwide use of a bilingual science laboratory and bilingual computer laboratory. During this stage of my teaching, I developed and implemented new curriculum.

Originally, as a new teacher, I taught in a center-based environment, which provided students with opportunities to work together creatively. As I gained experience and confidence, I matured into a more imaginative and innovative instructor and became known as a risk-taker among other educators.

During this phase of my career, I was chosen as an Urban Systemic Initiative (USI) Teacher Consultant for Miami-Dade County Public Schools to help other county teachers instruct science content. At the same time, I continued my
responsibilities as a classroom teacher, always observing my students in an effort to improve my style of teaching.

Fortuitously, through my doctoral studies at Florida State University and my experiences in the classroom, I began to evolve as a teacher-researcher. By viewing my students in this way, I recognized that my approach towards teaching had begun to change. I started to emphasize collaborative learning among my students and I also began to collaborate with them. We became a community of co-learners as my role diminished from the bearer of all knowledge to a resource of information, thus impacting the pedagogical techniques I had previously implemented in the teaching of science.

Throughout this research I notice that the lens from which I view the happenings in my classroom is far different from when I started the study. I am learning to follow the twelve steps of fourth generation evaluation by identifying myself as the sole evaluator, providing my credentials to my students and making them aware of the purpose of this inquiry by distributing permission letters. Signed by both students and their parents at the beginning of the school year, these letters were previously approved by the Human Subjects Committee at Florida State University. These letters include a statement of confidentiality and an agenda/timeline.

Are the Methods Tenable?

Qualitative research is a naturalist approach, which provides opportunities for an individual or individuals to collect data and derive conclusions inductively. It assumes that a theory emerges from data, collected to test a hypothesis.
However, in reality, theory does not emerge independently of the person who interprets the data (Newman & Benz, 1998). Keeping in mind that this is a possible limitation of qualitative research, to be discussed in Chapter Four, it still affords the researcher the opportunity to conduct the study in a natural setting, an important element for this inquiry. Also relevant for this investigation, is the role of the researcher who attempts to interpret situations and make sense of them in terms of the meanings that people bring to them (Denzin & Lincoln, 1998). In that regard, I observe girls and boys as they learn science together in a classroom setting during the course of a school year and attempt to draw conclusions from what they do and how they explore and discover together.

Constructivism, grounded in qualitative research, is a theoretical framework that exposes the constructions of many different participants and provides opportunities for each to critique the other in their quest for seeking new constructions (Guba & Lincoln, 1989). In that view, constructivism and the hermeneutic dialectic circle, a process of open communication that strives to develop joint constructions, gives ample opportunity for all the respondents in this study to be forthright, honest, and expressive.

However, in a constructivist setting, it is assumed that the teacher is open-minded, flexible, and interpretive. It also presumes that the teacher encourages and accepts student autonomy and initiative (Grennon-Brooks & Brooks, 1993). In other words, students may be the driving force in setting the stage for learning, sometimes causing the teacher to shift her style of teaching. In a constructivist setting, the teacher's role is to guide the students, focus their questions and 96
supply topics that motivate them and encourage them to take responsibility for learning. Although it may be difficult for some teachers to give up the control afforded them as "master" of the classroom, the implementation of constructivism best serves the needs of girls, the basis of this research, because it furnishes them with opportunities to discover, explore, and express their ideas openly.

Implemented through a constructivist paradigm, fourth generation evaluation is an evaluative tool that connects the constructivist approach to the methods of learning. It assumes that by following the twelve steps, operational guidelines, all the respondents are willing to communicate toward a common goal of resolving certain claims, concerns, and issues. However, it is a complex task that requires everyone to make a concerted effort toward success. It is my belief that in this case, each participant is intrinsically interested in understanding how girls learn science and therefore are amenable to execute and achieve consensus.

One of the methods of learning employed for this inquiry is based on the existence of collaborative group learning. In Chapter One, it was established that girls and boys learn differently (AAUW, 1998; Haag, 1999; Head, 1996). Girls learn better in a social environment that is conducive to building their self-esteem, where they are comfortable to confront ideas and have the opportunity to explore challenges (Kahle, 1989, 1996; Linn & Burbules, 1993; MacDonald, 1995; Mann, 1994; Mason, 1995). Collaborative learning mimics that kind of learning atmosphere, but it also assumes that girls have equal opportunities to participate during learning with boys because they enter into that learning group with the advantage of being on equal terms. Because of children's natural
curiosity, most of the time they discuss issues, accepting or rejecting others' viewpoints. Thus, collaborative learning is an effort in which group interactions render the participants the opportunities to negotiate differences of opinion that may result in a consensus (Tobin & Tippins, 1993).

However, another supposition assumes that by forming a collaborative learning group, girls and boys will automatically share knowledge and exchange ideas successfully. Placing socially unskilled students into a group does not necessarily guarantee that they will collaborate. "Persons must be taught the social skills required for high-quality collaboration and be motivated to use them..." (Johnson & Johnson, 1991, p. 58). Therefore it rests on the teacher, to promote a collaborative, interactive learning environment built on mutual respect and trust.

For this inquiry, constructivism, a naturalistic paradigm rooted in the ideals of qualitative research and implemented through fourth generation evaluation, is a tenable methodology that provides girls with the chance to share their knowledge as they explore and discover scientific concepts. For this investigation, the principles of constructivism provide the inquirer with opportunities to learn how girls discover science as they engage in science activities with other girls and boys, examining whether or not extenuating circumstances affect that learning. It is through these precepts that girls can build their self-esteem which is crucial for reaching their potential as science learners.
Summary

The focus of my study is explained in terms of qualitative research, which centers on process and meaning. It is descriptive in nature and data are collected in the words of the participants, interpreted through descriptions of the researcher. Merriam (1998) alludes to its benefits:

[Qualitative research] is an effort to understand situations in their uniqueness as part of a particular context and the interactions there. This understanding is an end in itself ... to understand the nature of that setting—what it means for participants to be in that setting, what their lives are like, what's going on for them... (p. 6).

Constructivism, a methodology and theoretical frame, which emphasizes learning through dialogue and interaction among its participants, is the basis for this research. By incorporating the hermeneutic dialectic circle, a circle of interaction, the process of learning is facilitated in collaborative groups when students engage in discourse with hands-on activities to learn science content. Finally, the ideals of constructivism are consolidated in fourth generation evaluation, an evaluative process based on twelve steps that unite a community of learners in moving toward a sound and viable outcome.
CHAPTER 4

LIMITATIONS

"Research outcomes are of no value if the methods from which they are derived have no legitimacy" (Newman & Benz, 1998, p. 27).

Introduction

The basis for this study, a constructivist inquiry, incorporates fourth generation evaluation, which consolidates the ideals of social constructivism. We may judge its viability by establishing certain quality criteria or standards to ensure a feasible investigation, whatever the context of the inquiry or the nature of the evaluative tool. Under the guidelines established for fourth generation evaluation, appropriate standards are essential for judging quality and goodness. By identifying these standards, fourth generation evaluation becomes both valuable and viable (Guba & Lincoln, 1989).

Parallel Criteria

Judging the goodness or quality of a research project depends on parallel criteria, only if you use positivism as a basis. Parallel or foundational criteria, derived from the positivist's perspective, are based on external and internal
validity, reliability, and objectivity. The positivists believe that external validity relates to how an inquiry could be applied to another context or subject. Internal validity asks how research findings match reality (Merriam, 1998). Reliability expresses consistency, predictability, stability, and dependability of a research study. Finally, objectivity posits neutrality, a freedom of bias and prejudice (Guba & Lincoln, 1989).

Although designed through the positivist lens, these criteria are incorporated into parallel criteria and modified for a constructivist inquiry to make it more meaningful. Guba & Lincoln (1989) profess, "...we set about to develop a set parallel to those conventional four, staying as close as possible to them conceptually while adjusting for the changed requirements posed by substituting constructivist for positivist ontology and epistemology" (p. 236). Thus, for purposes of this inquiry, the following criteria or strategies (Guba & Lincoln, 1989; Newman & Benz, 1998) add credence to my research, which investigates how girls learn science as they interact with other girls and boys in a collaborative learning group. Based on conjecture, these criteria help me to assess the value of my research.

**Credibility**

Do I, as the evaluator, liken students' beliefs about science to my own experiences about learning science? Guba & Lincoln (1989) specify that credibility is,

...instead of focusing on a presumed 'real' reality, 'out there' the focus has moved to establishing the match between the constructed realities of
respondents (or stakeholders) and those realities as represented by the evaluator and attributed to various stakeholders (p. 237).

The focus for this study is grounded on how girls in a collaborative learning group react and express attitudes toward learning science as they engage in science discourse with other girls and boys. As both the girls and boys proceeded through the process of learning science, they communicated with their peers and shared ideas, constructing new realities about many things. For instance, they built constructions on science in general and also on particular scientific concepts as well as ideas about each other and about themselves. At the same time, their previous experiences and those of the other stakeholders, including myself affected how they learned. As the evaluator, I took into account the students’ constructed realities with my own preconceived notions about how girls learn science along with those that I gleaned as a stakeholder and member of the hermeneutic dialectic circle. By identifying some of these factors, we lend integrity and credibility to the study.

**Neutrality**

Are judgments based on my opinion? Are those judgments consistent? How many observers are there for this investigation? In responding to these questions, I attempted to limit my personal judgments by utilizing the QSR NUD*IST 4 computer program, which allows me to sort, index and categorize data and systematically arrange it.

By employing the aid of a university intern and a classroom aide, I was not the sole spectator but part of a team who observed girls learning science,
particularly my student, Margarite (pseudonym), as she interacted with other girls and boys in a small collaborative learning group. While my task was to analyze and interpret data as objectively as I could, it is possible that there may have been indicators of personal prejudices based on my own values and beliefs. To the degree feasible, these will be identified and discussed.

**Prolonged Engagement**

Have I had enough involvement at the site of inquiry? I have established a trusting and easygoing rapport with Margarite since the third grade when I also had the opportunity to be her teacher. We have an unconstrained and relaxed relationship that has developed and evolved through mutual respect over the past three years. She is open and honest with me about her feelings. On the other hand, I have only known the other members of Margarite's collaborative learning group for one year but they all appeared interested in expressing viable and creative opinions about learning science.

**Persistent Observation**

Was there depth to the scope of the issue? Was there sufficient observation to understand how girls learn science when they interacted in science discourse with other girls and boys? It must be noted that the collaborative learning group was observed over a period of one school year of which five of its members have only been my students for fifth grade. In the long run, this may have been a cause for concern in assessing the credibility of the research because there may have been insufficient knowledge about the personalities of the subjects.
On the other hand, Margarite, the targeted subject of the case study, was a previous student of mine in third grade and participated in the pilot study completed two years prior to this inquiry. Thereafter, Margarite and I together watched third grade videotapes to observe her working in science with her then peers, and we were able to compare her behavior at that time to her demeanor in the fifth grade. This persistent and long-term scrutiny afforded some additional depth for evaluating the problem under investigation.

**Peer Debriefing**

Were preliminary findings and tentative analyses discussed with a peer? Did that peer ask me probing questions to help me understand my values and my role in investigating how girls learn science as they interact in a small co-sexual collaborative learning group? Certainly, I enjoyed a meaningful exchange throughout the study with my major professor, Penny J. Gilmer, and other members of my Dissertation Committee, which helped to facilitate the emergent research design. Additionally, my husband provided further insight into my writing, which helped me during the process to compile my thoughts into a reasonable and legible piece of work.

Moreover, I submitted preliminary findings of my study in a paper presented to the National Association of Research in Science Teaching (NARST) Conference, New Orleans, La., (Greenspan, 2000). Colleagues from around the world and I exchanged meaningful discourse about similar studies on girls learning science, many of these investigations focusing on girls at the secondary school level. Colleagues posed the following questions: "Are significant
differences apparent between girls and boys as they learn science together at the elementary school level?" "How do cultural and social factors play a role in learning science in elementary school?" "Are gender differences apparent in eleven year old girls and boys as they learn science?" These types of questions elicited from other researchers provided feedback that helped me to rethink and redirect the focus of this inquiry as it emerged into a sound investigation.

**Negative Case Analysis**

Has the premise that social and cultural factors impact girls learning science been revised and refined? Are there examples in the study that do not fit into my premise? From the onset of this study, many issues were considered resulting in a broader base of questioning in the interviews conducted with my students. As Guba & Lincoln profess, "...the qualitative data analyst ought not to expect that all cases would fit into appropriate categories" (p. 238).

One female student, in particular, reacted positively to questions about the way the boys treated her as a girl in their collaborative learning group. She conveyed different responses from those of the other girls in the group and suggested that she openly enjoyed the interaction of her group members as they learned science.

In another instance, in response to a student survey given in the early part of the school year, some of the girls replied that conflict among stakeholders did not exist. But as time elapsed and additional data were gathered, the inquiry suggested that girls, as stakeholders in collaborative learning groups, might engage differently than boys as they learn science and as a result there would be
some form of conflict as they interacted. On that assumption, there was an ongoing effort to continually clarify and specify possible underlying issues, such as attitudes related to social and cultural factors. Through my persistent observations, it was evident, in my mind that girls behaved differently from boys during the course of learning science together.

**Progressive Subjectivity**

How do I monitor my own developing constructions? How do I as the evaluator secure that the developing constructions are equal in nature and that I do not discuss or concentrate solely on my own constructions?

As a female growing up in the 1950s, certain expectations and stereotyping of a woman’s role in society were inherent in American culture, and are somewhat unique from our present-day society. Traditional female roles were manifested and more overtly apparent throughout daily life (Ivis, 1999; Lawler, 1999; Morse, 1999) and, therefore, I entered into this investigation with those constructions of how a female should behave toward males and other females. Guba & Lincoln corroborate, "It is obvious that no inquirer engages in an inquiry with a blank mind, a tabula rasa" (p. 238). Consequently, because of my prior experiences, the lens from which I viewed the behavior and attitude of girls, I have recorded the following expectations:

- I expect girls to be submissive toward boys (Harding, 1996).
- I expect girls to conceal their abilities and capabilities (AAUW, 1998; Mann, 1994; Orenstein, 1994; Sadker & Sadker, 1994).
Throughout this investigation, I strive to confront these and other issues in order to avoid bias and discrimination in my interpretation while my major professor also challenges any tendencies that I may project about female stereotyping.

As a result, my constructions have changed considerably during the process of this inquiry. In the initial stages of teaching as a constructivist, I assumed that cooperative learning among my students, as defined in Chapter One of this study, was the best avenue for acquiring knowledge. As I evolved in understanding the principles of the constructivist paradigm by implementing the hermeneutic dialectic process, I realized that collaborative learning was unique and altogether different from cooperative learning. During the passage of time, my students were slowly given opportunities to take full responsibility for their own learning, and I noticed that they were building interdependence among themselves and establishing communication skills which, I believe, will ultimately help them in the adult world. Thus, not only did my teaching beliefs change throughout this learning process, but because of my new understandings, my students benefited too.

Moreover, when I began, I had a premonition that elementary school girls might act differently in the presence of boys. I justified these ideas by believing that it was only natural for girls to be girls and boys to be boys, whatever the reasons. However, during the course of my doctoral studies, I read many literary reviews and books about the gender discrimination and gender bias suffered by secondary school girls and adult females. I wondered if an inquiry into girls at the elementary level might warrant investigation because it could possibly confirm
that the results of research on older females could be equally applied to younger females. Consequently, I formulated a theoretical frame, the lens from which I viewed how girls engage in science discourse and my constructions about girls' attitudes changed. As a result of this discovery, interesting findings have surfaced that will be discussed in Chapter Six.

**Member Checks**

How accurate were the data? How do stakeholders correct or alter false interpretations? One of the most important techniques for establishing credibility relies on member checking. Newman & Benz (1998) verify the attributes of member checks, "That is, when a researcher returns to those people interviewed and checks to make sure he or she 'got it right,' the researcher is member checking" (p. 52).

Member checking was accomplished throughout this examination on how girls learn science. Most useful to me was discussing sections of this dissertation upon submitting it to members of my Dissertation Committee, particularly to Penny J. Gilmer, my major professor and Nancy T. Davis, Associate Professor. Sometimes lengthy telephone conversations and electronic mail correspondence would also help to clarify my understanding. As a follow-up, they would present their comments and impressions, which provided me with an alternative point of view.

Member checking was also achieved with my student stakeholders. During and after individually interviewing each stakeholder of the collaborative learning group as they observed themselves on videotape engaging in science discourse,
I rephrased and presented back to them what they had communicated to me about their attitudes toward science and each other. It was a continuous process that allowed Margarite and other members of the group to add more information to what had already been communicated and gave me the opportunity to summarize and confirm what I believed I heard. In the same regard, we openly discussed data collected from their questionnaires, which encouraged them to express their opinion about the nature of science as they worked in collaborative learning groups with girls and boys. It also allowed them to reflect on many issues related to learning collaboratively.

Furthermore, as I transcribed the tapes and viewed the videotapes at home, I would follow-up with the student stakeholders the next school day when I asked them to verify what I had heard in the tapes and what I had viewed on the videotapes. Thus, member checking proved to be an essential ingredient in understanding the constructions of all of the stakeholders participating in this inquiry.

**Authenticity Criteria**

Additionally, authenticity criteria add credence to a constructivist inquiry and are formulated on fairness, ontological authenticity, educative authenticity, catalytic authenticity, and tactical authenticity (Guba & Lincoln, 1989).

**Fairness**

Fairness refers to preserving the constructions of all the stakeholders in the investigation. Throughout the examination, I attempted to remain as flexible as
possible and I listened attentively to suggestions and criticisms from all the stakeholders related either to the process of gathering data or writing the actual study. Even when I presented my initial findings to the National Association for Research in Science Teaching (NARST) 2000 conference, I submitted a draft to my major professor, Penny J. Gilmer, a key stakeholder, with the intention of focusing on what she believed to be relevant for the presentation. Although difficult to arrange because of the distance, fairness was accomplished during face-to-face meetings of the adult stakeholders such as at Dissertation Committee meetings. At other times I used electronic mail correspondence to achieve the same results. Easier to organize were the informal meetings at school with the students.

Likewise, in achieving fairness in this investigation, I identified three girls and three boys as stakeholders to participate in a collaborative learning group and used pseudonyms to identify them in the study. An equal number of girls and boys afforded each stakeholder the ability to express claims, concerns, and issues in a seemingly equitable circumstance and also gave each member an equal position of power.

However, the personality of the participants tended to interfere with the appropriateness of being fair which caused predesigned rules to be altered during the process of learning. Stakeholders constantly adjusted the manner in which they negotiated because they learned over time that the moods and demeanors of a person changed from day to day. They also learned and accepted that one person may have more power over another simply because of
that person's personality. Some would try to negotiate with that person while others simply sat back and allowed consensus to occur without adding input. 

**Ontological Authenticity**

Ontological authenticity alludes to the extent of learning that occurs within stakeholders and whether their own constructions improved, matured, expanded and elaborated to the point of possessing more information and becoming more sophisticated in its use (Guba & Lincoln, 1989).

To begin, my learning was complex and multifaceted. Not only did I learn how to use a computer relevant to corresponding through electronic mail and researching through the Internet, I learned to think as a scholar. I learned to write about observations that I made as a teacher and as a researcher, and I learned to interpret the data that I compiled into scholarly papers that were presented to colleagues in national scientific organizations and published for educators' perusal.

I also underestimated the amount of time needed to undertake the completion of a viable research project since the process included preparing and amassing data over a long period of time in order to procure sound results.

I did not realize the extent of obstacles I would encounter throughout the process. Although most of these hurdles were related to a lack of hours during the day for me to complete essential tasks, there were also lessons when students did not cooperate and mechanical problems with tape recorders and the video camera. Sometimes my duties as a classroom teacher and my responsibilities to the remaining 29 students of my class prevented me from
listening and observing the target group. Consequently, I missed some relevant data.

In addition, during that timeframe, my focus changed considerably as I learned more about the topic. Initially, I was interested in how students learn in cooperative learning groups, and as a result of a reflection on my teaching practices, I later altered it to collaborative learning groups. Next, I researched how children learn about the nature of science in collaborative learning groups, and I observed them as they created their own patterns, relating it to patterns in science. This was based on research I conducted with a mentor scientist as part of my doctoral studies. Eventually, I noticed a difference in girls' and boys' behavior as they learned science together in these collaborative learning groups, which I had incorporated into my teaching and learning of science, focusing on it as a salient issue to research.

Next, my major professor, Penny J. Gilmer, a stakeholder in my hermeneutic dialectic circle, appeared to be learning through vicarious experience. Via electronic mail, I sent her my daily journals of my research, and later my pilot study, from the Parrot Jungle and Monkey Jungle, Miami, Florida. I described my observations to her about what I saw and how my students, particularly the girls, reacted as they were learning about birds and primates. She would respond by sending feedback via electronic mail correspondence. One time she remarked, "As a bird enthusiast, I saw that bird just recently. How lucky you are to have seen it so soon in your bird watching (personal communication, October 1997)!

Another time, she commented, "Sometimes, when I read your journals, I believe I
am right with you in the rainforest. I can picture the squirrel monkeys in my mind* (personal communication, September 1998)!

I knew other stakeholders, especially my Dissertation Committee members, were learning during the course of my investigation, when they asked questions and made suggestions such as, “How do girls resist learning science when they are confronted with peer pressure?” “How do you define a leader?” (referring to a question I had incorporated into my research and later eliminated) and “Why not add a case study report to your research on your student of third and fifth grade, Margarite, as it will provide you with a unique opportunity to compare her point of view from one grade to the next?”

Finally, I recognized that my students were increasing their awareness of science and each other. The quality of their scientific knowledge was augmented through their lengthy and descriptive essays. They built upon each other’s enthusiasm for learning science simply by ‘catching’ it from their peers. As soon as they received the materials to begin an experiment, they all appeared to try at once to proceed. They also seemed more cognizant of collaborative learning and its significance because they knew I was videotaping them and recording their conversations. One girl said:

We all have different...all of us in this group think different so we are all going to come up with different ways to put this rocket together (interview, May 16, 2000).
It was evident through taped conversations and videotaped clips that my fifth grade students were adding and improving their information on scientific concepts and enjoying science learning.

**Educative Authenticity**

Educative authenticity refers to how stakeholders are able to understand the constructions of other stakeholders (Guba & Lincoln, 1989).

For me, it was simple to understand the viewpoint of the other stakeholders because they were consistently providing me with feedback on the drafts of this dissertation. I was learning from them and they were learning from me. As a result of receiving highlighted and commented text on each chapter, I gained a better understanding of the constructions of my major professor, Penny J. Gilmer and Nancy T. Davis, Associate Professor. Thus, my own constructions changed based on their contributions.

As the girls and boys of the collaborative learning group proceeded through the process of learning science from each other, while altering their previous beliefs about fifth grade scientific concepts, they showed signs of appreciating each other's viewpoints, even though there was evidence of some conflict among them.

The dynamics of the collaborative learning group appeared to change over time. As the end of the school year approached, it seemed that the students listened more intently to each other when learning about electricity, a fifth grade competency. They also appeared to accept each other's constructions of knowledge more than at the beginning of the year and by doing so, they
achieved the ability to understand the other's constructions that were different from their own. Consequently, they ostensibly accomplished an appreciation for the hermeneutic dialectic process, a process of discourse and negotiation, as both girls and boys exchanged ideas toward consensual agreement.

**Catalytic Authenticity**

Catalytic authenticity requires some action and ownership on the part of the stakeholders participating in learning science. During the summer of 1997, I participated in a physical science class as a requirement for my doctoral studies. My major professor was my instructor and she incorporated collaborative learning into her teaching practices. As I began my third grade class that fall semester, I implemented collaborative learning groups into my own science curriculum. The results were profound. Margarite was a member of that third grade class and recently, as she viewed herself engaging in science in the third grade remarked:

> Wow, it was fun, a lot of fun. And it still is doing science...is still fun...and doing it with you. I think everybody learned more because it's hands-on. How could you forget that? And it's been three years and I still remember half... all of this stuff.

As a teacher and stakeholder of the group, it was my aim to encourage all participants to take responsibility for their learning. Evidence of catalytic authenticity will be visibly stated in Chapter 5 which deals with Margarite's (pseudonym) testimony and her involvement in science learning within the collaborative learning group.
**Tactical Authenticity**

"Tactical authenticity refers to the degree to which stakeholders and participants are empowered to act" (Guba & Lincoln, 1989, p. 250). As each stakeholder shares in the inquiry, does each believe they have a significant role in the process?

As the main participant, did I believe I had a significant role in the inquiry? Indeed, throughout the research project, I understood the position I should play, utilizing different power and negotiation methods. However, in retrospect, I would have changed several techniques. I would have gathered data differently for this research study, especially during Margarite's third grade school year. At that time, I did not realize that she would be the subject of my case study for this examination and I would have focused solely on her as she worked with her peers. I also would have enlisted an informal interview, which would have provided me with a better indication of her thoughts and feelings as a third grader.

Next, I would have preferred to spend more time on my research. As I evolved through the learning process during the course of four years, a full time teaching position was my main responsibility. I taught in third grade and then fifth grade. Because of the demands of my teaching load and extracurricular activities, Science Fair Coordinator, Educational Excellence School Advisory Council Secretary, Spelling Bee Coordinator and Vice-President of the Miami-Dade County Science Teachers' Association, there were times when it was difficult for me to focus on my research. In retrospect, it would have been more
beneficial and empowering if I had become a full time student where I would have been in the milieu of academia, concentrating completely on this monumental task.

With regard to the student stakeholders, the intent of this investigation was to ensure that both the three girls and three boys of the collaborative learning group felt empowered to act during the negotiation process. To the degree allowed by personality clashes, I believe that each was given an opportunity to equally participate during the process of learning scientific concepts as they worked together in collaborative learning groups. Additionally, to ensure that they felt empowered, I solicited testimony from each group member by means of an informal interview and opinion questionnaire, the findings of which will be fully discussed in Chapter Six.

As for Margarite, I believe she certainly felt empowered because she was given the opportunity to share her feelings as she viewed herself on videotape for both grades. In her own words, she stated:

Mrs. Greenspan: How do you feel about watching yourself in third grade?

Margarite: It's different (she laughs). I look different. But I remember all the fun we had. I just loved third grade (smiling).

Mrs. Greenspan: Why?

Margarite: I remember once you had said I was the scientist at building the kite (referring to tetrahedron kites) because I just made the triangles and set them on top. I still have that kite.
Mrs. Greenspan: You do? (acting surprised).

Margarite: I do! I still have it. It’s in red and I sometimes fly it. One of the straws bent, so I had to take that triangle apart. I’m almost done fixing it, and I want to go fly it again. It flew very well.

Mrs. Greenspan: Fantastic!

Margarite: My cousin was very jealous. He asked me – well, this was in third grade and he was in - wow - fifth grade. He was in fifth grade when I was in third and he was still jealous because he didn’t know how to build any type of kite.

Mrs. Greenspan: You didn’t want to show him?

Margarite: I did show him but he still found it confusing and so I taught him how to do a triangle kite, a regular type of kite (interview, May 16, 2000).

Textbox 4-1. Feelings of Empowerment.

Tactical authenticity is evident in Margarite’s remarks. She certainly enjoys describing every detail of an experiment, explaining what she did, what she learned, and how she was able to apply it to a situation outside of school. It is obvious that in this instance she takes pride in her achievements, especially since she can share her experience with an older cousin. In my opinion, Margarite felt empowered because she realizes that her thoughts and feelings are meaningful to me, the researcher. She understands that she is the subject of this inquiry and that her reflections on learning will be significant in helping me to understand how girls learn science.
The Nature of Generalizations

The nature of generalizations, external validity, in qualitative design focuses on results that can be applied, transferred and replicated in terms of other contexts (Merriam, 1998; Newman & Benz, 1998). The hermeneutic dialectic process is also essential in judging the nature of generalizations (Guba & Lincoln, 1989).

Naturalistic generalizations, through the inquirer's narrative, provides the reader with vicarious experience, paralleling actual experience, which allows the reader to maximize learning by developing an awareness and understanding of the issue (Denzin & Lincoln, 1998). In other words, the inquirer provides,

...as complete a data base as humanly possible in order to facilitate transferability judgments on the part of others who may wish to apply the study to their own situations (or situations in which they have an interest) (Guba & Lincoln, 1989, p. 242).

For purposes of this study, applicability, transferability, and the hermeneutic process will be discussed in light of aforementioned limitations.

Applicability

First, the ethnicity of the collaborative learning group under investigation consisted of a culturally diverse representation of the population of my classroom and the school. Based on the multicultural backgrounds of these students, generalizations were made about Hispanic and African American cultures. How does this apply to all students in each ethnic group? How do the results apply to all Hispanic and African American girls? Moreover, in the same regard, girls
from the Miami area, a community predominately influenced by the Hispanic culture, may think and act differently than girls from another American community where 58% of the population is not bilingual.

Second, six students were chosen to participate in the investigation. Of that number, only three were girls. With so few girls under scrutiny, how can generalizations be made about the behavior and attitude of girls learning science? How can the results be applicable for all girls learning science?

Third, at times children may communicate and behave according to the expectations of their teacher. They may have a tendency to say things that they believe the teacher wants to hear and may behave accordingly. Also, girls and boys may act in a certain way because they realize they are the center of attention, especially since they are being videotaped and their conversations are being recorded. In essence, with these possible limitations, how can generalizations be made to the truthfulness of their comments and the honesty of their actions?

**Transferability**

In order to establish a degree of transferability, thick description is essential. As one of the more important elements of a research inquiry, it allows readers to determine how closely their situations match the research situation (Merriam, 1998). She defines thick description:

*Words and pictures rather than numbers are used to convey what the researcher has learned about a phenomenon. There are likely to be researcher descriptions of the context, the players involved, and the activities
of interest. In addition, data in the form of participants' own words, direct
citations from documents, excerpts of videotapes, and so on, are likely to be
included to support the findings of the study (p. 8).
In this instance, I have described and provided situational excerpts from the girls
and boys chosen to be the subjects of this inquiry. Through this thick description,
the reader will decide whether the information will be transferable and relevant
for a similar study. The descriptive information may also be considered pertinent
in promoting a change in teachers' attitudes about girls and how educators teach
them in an elementary classroom setting.

In addition, the goal of transferability is for people to look for patterns that
explain experience as well as events in the world around them (Merriam, 1998).
In this case, as the researcher, I may read into what is happening with the girls
and boys in the collaborative learning group and view it according to my own
interpretation of what I would expect from girls in such a learning situation. That
interpretation may be based on my prior experiences with regard to what I have
read about gender discrimination and how I personally felt about myself when I
was learning science at a similar age. Equally, a reader may echo similar
sentiments.

The Hermeneutic Process
Looking within the hermeneutic process helps me to judge the quality of an
evaluation. Its intent is to ensure that all the stakeholders participate and are
given equal opportunity to share ideas and beliefs toward reaching the goal of
consensual agreement. During the course of the process, stakeholders change
their constructions and build new ones based on what they have heard from other stakeholders in their hermeneutic dialectic circle (Guba & Lincoln, 1989).

In conjunction with these criteria, my initial thoughts centered on developing a study about how both girls and boys learn science. Following many conversations with my major professor, the focus of the study changed significantly from its first inception. We learned the nature of each other's constructions, digested them and formulated the present inquiry, which solely examines girls' attitudes and behavior as they engage in science learning.

Not only were there conversations with Dr. Penny J. Gilmer but dialogue developed between the other stakeholders of my hermeneutic dialectic circle. It was easier to have conversations with those in the school, for instance, with administrators, other data collectors and student stakeholders on site (see Chapter Three). In every instance, there was a development of thought that was altered and modified as I learned to understand their beliefs. In one instance, as the aide, one of the data collectors, was gathering data, she explained that her seating position was not conducive to listening to the students' conversation. We agreed that the next time we would place the students in a different location, affording her a better place with which to record their conversation.

In selecting the student stakeholders for the hermeneutic process, I initially considered many possibilities but after discussing it with my major professor and reviewing each other's constructions, we agreed upon its present configuration of six ethnically diverse students, three girls and three boys. At one point, I considered observing the entire class population of 35 students who would be
arranged into small collaborative groups with four students in each group.
Realizing the magnitude of gathering data in such a situation deterred me from following through with it. However, in retrospect, I believe I would change the design of the collaborative learning group by assembling a smaller group of students to study, simply because it would be easier for the students to communicate more openly among four rather than six stakeholders.

So What?

Granted there are many factors that could impact the credibility of this research project. Denzin & Lincoln (1998) summarize the validity of qualitative research, “Validity in qualitative research has to do with description and explanation, and whether or not a given explanation fits a given description” (p. 50).

Denzin & Lincoln (2000) describe securing rich descriptions, which will enhance the success in applying the results of qualitative research. The qualitative researcher believes that a rich, thick description of the social world is valuable, characterizing the experience itself. The authors clarify, “It [a constructivist approach] means listening to their stories with openness to feeling and experience” (p. 525). Specifically, a case study on Margarite which details her beliefs about science teaching and learning as she is observed in action with other girls and boys strengthens the reliability of the results. As she speaks about her beliefs about science learning and describes, in her own words, her views about the personality traits of her peers, the reader can enjoy and
understand how girls learn science through her lens or perspective and
determine the possible applicability for their own purposes.

Merriam (1998) outlines several other strategies to strengthen applying the
results of a qualitative research inquiry. First, she believes that it is important to
describe how typical the project is compared to others in order for potential users
to make comparisons to their own situations. In this case, since there appears to
be an intense desire in our present society to understand why girls are not
matriculating in science courses or seeking science-oriented careers, an
elementary school study of this nature may shed some light on how fifth grade
girls behave as they learn science. From that vantagepoint and as a result of the
findings of this study, others may wish to compare it to their own circumstances
either to impact their teaching practices or simply to gain a better understanding
on how girls learn science.

Second, the use of multisite designs adds validity to an investigation. In this
research, girls and boys were observed learning science in many different
situations under various circumstances. Occasionally, they were seated on the
floor, and other times they were sitting in a semi-circle or propped at a table.
Sometimes, they were learning different topics related to science such as cell
formation, forces of motion, and electricity. Furthermore, by targeting one girl in
an attempt to understand how she learns science we maximized the diversity of
this study, allowing the results to be applied to other research projects (Merriam,
1998).
Finally, there are many visions of what 'reality' signifies. Denzin & Lincoln (1998) define critical subjectivity as, "...all the ways in which human beings fool themselves and each other in their perceptions of the world, through faulty epistemology, cultural bias, character defense, political partisanship, spiritual impoverishment, and so on" (p. 268). For that reason, there can be no right or wrong realities based on the results of this study. There are no absolutes but simply an opportunity to see more clearly how girls learn science and to glean from that moment in time.

Summary

According to Woolf (1974) in the Merriam Webster Dictionary, viable is defined as “capable of being put into practice” (p. 770) and valid is labeled as “capable of being justified or defended” (p. 762). The quality criteria to judge the viability or what works for this study are based on the fourth generation evaluation. The validity or justification for this study centers on the constructivist paradigm. Including the aforementioned qualities, parallel or trustworthiness and authenticity criteria give credence to the investigation, empowering the stakeholders to be equally represented in sharing ideas and negotiating toward consensual agreement. Guba & Lincoln (1989) propose that it is a sociopolitical process, one that fosters meaning to it because of its dimensions of social, cultural and political factors. In that regard, it is a teaching and learning process whereas the evaluator is both a learner and teacher along with other members of
the group. Although unpredictable at times, the intent is to create an emerging, continuous, challenging, and equitable exchange among all its participants.
CHAPTER 5

MARGARITE: REFLECTIONS ABOUT LEARNING SCIENCE

"I like science very much. It is my favorite subject and I want to be a scientist when I grow up. I haven't decided what type but I like chemistry and oceanography. I like a lot of different things in science and I think it is very fascinating the things you can learn while doing science and I think it's a lot of fun. And I love the way you help doing science for us like you put them into hands-on projects which I really like like the rocket balloons which was a lot of fun and I learned about motion and the different types of motions"

(Margarite’s interview, May 16, 2000).

Introduction

For purposes of this study, understanding how girls learn science in an elementary school scenario is best described through the reflections and impressions of a fifth grade girl as she learns scientific concepts in a co-sexual setting with other girls and boys. One of the techniques utilized was interviewing Margarite, which allowed me to gain insight into her situation and at the same time identify other relevant sources of evidence (Yin, 1994). Yin further proposes,

One of the most important sources of case study information is the interview
Most commonly, case study interviews are of an open-ended nature, in which you can ask key respondents for the facts of a matter as well as for the respondents' opinions about events. In some situations, you may ask the respondent to propose his or her own insights into certain occurrences and may use such propositions as the basis for inquiry (p. 84).

I have chosen Margarite, pseudonym, as the subject of this story for various reasons. First, Margarite was my student in the third grade, 1997-1998, and participated in a pilot study (see Chapter 1, Initial Research; Greenspan, 1998; Greenspan, 1999) which I conducted during that school year. She was also my fifth grade student during the 1999-2000 school year. During that timeframe, I videotaped Margarite working with other students in collaborative learning groups. Upon viewing her third grade videotapes during the fifth grade, Margarite had an opportunity to reflect on how she learned science at that time. In the same manner, Margarite viewed fifth grade videotapes, and contrasted and compared her performance while she engaged in science discourse with her peers in third grade, expressing her feelings about learning science from one grade level to another.

Second, Margarite was representative of the diverse cultural population of my fifth grade classroom. As previously mentioned, 65% of those students are identified as Hispanic, which is the predominant ethnicity of my classroom students and nearly mirrors the majority of the school population. Evidence has revealed that Hispanic females, among other minority groups, lose their
academic confidence, belief in ability and personal importance and that those factors drop substantially during the ages of nine and fifteen (AAUW, 1998; Orenstein, 1994; Pickard, 1995; Sadker & Sadker, 1994). Although the design of this investigation is to present evidence on how girls learn science through the example of Margarite’s perceptions and observations, the assumptions made should not be construed as indicative for only minority girls. It may be merely a possibility that because Margarite is Hispanic and also a girl that there are other cultural issues affecting her learning.

Third, I chose Margarite for this case study because she demonstrated leadership qualities as a third grader (Goddard, 1990; Kaye, 1998; Kerfoot, 1998). This was evident in the way she handled herself with other students as she learned science, mathematics and social studies. She demonstrated respect for others in her learning group and processed all the information from them, making sure that she understood what they were trying to say. Simultaneously, she was accessible to her classmates, exhibiting candor and sincerity (Kerfoot, 1998). They viewed her as intelligent and a fast learner, though they sometimes labeled her as ‘bossy’. Other teachers in the school are equally impressed with her hard work, fortitude, determination, and exemplary behavior whether she is competing in a running contest in Physical Education, learning how to paint a tile in Art or playing a recorder in her Music class.

It is my intention to compare Margarite’s behavior and attitude in science class from the third grade to the fifth grade to consider if there is any evidence of
change in her attitude and behavior toward science. The purpose is to focus on the two questions addressed in the beginning of this inquiry:

- How do girls, as stakeholders in collaborative learning groups, engage in learning science?
- How do girls interact with others in collaborative groups?

The objective of this chapter is to understand Margarite's viewpoint as a young female learning science while engaging in science discourse with other girls and boys. These questions, as stated in Chapter One, will be discussed relevant to Margarite's performance in the third and fifth grade science classes.

**Margarite**

**Who Is She?**

Born in October 1989 in Miami, Florida, Margarite who is bilingual in Spanish and English has attended David Fairchild Elementary School since kindergarten. Both her parents were born in Cuba, as well as her two surviving grandparents, her paternal grandmother and maternal grandfather. She has four siblings. There are two sisters, 9 years old and thirty years old and two brothers, twenty-eight and twenty-three, respectively. As my third grade student, she qualified to attend a pull-out gifted program twice-weekly on the school grounds, which was designed to enhance the study of language arts and promote critical thinking skills. The status of being gifted will remain with her throughout her Miami-Dade County school years. Consequently, in the fifth grade she attended a similar gifted program for two hours daily. She enjoys extracurricular activities such as
musical theatre sponsored through the Miracle Theatre on the Mile, Coral Gables, Florida, where she sings in the chorus. She is cooperative and always willing to help her teachers and her peers. A fifth grade student sums it best:

Margarite is very smart and [a] brilliant bright mind...Margarite is basically the brains of the group (interview, May 16, 2000).

As my fifth grade student, she volunteered to create and demonstrate science experiments schoolwide on WKID, an in-house news station. She was also selected to serve as a Patrol Guard and was a member of the Chorus, Recorder and Art Clubs. In that regard, she auditioned to play the recorder in the Honors Musical Festival of Miami-Dade County. Because she is an all-around student, she is interested in sports and last year she was a member of a junior swim team at the University of Miami. Recently, she was selected and qualified to attend Carver Middle School for sixth grade next year, a magnet school. Margarite applied and was accepted to study in German, a rigorous foreign language curriculum.

Addressing the Questions

How Do Girls, as Stakeholders in Collaborative Learning Groups, Engage in Learning Science?

Third grade

During the third grade, Margarite and her classmates learned about the elements of weather and the movement of water while working in partner pairs and small collaborative learning groups. "They became more proficient with science
process skills and learned to reflect and apply their knowledge in a real world context" (Greenspan, 1998, p. 3). Margarite espouses her new knowledge in an essay written in February 1997. The spelling, punctuation, grammar, and capital letters are the work of the author.

<table>
<thead>
<tr>
<th>What is Weather?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What weather is is it's a type of mass. A baramator measure's the air pressure.</td>
</tr>
<tr>
<td>For example if the pressure was under 20 a storm may be coming. A windgage measures wind speed.</td>
</tr>
</tbody>
</table>

Textbox 5-1. Margarite's View of Weather.

Even then Margarite had an ability to grasp abstract elementary scientific concepts and apply them to her own experiences although her explanation was simplistic and unsophisticated. Having used weather instruments daily in a weather station as part of her third grade curriculum, Margarite knew how to read the instruments for measuring weather. Specifically, she did not fully understand that a barometer measures the weight of air at any point on the earth's surface and it is equal to the weight of a column of mercury about 30 inches high (Nault et al., 1977). In view of her essay, Margarite has a limited understanding about forecasting weather patterns, realizing that when the mercury in the barometer falls rapidly, a storm is quite likely to occur. Based upon her encounter with Hurricane Andrew, one of the most devastating and destructive hurricanes of the
twentieth century, she was aware that if the barometric pressure was below twenty inches, a storm would occur. On the one hand, she has some basic knowledge about weather and on the other, her rudimentary knowledge gives her further opportunity to expand upon what she already knows.

In her collaborative learning group in the third grade, students assumed the duties of either project director, assistant director, materials manager, reporter, or team member (see Chapter One). These jobs helped the young third grade students to organize and focus on the task at hand, which ultimately led them to be more accountable and responsible for their own learning. It was a difficult task to achieve because these 8-year-old children were not familiar with working together when they began third grade. It was a gradual process that evolved from partner-pairs to cooperative learning groups to collaborative learning groups impacting Margarite's science learning in third grade.

Once the students were in control of their own learning, they looked to me as the guide rather than the sage in their quest for new knowledge. McGonigal (2000) in an autobiographical case study examines how she, as a teacher, risks becoming a constructor of science knowledge, through her own worldviews and at the same time facilitates students' science investigation. In that regard, I have revised my own ideas about scientific concepts and together my students and I take opportunities to test and confirm new explanations about science. Over a period of time, because of my new role as their teacher, students acquire confidence in their ability to take responsibility to think and problem solve, gaining the needed support from their peers (Greenspan, 1998).
It was obvious that Margarite loved to engage in science with her peers because she had the opportunity to listen and respond to others' viewpoints while learning to interpret a more accurate understanding of a scientific concept. Guba & Lincoln (1989) suggest that "...participants are accorded the privilege of sharing their constructions and working toward a common, consensual, more fully informed sophisticated, joint construction" (p. 11). She was enthusiastic about most science experiments and attempted to be the first to get her hands on the manipulatives. As a member of a team, she usually had a job and when she was asked about being the manager, a leadership position, in a chromatography experiment, she remarked:

Yeah, that day I was manager but I wasn't often the manager. I let other people manage sometimes, well, almost all the time. I like to manage. I just like it the best, I don't know why (interview, May 9, 2000).

Textbox 5-2. Margarite’s Favorite Job.

Margarite also disclosed that she enjoyed being the recorder of a collaborative learning group in third grade. As she viewed a videotape showing her and the stakeholders of her collaborative learning group engaging in an evaporation experiment in the third grade, she was asked how it felt to be the recorder:
Yeah, I was usually always the recorder. It makes me feel smart. It just makes me feel like I know more when I am writing (interview, May 9, 2000).


Although Margarite admitted that the manager job was the best position of the group, she chose to take on the role of the recorder more often. In both instances, she demonstrated that as a stakeholder in her learning group, she is in control of her own learning and, in a way, contributes to the learning of the rest of the members of her group (Goddard, 1990; Kaye, 1998; Kerfoot, 1998). By being the recorder, she has to constantly review her notes to her peers to remind them about what they have discussed. She also has to make sure that everyone remains on task as they listen and respond to her presentation. When all the findings have been discussed and a consensual conclusion is reached, the students listen to Margarite because as the recorder she brings closure to the lesson. Thus, all eyes turn to Margarite throughout the lesson, which gives the others the impression that she is smart and gives her a feeling of success.

Additionally, as mentioned previously, I conducted scientific research at the Parrot Jungle, Miami, Florida, part of the requirements for my doctoral studies. "Through this research I learned many aspects about birds specifically related to their color, plumage, body size and shape, mating practices and habitat preference" (Greenspan, 1998, p. 5). As my research progressed, it became obvious that the data I was compiling and the scientific concepts I learned should
be incorporated into my classroom science curriculum, which was mandated by the guidelines of the Competency Based Curriculum of Miami-Dade County and the Sunshine State Standards of Florida. Margarite as a member of my third grade pilot study enjoyed learning about birds. She became totally committed to learning about birds and became a loyal bird watcher. She summarized (with her own spellings) her thoughts on birds:

**Birds**

I learned that it is called molting when they lose feathers. Next, I learned that it take paint to bird watch because the birds are very scared. Then, I learned that there a varieties of bird’s like the tree climbing bird and others. Owls look like a wise bird but compared to the body its not so smart. Also one of my favorite birds are Tody, Mawcaw, Birds of paradise, Honeycreeper, Motmot, Toucan, and the Parakeet! Male quetzals are green to camalashe with the tree leaves. Goldencrest are the smallest birds in Europe (written February 25, 1998).


Margarite learned much of what there was to know about birds and what to do if she was bird watching. Additionally, she learned how to identify birds and recognized that their body color was beneficial for their survival. She was captivated by her new knowledge of birds and she shared what she already knew about birds with her peers. That made her more aware of what she did not know.
As she viewed a videotape of her group when she was placing a model bird onto a paper tree, Margarite noticed that she was nervous because she made several mistakes in her demonstration. She claimed she was probably frightened because she was not used to making presentations.

Mrs. Greenspan: All right, let's talk about how you felt at the time you were presenting to the rest of the class.

Margarite: In third grade, when I was presenting to the rest of the class, I was usually nervous. I wasn't as like up to it as I am now. Like I didn't really feel like it at the time. I got nervous and I made a lot of mistakes in my words. I just didn't like presenting then I guess.

Mrs. Greenspan: Why not?

Margarite: I don't know. I think I was just frightened (interview, May 9, 2000).

Textbox 5-5. Margarite's Self-Perception.

Although it is normal for young children to be apprehensive in front of their classmates in school, they usually lose that fear once they begin to speak. However, it is noteworthy that Margarite, who appeared to be a leader of her peers, became nervous and frightened. It is possible that because her peers placed her on a pedestal and looked to her for guidance that she felt at the time she was not worthy of their expectations. In other words, their perception of
Margarite may not have been equivalent to how Margarite perceived herself. In her own words from a video segment, acting nervously, Margarite said:

**Birds of Paradise**

Birds of Paradise, the male dances around, dances around, uh and manages to attract the female bird and uh they use its flock of gold feathers on their caps, I mean hats. That's why they're endangered species (videotape, October 24, 1997).

Textbox 5-6. Margarite Displays Nervousness.

Furthermore, other activities were integrated into the science curriculum such as aerodynamic concepts relevant to the study of birds. The students constructed parachutes from napkins and yarn, learning the basics of lift and drag by simply experimenting with their self-made parachutes (Greenspan, 1998).

From their experiences and discussion with each other, they learned to drop their parachutes in a certain way for a successful flight and consensually agreed which position and placement would perform the best. "Some explored different weights for best results, sharing their conclusions and motivating others to investigate with different objects, like paper clips, pencils, and miniature toys" (Greenspan, 1998, p. 11). Margarite wrote in her own words:
Peractutes

What I learned was that if there were weight on it it would fall faster. If there was nothing on it then it would stay in the air longer and we were looking for the smoothest and fastest landing. The two winners were Ray (pseudonym) and Robert (pseudonym). Ray used a plain parachute and tied a pair of scissors and a ruler. Robert had a plain parachute and tied a paper plane to it. Finally, they both won because they got 0.98 seconds (written March 27, 1998).


Thus, it appeared that Margarite learned some basic scientific concepts for third grade by participating in hands-on, mind-on activities with other girls and boys. Her science vocabulary increased and her science process skills of observing, communicating, classifying, measuring, inferring and predicting led to exhibiting curiosity, questioning and an interpretation of the world around her. She consolidated her third grade experiences in the following words:

My favorite part about third grade was doing all those science experiments like the Jewish pancakes with apple sauce, ice cream, pizza, evaporation, parachutes, making bird nests and learning all about birds. Those are my favorite memories in third grade (Margarite’s essay, May 24, 1998).

Textbox 5-8. Margarite’s Tells about the Best of Third Grade.
All in all, Margarita as a stakeholder in a collaborative learning group fundamentally engaged in learning science. She demonstrated that she was bright and capable of leading her peers toward consensual agreement. But it appeared she needed to organize her peers and preferred to transcribe their thoughts as the recorder. She played a key role, though not as manager, in assuring that the task was complete in her small learning group. In this case it consisted of three boys and Margarita, and when she had to prove her knowledge to the whole class, she became nervous and frightened. Even at this early stage in her development, Margarita had a fear of being too smart in the presence of classmates, conveying uneasiness and tenseness when she had to make a presentation. It is difficult to determine at this point if this discomfort was related to whether boys were part of the audience.

On the other hand, it is possible that she felt more comfortable with her collaborative learning group members, even though the majority of them were boys, rather than the entire class. One possible reason may be attributed to the fact that they worked closely together during the year and they understood each other's idiosyncrasies, adjusting their personalities accordingly to achieve agreement and ultimately success. At any rate, her perception of herself was obviously different from what her peers believed, because they continually chose her in a leadership role. However, when she had to perform as the manager or leader, she displayed fear and nervousness.
**Fifth grade**

Margarite enjoyed engaging in science learning in collaborative learning groups. She applauded it:

| I think working in groups is very productive. It helps us share knowledge and other things from our group members and we learn a lot more working as a team and I think it is very productive for the whole group (interview, May 1, 2000). |


However, she appeared to be very concerned about the dynamics of group learning and the conflict that arises as stakeholders engage in the learning process. She is aware of character attributes and flaws of each individual of the group and openly described them:

| Tom (pseudonym) likes to fool around but he also gets to work. William (pseudonym) he likes to fool around and likes to play with the materials and he also makes himself boss. Amy (pseudonym) is cooperative and she does like to give her opinion a lot and I like that. Don (pseudonym) has a lot of opinions and does some work but he likes to talk a lot more than he likes to do things... we have to put him back on track, back on science. He is not very often productive but he helps, he gives his opinion. Cathy (pseudonym) doesn't agree on a lot of things, actually she doesn't like anything we do and when we go and do |

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something she goes against all of us (interview, May 16, 2000).

Textbox 5-10. Margarite’s Perception of Others in Her Group.

In that sense, she is very cognizant of the temperament of each classmate in her learning group, noting their shortcomings and strengths. Because of that intrinsic ability to understand each and every person of her group, Margarita proves to be a mature, responsible child and acts accordingly as she works with them. She understands her peers’ behavior as they engage in science and appears to get along with them most of the time. She accepts them for who they are, which in turn impacts her learning science because she adjusts her own behavior sufficiently in order to accomplish her goal; i.e., learning science. In other words whether there is peaceful discussion or conflict among her peers, Margarite is prepared to engage in learning science, no matter her peers’ attitude.

Effective learning occurs through language and culture (Driver et al., 1994). Nonetheless, social conflict may occur among stakeholders of a collaborative learning group when one or more persons in the group become totally convinced that their opinion or belief is the correct one. If peaceful persuasion does not succeed, these students, on occasion, can resort to aggressiveness and become argumentative.

Margarite discussed how conflict originates in her group as she and her classmates attempted to reach consensual agreement. At first, jobs were assigned among the participants to offer structure to the learning group, as in the third grade. But gradually over time, Margarite’s collaborative learning group
structured their own form of organization to help them reach decisions together. They decided to distribute the power, which appeared to have solved some of the overt conflict they were experiencing. It was decided that each stakeholder would have one responsibility in completing the experiment. Each student was accountable for doing one small section of the experiment and then another would execute yet another segment of the experiment. For instance, in a balloon rocket experiment, one person hung the balloon, someone else blew up the balloon, and a third person placed the balloon in a plastic bag. Although they were little tasks, everyone knew what was expected of them.

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Well everybody doesn't usually agree so we make each other the boss. We are all bosses in our group. We all try to make it as fair as it can be (interview, May 16, 2000).
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Textbox 5-11. Who's the Boss?

Nevertheless, because of her past science experiences, Margarite usually felt confident in seeking a conclusion for an experiment but she would not proceed until she received a consensus from all the group members. Her aim may be to simply reach agreement or it is possible that Margarite once again withholds science knowledge because she fears possible consequences from her peers, whether it is acceptance or rejection. Her fear of being too intelligent in the presence of boys may be affecting what she knows and wants to understand. In
one way, she is cognizant of her ability, as in the following excerpt, but in another she suppresses her knowledge. In the case of building a rocket, she was adamant about building it because she had done it in third grade:

I did that because they all decided that I would do that because I had already built a rocket once so they decided that I should look over it and make sure it was the same as we did it in third grade (interview, May 16, 2000).

Textbox 5-12. Margarite Displays Self-Confidence.

She faced a similar dilemma while making a model roller coaster. She knew she was right, based on her previous construction about roller coasters, but she was reluctant to share it with her classmates, particularly the boys. She shared what she knew about roller coasters with the girls but waited patiently for the boys to try what they believed was appropriate for the marble to gain speed. When they were unsuccessful, she encouraged them to see her point of view. She did not take the initiative to show what she knew but delayed her actions until the boys were ready to accept her knowledge.

I knew it wasn't going to work because the marble needs to gain speed like in a roller coaster. It needs a little section where it is rolling. It needs to gain speed and the faster it goes it'll...the more probability it will have of going through the loop. But William left only a few inches of space to gain speed
and it wasn't enough space to gain speed and it went halfway around the first
loop and then fell down in the middle of the loop. And then they (referring to
the boys) decided maybe we're (referring to the girls) right and they did it our
way a bunch of different times with a bunch of different loops and but, of
course, it worked (interview, May 16, 2000).


Once again, Margarite represses what she knows about scientific concepts for
fear of the consequences. Socially it is to her advantage, she believes, not to be
argumentative but to wait until she is approached about what she knows to be
ture. Becoming a legitimate participant of a science community entails explaining
and justifying one's understandings, as well as questioning and employing
methods for drawing conclusions (Davis, 2000). It is not uncommon for some
girls to behave as Margarite because researchers agree that females' percepts about science act as barriers on how they express interest in scien
t school (Harding, 1986; Kahle & Meece 1994; Keller, 1986).

Throughout the year, Margarite was determined to be the best scientist. She
approached each activity with enthusiasm and interest and took her role very seriou as a stakeholder in her collaborative learning group. If she was the
recorder, she immediately began writing her notes, gathering everyone around
her. They would speak, she would write and repeat what she heard. Sometimes
she would write her own thoughts, disregarding those of her peers because she
knew they were wrong. Whatever position she held she attempted to keep everyone on task but waited patiently for each member to share his or her constructions. Then she added her own input, confident that she was right even though there were times when she admitted to being shy. If her ideas were not accepted, she would retreat into silence.

Although Margarite is knowledgeable about science, she is also very humble about her abilities. When Margarite was asked if she should get any special privileges because she considered herself the most popular student in the collaborative learning group, she said that she should not get most of the work simply because her peers were aware that she knew more about science. Rather Margarite felt that all the people in her group, popular or otherwise, were just as smart and just as capable of doing an equal amount of work.

It is essential to remember that cooperative learning jobs (manager, assistant manager, recorder, reporter, materials manager, member-at-large) are initially constructed to help young children organize themselves (Johnson & Johnson, 1991) and Margarite is accustomed to beginning a lesson by assigning these jobs to each student (see Chapter One). A cooperative learning group divides a task into parts with each member completing one part of the whole project, while a collaborative learning group has two or more students jointly solving a single solution for a problem. By fifth grade, Margarite and her peers continued, most of the time, to incorporate cooperative learning jobs as they collaborated to solve a scientific problem.

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As a leader in a collaborative learning group, she creates trust among her peers, asks questions, assimilates knowledge, and conveys clear expectations about the task (Kerfoot, 1998). She also learns to listen to nonverbal language, accepts information with an open mind, encourages risk and foresees and develops a vision (Goddard, 1990; Kaye, 1998). Because of this attitude toward others, Margarite is willing to sacrifice her position of leadership in order for everyone in the group to actively participate.

Whatever the circumstance, Margarite’s main goal is to learn science. She puts forth her best effort, learning from her peers in her collaborative learning group because she wants to pursue a career in science. In her mind, it is beneficial to learn science with her peers even though it might infringe upon her own abilities as a scientist and what she already knows.

Margarite is proud that she can infer and solve scientific problems and she is willing to share that with the stakeholders of her collaborative learning group as she writes down every aspect of an experiment. Even in her homework assignments, she adds details and displays a real understanding for the concept of electromagnets. In her own words, she described what an electromagnet is:

<table>
<thead>
<tr>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is an electro-magnet. Well I'll tell you. An electro-magnet is well a type of magnet. The electro-magnet is a electricity magnet. We built and electro-magnet in class. The way this magent was built was with a nail, 2 batteries, 1</td>
</tr>
</tbody>
</table>

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red wire and washers. 1st we attached the wires to the batteries then wrap the red wire attached to the batteries then you use the electricly charged nail to pick up the washers. The wires charged by the batteries make the nail an electromagnet. This all happened because metal is a conductor, allowing the battery charges to flow through (written May 27, 2000).


Thus, Margarite, as a stakeholder in her collaborative learning group, generally engaged in science discourse in fifth grade with self-assuredness because she was confident that she was capable of acquiring new knowledge while at the same time sharing her previous constructions of scientific concepts. However, there was another side to her behavior as she also displayed moments of humbleness and insecurity, which sometimes interfered with how she engaged in science with her peers. In spite of such behavior and the obvious conflict she experiences among the girls and the boys of her group, Margarite remains committed to learning everything she possibly can.

How Do Girls Interact with Others in Collaborative Learning Groups?

Third grade

During the latter part of fifth grade, Margarite viewed videotapes of herself when she performed experiments in the third grade. She was excited, enthusiastic, and animated about what she reviewed. Several issues were presented, and she discussed them openly and honestly.
One of the first videotapes showed Margarite learning science with her female partner, Jan (pseudonym). In the beginning of third grade, students chose their partners for learning science. When they were mature enough to handle the responsibility for learning, which happened midway in the fall, they sometimes engaged in science discourse with their table buddies. Later in the year, they were given the option of choosing whomever they wished for their collaborative learning group. Upon viewing a segment of the third grade videotape, the atmosphere appeared to be conducive to sharing and Margarite appeared to be motivated to consensually solve scientific problems with her peers (Greenspan, 1998). Unknowingly and with little intent, Margarite and I discussed with whom she preferred to learn science. She said:

I felt comfortable with her. One of the reasons it is is because she is my friend since... well since second grade and I felt comfortable around her, and I felt we could do anything together because we were friends. And she was intelligent and so was I, and I just felt comfortable. I could show off being smart around her (interview, May 2, 2000).

Textbox 5-15. Margarite's Thoughts on Working with Friends.

It appeared at that time, when Margarite had an option to choose someone with whom to learn she preferred to work with a friend. At this point, she did not designate whether she favored working with girls or boys. What is significant is
that she chose to work with her best friend, who consistently helped her during the learning process.

Margarite's definition of a friend is someone with whom she can be herself. In other words, she can truly show what she knows and what she is learning, and it is the main criterion for selecting a partner in the third grade. Friends, in her eyes, can be relied upon to be open and honest, therefore creating an atmosphere of comfort. For Margarite, it was very important that she felt comfortable in the learning environment and that could only be achieved by learning science with a friend. Because of that belief, Margarite allowed herself to share her knowledge and be the person that she perceived herself to be which was a smart, intelligent third grader. It may be construed that Margarite would not be that person if she learned science with someone who was not her friend because then she would be more guarded and inhibited.

Additionally, in this notation, Margarite suggests that she feared being too smart because she said she felt she could act intelligently only with her friend, implying a possible fear of being too smart with anyone else in the class. That discomfort apparently did not extend to the gender of her partner:

I sometimes chose Jan and she sometimes chose me and sometimes depending on the project and if I didn't have a partner, I would work with Don (pseudonym), a boy (interview, May 2, 2000).

Textbox 5-16. Margarite Chooses a Girl or a Boy.
She further commented about choosing Drew, a classmate in third grade:

Well, because we were also friends then. I haven't seen him for an awful long time but we were still friends and well, I liked working with him. I could learn a lot. It didn't matter to me if he was a boy, and it still doesn't matter to me if I work with a boy or a girl. I don't know. It just doesn't. I don't know why but some girls don't feel comfortable working with boys. They all have their reasons. I don't know that. But it just doesn't matter to me and I don't know why (interview, May 2, 2000).

Textbox 5-17. Margarite’s Thoughts about Learning Science with a Friend.

In essence, Margarite indicates that her preference for learning science is exclusive to friends without regard to gender. Her main guideline for choosing a partner appears to depend on the opportunity to act intelligently, which she can only accomplish with a confidante and trusted companion, her interpretation of a friend. What is insinuated is that she may fear being too smart with someone who is not her friend, which may result in her indifference and apathy toward science.

While further viewing the videotapes of herself, Margarite remarked that all the students had changed in their appearance and attitude from the third grade to the fifth grade. When she was asked to expand on that idea, she selected a boy who had been her third grade peer and described his behavior:
They all have attitudes now. Like Arnie (pseudonym), we'll use him as an example. He was a lot calmer, a lot nicer, he didn't talk back as much and now he says 'forget you' and has a big attitude and he doesn't like being around people that much (interview, May 2, 2000).

Textbox 5-18. Boys' Attitudes.

She further commented about another boy:

Carlos (pseudonym) (another former third grade classmate) is now more into like war like his father. He likes guns a little bit more than he used to and he is a little bit more rougher than he used to be. Like he didn't use to talk that much at all. I was in his table (in third grade). I sat right in front of him and he talked very little then. Now he would talk a lot (interview, May 2, 2000).

Textbox 5-19. Comparing Boys in Third Grade and Fifth Grade.

Margarite was aware that changes do occur in children's personalities. She appears to accept those modifications, particularly in boys she knew in the third grade, and consistently describes their behavior as an example of how children may be different from one grade level to the next. She regularly mentions these distinctions in boys' behavior and does not mention girls' behavior, possibly due in part because she has not observed any changes in girls' demeanor or simply because the boys' behavior is more overtly pronounced and obvious. Yet

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another possibility is that Margarite, as a female, understands changes taking place in the other girls and as a result, it is not a conflict for her.

Since I have known Margarite and her family for a long period of time, I know that she has a close relationship with her mother and discusses different issues with her. In an informal discussion in my presence to decide Margarite's choice of schools for sixth grade, Margarite's mother advocated selecting a more challenging learning environment to study even though Margarite was concerned that her friends would not be attending that school. Her mother aspires Margarite to be an independent and creative thinker and encourages her to achieve to the best of her ability. In considering what motivates fifth graders to change, Margarite commented:

**Margarite:** I talked to my mom about that once and she said it was growing hormones and people change and you can't change anything about that — people just change.

**Mrs. Greenspan:** Have you changed?

**Margarite:** My mom thinks I am a lot shyer, that I wasn't shy then (in third grade) but now she thinks when I meet different people, of her friends, she thought I wasn't shy then, but now I've grown shy. I think, as you grow up your body changes, your state of mind changes. The way you talk, the perspective, the way you look at things. It is just changed.

**Mrs. Greenspan:** How do you feel about being shy?

**Margarite:** I don't like being shy. I really don't like being shy because that is
just less opportunity for me. That’s how I feel. But when I’m around adults, I’m comfortable being around you. I feel like I could say anything around you. With other kids, I don’t feel shy around them, like from time to time depending on how long I’ve known them. Like some of the boys in the class. Like Tom (pseudonym) I’ve known him for some years now, like second and first grade. He was in my class with the exception of third grade. He’s been in almost every one of my classes, so I feel a lot more comfortable talking around him, but sometimes I am shy with him.

Mrs. Greenspan: Does it matter who it is?

Margarite: It doesn’t matter to me if it is a boy or a girl. It’s just how long I’ve known them that makes me shy. Like I’ve known my dad’s friends for a long time, but I don’t just say anything around them...it would hurt my dad’s reputation or something by saying just anything (interview, May 2 and 16, 2000).

Textbox 5-20. Margarite on Being Shy.

The literature remarks that young girls have certain self-perceptions (AAUW, 1998; Haag, 1999; Mann, 1994; Orenstein, 1994) and Margarite, in one sense, is extraordinary. She has an amazing capacity to distinguish between what she is and how others perceive her. At times, she appears to lose her academic confidence and the belief in her abilities by acting shy around unfamiliar acquaintances. She knows she is an intelligent human being who can display that intelligence with good friends. However, she still remains guarded with them.

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even if she has known them for a while. There is always an edge to her relationship with peers, even with her friends. She cannot show she is too intelligent so she covers it up by becoming shy and keeping her thoughts and opinions to herself. In her mind, there is something that holds her back from being the person that she knows she should be and that prevents her from being herself.

Furthermore, Margarite was mindful that the stakeholders of her third grade collaborative learning group cooperated differently than those in the fifth grade. She realizes that third grade conversations differ from fifth grade. She expounds:

| Yeah, we used to cooperate a lot more than we do now (referring to third grade). Like we’d talk a lot, easier than we do now. Like it’s a lot different talking now. I don’t know why, but as you get older you feel a little different talking about things like you did in the past (interview, May 16, 2000). |

Textbox 5-21. Margarite’s Description of Differences Between Third and Fifth Grade Conversations.

At one point, Margarite rationalized that those changes possibly pertain to something that exists under the surface between girls and boys. She alluded to a discord, a kind of antagonism or friction between females and males. She discussed the subject of an undercurrent conflict among girls and boys, specifically how third grade boys act with third grade girls. She reasoned that boys in third grade were not as competitive, allowing girls to do an equal amount
of work most of the time in their collaborative learning group. She claimed that her group’s method of delegating the tasks was by voting and in her eyes, that was a fair and viable method of making decisions together. She also believed that third grade boys were nicer and were more willing to listen to everyone’s views, generally speaking, but then there were other times when girls felt of lesser value. She appeared to have had these feelings of inferiority when she remarked:

The boys didn’t feel they were the lesser half. They felt that they were our equal but sometimes they felt that we weren’t as smart in the third grade. They also thought they were superior (interview, May 16, 2000).

Textbox 5-22. Boys Feel Superior.

By admitting that boys believed they were superior, Margarite intimated the possibility that she was inferior to their superiority. She does not defend her position of intelligence but simply accepts what the boys believed. They, the boys, were convinced they were more intelligent than the girls were and Margarite, in this instance, agreeably concurs with them.

On the other hand, Margarite confirmed that third grade boys were equal intellectually and physically to third grade girls. However, she continued to verify that some underlying notion of inequality exists between girls and boys, especially when she discussed the differences between a gifted boy and a gifted

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girl. For her, the gifted children in her class believed that they were superior in knowledge to others in the class, except in her case. She did not consider herself exceptional and reasoned that others in the class were equally smart and could learn just as much as the gifted student. She reasoned that the gifted student learned faster. Once again, Margarite posits that she was of less intelligence than even her gifted cohorts and her classmates in a regular classroom. Since the majority of the fifth grade gifted students in the class are boys, it is possible she feared being too smart in their presence but whatever the reason, she appeared to demean her own abilities even when the status of her competence has been identified as gifted.

Finally, Margarite is cognizant of behavior changes occurring among some of her classmates during the two years that she has known them. She appears to have difficulty pinpointing the actual cause of these personality modifications and openly remarks that some things cannot be discussed as easily as one ages. Several factors may be attributed to her feelings. At this age, it is particularly important to be accepted by one's peers and she may be aware of potential consequences of not being socially accepted by her friends, whether those consequences are real or imaginary for her. Therefore, she acts differently in science than what she believes she can do. She has learned to depend on the person with whom she is interacting to give her a sense of comfort and she has learned to act according to the circumstances. She knows she is intelligent and can be herself with her friends but she is more cautious with others, not revealing
her true self. Even at this young age, although subtle but related to interaction among girls and boys, it appears that social factors impact her science learning.

**Fifth grade**

Margarite considers conflict to be a primary issue with girls as they interact with other girls and boys in their collaborative learning groups. Throughout our conversation, she initiated discussion about it and spent a great deal of time describing how girls and boys interacted together. Although there were moments, sometimes lengthy in nature, when the stakeholders did share constructions, Margarite was aware that occasionally the boys worked together, disregarding the presence of the girls. She did not suggest that major conflict was apparent between the girls but rather there was a prevailing conflict evident between girls and boys. In one instance, the girls wanted to manipulate the objects to complete an experiment and the boys monopolized the materials. Margarite and the other girls solved the problem by removing the supplies the boys needed to finish it. They did not shout nor try and persuade them by talking to them. Rather, they simply waited until the right moment and eliminated the objects from the scene.

There is always conflict...we are always having little arguments about what we have to do...they (the boys) didn't want us to do much of the work so we took away stuff that they were going to the work with...(interview, May 16, 2000).

Textbox 5-23. Conflict in Science Discourse.

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Margarite also feels a sense of injustice as she interacts with the boys in her collaborative learning group. She claims that she tells them how she feels, but I have observed her while she is working with boys and she has a tendency to sit back, allowing them to read instructions and manipulate objects. Even when she becomes angry at something they may do or say, she usually withholds her feelings until the right moment. Then, she will do one of two things. First, she may express her opinions in a calm manner or she will wait until the boys are unsuccessful in their attempts. Invariably, they will ask for her input and she will guide them in the right direction toward closure. However, interestingly she usually does not take the initiative in sharing her knowledge, unless she is absolutely sure she knows what she is talking about, always waiting for the boys to approach her for a solution.

They felt that the girls shouldn't build the rockets, and I had commented that girls can do just as much as boys can and even more...I am just as smart as they are and I feel really really angry. I just give them a lecture (interview, May 9, 2000).

Textbox 5-24. Girls Are Just as Smart.

Margarite believes the best way to solve visible conflict in the collaborative learning group is for the boys to talk to the girls when science class is over. The following remarks confirm her convictions:

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The boys should talk with the girls and try and understand their point of view and the girls should talk with the boys and try and understand their point of view (interview, May 16, 2000).

Textbox 5-25. Margarite's Solution for Conflict.

Although this may be a possible solution to the problem of arguing and dissent, the fact remains that the boys are a close knit group, just as the girls are. Each of the sexes claim they prefer to learn science in a group comprised of just girls or just boys. This may be due in part to the nature of primate behavior in which the same sexes play together because they feel more comfortable and secure (Schaller, 1972) with their own kind. Nevertheless, it may be relevant to assume that the girls have more in common with each other than with the boys and vice versa. They may share common experiences that generate an attitude among them of camaraderie and companionship.

Evidence of Change

To summarize Margarite's behavior and attitude toward science during third and fifth grade, it is essential to briefly restate what I believe illustrates evidence of change as she enculturates to become a science learner within a collaborative learning group. In both grades, she loves the subject of science and is excited and proud of her accomplishments in learning basic science concepts. She generally assumes the role of a leader, sometimes manager, assistant manager, or recorder, in her learning group because she feels that she is bright and
intelligent. At the same time, she is humble and somewhat apprehensive in front of both girls and boys when she has to share what she knows, although these latter feelings are more pronounced in third grade. Also I noticed that in both grades she is usually willing to learn with either girls or boys in a collaborative learning group and asserts that it really does not matter to her, except that they be her friends.

Evidenced in fifth grade and relevant to an apparent modification in her personality is her reaction to conflict as she engages and interacts with cohorts in her collaborative learning group. Granted she admits that conflict was evident in third grade but its effect on her learning appeared to be insignificant. However, in the fifth grade, she faces both overt and covert conflict with boys, becoming infuriated and frustrated with what they say to her and the other girls and how they express it. Consequently, she withholds her knowledge and retreats into silence until the boys approach her for help. In that regard, Margarite acts differently than she did in third grade. Whereas previously, she would simply express her views and exchange ideas enthusiastically, instead in the fifth grade, she disengages and waits patiently until the right moment. I believe her fear of being too smart in the proximity of boys impels her to be inhibited and unresponsive in demonstrating what she knows and what she is coming to understand.
Summary

In summary, it is my belief that there are some social and cultural issues that impact upon Margarite's learning science. First, her perception of herself as a science learner differs considerably from the way that she behaves. Margarite is aware that she is bright and intelligent when it comes to learning science, yet she withholds her knowledge until she knows that the stakeholders of her collaborative learning group will accept it. I have speculated that this is due in part to a fear of consequences imparted by her peers, whether it be rejection or simply because she wants to be liked by everyone. Many girls who excel in science feel similarly. One girl, selected to attend an ethnically diverse magnet school for high school students where girls outnumber boys by almost 2 to 1 remarked, "A lot of people, like, don't even know that I'm smart" (Hall, 2000).

Because Margarite represses what she knows in science, it affects her behavior among her peers. She appears to realize that her behavior and attitude toward science has changed over the past two years, but does little to offset it among her cohorts. Instead, she quietly accepts the superiority of the boys and underhandedly overturns their decisions. Where once science typified a 'geek,' a person who inhabited a rarefied universe, where everything intellectual was easy and everything social was hard (Hall, 2000), girls today are slowly altering how they perceive themselves as scientists. In my opinion, Margarite has not reached that echelon. I believe she is just beginning to enter
into the adolescent stage where the admiration of friends far outweighs a need to be scientifically astute.

In her own words, Margarite summed up who she is:

| Some of the boys think I am a tomboy just cause I like sports. I do a lot more sports than the rest of the girls. I know the boys’ point of view and the girls’ point of view. I have seen them both. Boys, I understand them. I understand that they feel they have to defend their title, but there is not really much to defend when they all feel they are equal to each other (interview, May 16, 2000). |

Textbox 5-26. Margarite Understanding Boys.
CHAPTER 6

FINDINGS

"Sometimes it goes boys don't agree and sometimes the girls don't agree"

(Margarite's interview, May 16, 2000).

Introduction

Based on qualitative research, this chapter focuses on how girls learn fifth grade scientific concepts in a collaborative learning group with other girls and boys. The first section of this chapter presents findings that were compiled by observing three girls and three boys as they engaged in science discourse during fifth grade science class. The data were gathered by videotaping students, examining their written work, recording their dialogue for about seventeen lessons, approximately one hour each, and interpreting opinion questionnaires, which were solicited at the end of the school year. Various scientific concepts were studied, such as magnetism, forces of motion and electricity.

The data on girls, the target group, will be presented first followed by data on the boys. I will incorporate transcribed conversations of the students as a means for allowing the readers to reconsider their knowledge of this case and to modify existing generalizations. By incorporating students' discourse, readers will also vicariously experience some examples of fifth grade girls and boys learning.
science together, which will help them to reflect on the uniqueness of this inquiry (Merriam, 1998).

Grounded on a linear-analytic structure, this investigation explores the issue of how girls learn science with other girls and boys in a collaborative learning group, and covers some of the methods for examining this problem. In view of the evidence, I will explain, describe, and discover how elementary level girls learn science in an effort to determine if social and cultural factors impact their learning. Thus, I will discuss relevant findings and as a result attempt to draw credible conclusions in Chapter Seven, offering the reader an opportunity to further inquire into the topic for future research (Yin, 1994).

Findings

Using QSR NUD*IST 4, a computer software program, to store, locate categories and index data, I have identified a common pattern in students’ discourse, interviews, drawings, and opinion questionnaires. The figure below illustrates five predominant themes or nodes I found as I sorted through the vast amount of data using the software program. Once these nodes were established, I was able to code documents in a hierarchical index tree, which helped me to organize data, clarify concepts, and store relationships. Based on a tree index system, the figure represents a hierarchy of four levels encountered in the analysis of my data. During the process, new theories were constructed and tested by exploring possible links between these new constructions and the information gathered on my students. Level One signifies social and cultural factors that may impact how
girls learn science whereas Level Two represents some of the behavior
c characteristics derived from these factors. Level Three and Level Four are
subcategories that were revealed as I searched the data by exploring text,
building it cumulatively from my discoveries (Qualitative Solutions & Research
Pty, Limited, 1997).

<table>
<thead>
<tr>
<th>Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2</td>
</tr>
<tr>
<td>Level 3</td>
</tr>
<tr>
<td>Level 4</td>
</tr>
</tbody>
</table>

Social and Cultural Factors
Conflict
  - Overt
    - Female Anger
    - Male Anger
  - Covert
    - Boys’ Superior Attitudes
    - Female Submissiveness
Solution
  - Solving Group Conflict
Expectations
  - Working Together in a Collaborative Learning Group
  - Confusion
  - Feelings about Science
  - Friendship
Self-Confidence
  - Pride
  - Ability
  - Trustworthiness
Positive Attitudes
  - Flirting
  - Being Cordial
Interaction
  - Scientific Jargon
  - Best Way to Learn Science
  - Preference
  - Job Preference

Figure 1. QSR NUD*IST Tree, Prevailing Themes.
Initially, I began the painstaking task of inserting students' narratives, interviews and other data into the QSR NUD*IST computer program, and then I examined each, looking for a common thread. Interestingly, throughout this diligent process, I believe I gained more insight into my students' thoughts, preparing me for the next step which was to analyze their reflections and how my own were relevant to what they were attempting to convey to me.

As I analyzed each section of the data, I further reflected on its relevancy to my two questions, which helped me to consider each in depth, looking for hidden meanings and significant messages from what students communicated through conversations and behavior. Once found, I continued by assigning these sections of narratives and interviews into a specific theme or subgroup. With the aid of QSR NUD*IST 4, I was able to devise a display tree created from the index system containing my data. Eventually, I recognized that there were certain common elements, which developed into main themes of information, modeled in the above figure. Some of those themes are discussed in this investigation while others, such as scientific jargon, cordiality and flirting among stakeholders will be developed in other studies at some future date.

The results highlight how students' behave and act toward each other and emphasize how girls and boys interact as they learn science. Of course, throughout the learning process, these fifth grade students are learning about scientific concepts but, for purposes of this inquiry, I am interested in social and cultural factors that may influence their science learning. What is important for this investigation are students' attitudes during the course of learning science,
their behavior toward each other, and what they perceive and expect from one another as they perform hands-on experiments. The implication is that these factors may overlap and influence and affect how they learn science. In my discussion, I will first offer a review of attitudes and perceptions of the three girls followed by a similar examination of the boys.

The Girls

Three girls were stakeholders of a collaborative learning group, an African American, a Caucasian and a Hispanic. Margarite, a Hispanic, was the subject of Chapter Five. There were certain underlying factors common in their attitude about themselves and each other. One of those factors centered on their level of confidence. In some cases, the girls felt proud of their accomplishments and confident that they could achieve success. Margarite, the female focus of Chapter Five, takes pride in her achievements and on two accounts remarks to Tom, a member of her group and on one account to me, her teacher:

**Textbox 6-1. Pride in Margarite's Achievements.**

<table>
<thead>
<tr>
<th>Margarite (to Tom):</th>
<th>I am recording because Mrs. G. said I did a good job last night at the Science Fair Parent Evening (interview, May 16, 2000).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margarite (surprised to Tom):</td>
<td>Look at this one, I improved William's plane testing airplanes, February 22, 2000).</td>
</tr>
<tr>
<td>Margarite (to Mrs. Greenspan):</td>
<td>There's a bunch of different popular kids in different groups. Like in science group. For girls, I am the most popular. For boys, Tom is the most popular (interview, May 16, 2000).</td>
</tr>
</tbody>
</table>
In these three separate instances and also elaborated in Chapter Five, Margarite perceives that she is capable in science but at the same time she is often surprised by her innate ability to grasp scientific concepts. In one way, she acknowledges her intelligence in a matter of fact fashion yet in another way, she appears to convince herself and others in her group that she can be smart.

Amy is another stakeholder in the collaborative learning group. Her self-perception is somewhat different from Margarite’s self-perception. In Amy’s case, she has a tendency to downgrade what she knows in science and appears to be self-conscious when asked to express any feelings about herself and other stakeholders of her learning group. The following narrative conveys her thoughts:

**Amy:** Margarite was trying to put that thing together because none of us could put the thing in. It was kind of hard, we all tried. I tried!

**Mrs. Greenspan:** And?

**Amy:** It wouldn’t go in. I didn’t know how to and she said, “Let me see it!”

**Mrs. Greenspan:** So how did you feel when you couldn’t do it?

**Amy:** Nothing. I knew I had tried (interview, May 16, 2000).

Textbox 6-2. Amy Displays Self-Confidence.

Throughout her interview, she seemed to be guarded and tight-lipped. Not as candid and straightforward as Margarite, there were moments however when Amy did convey some feelings of self-confidence as illustrated in the above textbox. Amy knows that she has put forth a maximum effort in assembling a
rocket and she is proud even though her attempt is unsuccessful. For her, trying to accomplish something gives her positive feelings about herself and as a result augments a feeling of self-satisfaction.

Cathy, another stakeholder in the collaborative learning group, also reveals that she is self-confident, as she compares a home experience to one at school. In the following narrative, she wants to share her knowledge about building a rocket but she is scorned and rebuked by the boys. As I watched her interact with her peers over a long period of time, she consistently accepted a nonassertive role, not even trying to convince her peers of her abilities.

Cathy: Since I'm pretty good in understanding instructions, I basically helped my dad put together the swing set yesterday, I thought maybe I could help them.

Mrs. Greenspan: And what happened when you tried?

Cathy: They [the boys] really wouldn't hand it to me (interview, May 16, 2000).

Textbox 6-3. Cathy's Nonassertive Behavior.

By observing them and listening to their accounts, it appears that the girls in this group are fairly self-confident which enables them to share knowledge and perform science experiments. Because each of them feels good about what they accomplish, they believe that they can and should be active participants in their learning group. However, as a result of their interaction with the boys, they sometimes step back and do not perform according to their ability.
On the other hand, their behavior does not thwart how they feel about science or what they have learned throughout the year. In an essay, Amy claims that she has learned many things in science this year. She states:

In conclusion, you can see that we have learned a lot of things in science. There is still a lot we have to learn in science until the end of the year. At the beginning of the school year, I hated science but now I love science and am making an ‘A’ in science (Amy’s essay, May 1, 2000).

Textbox 6-4. What Amy Learned in Science.

In her own words, Margarite also wrote:

My favorite project yet is the airplane project. That was where we constructed five different airplanes made of paper and flew them and measured how far it would go. The best part was there was a nice wind blowing. Then there was the famous ‘Peoples Coaster.’ We were studying motions. Better known as one of Newton’s three laws of motion. Next was the rocket balloons. That one was also motion. We took a balloon and placed it in a plastic bag attached to a straw attached to a piece of string. We released the balloon and watched it too (Margarite’s essay, May 7, 2000).

Textbox 6-5. What Margarite Learned in Science.
On the one hand, Amy believes that loving science is equivalent to achieving a good grade. We all know that when children are engaged in learning, they are animated, excited, and responsive (Brogan, 1998). As Amy evolved from a fairly inactive participant in the beginning of the year to a more involved and committed stakeholder, her self-confidence escalated and she learned to love science. Therefore, her grades improved.

In Margarite's essay, she summarizes her fifth grade science experiences by espousing her knowledge. She writes a detailed story listing all the scientific concepts she has learned. For both girls, it appears that even though on occasion the boys treat them poorly, they overcome that adversity and in spite of it, display a love of science and a pride in sharing what they know.

To further understand about girls' feelings toward science, each of the three girls drew a portrait of a scientist to illustrate girls’ perceptions about science and scientists. Seated far from one another in the classroom, they each drew a smiling female scientist wearing a jacket with pencils in a breast pocket surrounded by scientific paraphernalia such as beakers, test tubes, and a Bunsen burner. In one instance, the scientist was wearing eyeglasses although none of the girls wear them. It is evident from these illustrations that Margarite, Amy, and Cathy believe scientists can be females and not males with bushy mustaches and frazzled hairdos, contrary to common perceptions and stereotypical misconceptions (Barman, 1997). For all intents and purposes, it appears that the girls have a positive attitude about learning science, holding the view that females are equally qualified as males to be scientists.
In my opinion, these girls indicate most of the time that they are proud of their accomplishments in science and are self-confident as they engage in science discourse with boys. They further appear to be self-assured about their abilities as amateur scientists and willingly want to share science knowledge with their peers as exemplified in their essays describing science experiences.

Additionally, they are aware of their strengths and weaknesses, but it also appears, from the aforementioned excerpts, that others question their intelligence and ability. Amy, in this instance, gains inner strength by knowing she has tried to achieve, not needing the acceptance of the boys in this instance but at other times wanting approval from them. In Margarite's incident, she convinces her peers that she should be the recorder because the teacher has given her a compliment the previous night. In the case of Cathy, she wants to read instructions from an experiment but her peers prevent her from having the opportunity. Therefore, we can summarize by reiterating that these girls appear to take pride in what they know in science. But, on occasion there seems to be extenuating circumstances, as a result of interacting with the boys, which make them question who they are and how they should act.

Furthermore, during the students' conversations as they solved problems and interacted with each other there appeared to be moments when the stakeholders were cordial to each other, evidenced by sharing constructions. Another noteworthy feature is that the atmosphere at the end of the year was more agreeable to sharing than at the beginning of the year. They exhibited more of an effort to learn together as a team, helping each other toward reaching
consensus. This may be attributed to the fact that they had worked together for a year and that each person understood different aspects of a problem, which allowed each one to try out a solution as others improved upon it (Frankenstein, 1997). One of the data collectors observed the students as they completed an experiment, which required counting the number of washers held by a magnet:

Showing signs of real teamwork as each one puts washer one at a time (observation, May 11, 2000).

William also remarked about an experience of making a rocket near the end of the year:

Uh, huh! At the end we opened the rocket and all of us worked together to build it (interview, May 22, 2000).

On the contrary, dissension and discord was commonplace among the team members as they began an activity. Once it was decided who would do what part of an experiment, then teamwork was usually achieved for a short period of time. In this instance, it appeared that the stakeholders were committed toward a mutual purpose of coordinating and integrating their efforts (Johnson & Johnson, 1991).

However, there was a pattern of conflict among the stakeholders part of the time, affecting the science learning of all six students, particularly the three girls. The data imply two different forms of conflict: one was overt, manifested through female anger, submissiveness, and aggressiveness, and the other was covert, exhibited through sarcasm, banter and body language. First, overt conflict is
obvious in the following example of female anger expressed during an experiment on static electricity:

<table>
<thead>
<tr>
<th>Tom:</th>
<th>We'll try everyone's hair.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amy:</td>
<td>(getting angry) I just told you, I am not touching my hair!</td>
</tr>
<tr>
<td>Don:</td>
<td>Oh, come on, Amy!</td>
</tr>
<tr>
<td>Amy:</td>
<td>You boys have no respect for us!</td>
</tr>
<tr>
<td>Tom:</td>
<td>We don't have respect for you!</td>
</tr>
<tr>
<td>William:</td>
<td>Say I am sorry for yesterday. I never hit you.</td>
</tr>
<tr>
<td>Amy:</td>
<td>You are a pain (static electricity experiment, March 6, 2000)!</td>
</tr>
</tbody>
</table>

Textbox 6-6. Expression of Female Anger.

Although Amy is emphatic that she does not want her hair touched for this experiment, the boys are relentless. They badger her until she remarks that they do not respect her or any other girl. It is possible that there is some other underlying issue that permeates this discussion due to William's remark, but it also exemplifies that Amy is angry at the boys' actions.

In another instance, in an attempt to stay on task, Margarite tries her best to get everyone involved in the experiment but she finds it difficult to achieve. Her only outlet is to get mad and make a sarcastic remark to alleviate her rancorous feelings.
William: This isn't your desk anymore. Get out of my desk!

Margarita: No! Stop playing! Look, static electricity! Nothing happens. Give me the string!

Tom: Use the back and rub it against your hair.

Margarita: It is working. (getting mad because boys are not paying attention).

Let’s get something cuz he’s too passive (pointing to Don). (static electricity experiment, March 6, 2000).

Textbox 6-7. Displaying Overt Female Anger.

In this scenario, one of the boys shouts at Margarite but she counters in kind with an angry response. It appears that in her mind in order to achieve success, Margarite must take control of the materials for the experiment by demanding them from one of the boys. As a result, while she manipulates the objects to solve the scientific problem she reestablishes her self-confidence and singularly reconfirms that what she is doing is successful. At the same time, she becomes angry with the boys for not giving her the attention and respect she believes she should be accorded and is frustrated with the boys’ attitudes.

In another example, Margarite grabs glue from William, as she becomes impatient with the way he is gluing a piece to a model of a rocket. While trying to use a ruler and hold the instructions at the same time, Margarite gives the instructions to Amy who passes them to William. William then begins to read the directions, laughing with the others while Margarite grabs them and carefully reads them to herself. Then, she attaches a piece to the rocket to complete the
model. Filled with frustration, Margarite resorts to completing the assignment alone.

Amy, too, becomes frustrated with Don because she feels he is not working to his potential. Not demonstrating any effort to participate and share his knowledge, she remarks,

Don, everyone is working together but you are not (bolt experiment, January 11, 2000)!

In another scenario, rather than openly express her anger toward the boys, Amy vents her rage through body language by standing up and folding her arms, a signal that conveys hostility and animosity. It is interesting to note that throughout her collaboration with the boys, Amy does very little to solve her frustration. It seems she withholds her rage to a point and then retreats into submissiveness. From Margarite's following remarks, it is probable that she recognizes that Amy is agitated as she plays the position of peacemaker, ensuring that everyone is involved in the project and demanding that Don participate.

<table>
<thead>
<tr>
<th>Amy:</th>
<th>They [the boys] are not letting us do anything (as she stands up with arms folded).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margarite:</td>
<td>Okay, let's share!</td>
</tr>
<tr>
<td>Don:</td>
<td>Talk about conductors and insulators!</td>
</tr>
<tr>
<td>Amy:</td>
<td>This is not organized at all!</td>
</tr>
<tr>
<td>Margarite:</td>
<td>Pick one. Quick! You are the only one with one. You've got two.</td>
</tr>
</tbody>
</table>
You don't need more. There, everyone has something. (She stands up and defies Don). Now that we have sorted this, the only conductor is the paper clip.

Margarite: Don, sit down! Good boy! What are you talking about?

Amy: We are NOT organized. I say three minutes; we have three minutes left

Textbox 6-8. Conveying Negative Body Language and Becoming a Peacemaker.

In this case, both Amy and Margarite are attempting to establish a position of authority in their collaborative learning group. Their efforts are rewarded because Don complies with their demands and does not argue with them. It appears they are able to manipulate Don’s actions, perhaps because of the role he plays as a stakeholder in the group or because of the nature of his personality.

In another experiment, Margarite is actively listening to Tom as she tries to test some objects for magnetism. Even though all the stakeholders are seated in a circle, only she and Tom are engaging in discourse. Tom manipulates the objects despite her protests and within a short period of time she accepts his mandates.

Margarite: Let me do it!

Tom: No, I am doing it. Look, the table is magnetic (magnets/bag of goodies,
March 28, 2000).

Textbox 6-9. Displaying Female Aggressiveness.

Sometime later, Margarite and Tom continue to banter while William and Cathy join them. Cathy apologizes for her behavior, but Margarite soon becomes angry at the boys' actions and walks away from the group to answer the door. Cathy accedes to William's directions while Amy and Don observe.

Margarite: You're in gifted, Tom!

Tom: Well, so are you!

William: It's a miracle!

Tom: Why did we get a motor?

Cathy: To confuse us.... maybe!

William: Shut up, Cathy (Manipulates washer to electromagnet).

Cathy: (retreats to silence).

Margarite: (with disgust) goes to answer the door (leaving the scene).

Tom and William manipulate objects while Don, Cathy, and Amy watch them (making an electromagnet, May 23, 2000).

Textbox 6-10. Expression of Female Anger and Submissiveness.

Second, covert conflict in the form of sarcasm is evident among girls by the following remarks from both Margarite and Amy as they begin to design paper airplanes. This exchange of dialogue occurred within minutes of each other.
Margarite (addressing Tom): You want an ‘A,’ so let’s start!

Amy (to William): You had someone do *all the* work and write it for you (making airplane designs, February 24, 2000).

Textbox 6-11. Displaying Female Sarcasm.

As shown, both Margarite and Amy resort to sarcasm when they interact with the boys in an effort to lessen the tension they are experiencing. Likewise, Margarite, as a committed stakeholder, is intent on proceeding forward, undertaking the task of persuading everyone to work toward consensual agreement as illustrated in the following dialogue with the other girls:

Girls, (as she reads the directions) we have to work with them, not against them. It’s not working this way (making a rocket, April 20, 2000).

Textbox 6-12. Margarite, a Committed Stakeholder.

Yet she clearly overcomes some of her anger at the boys’ behavior toward her by expressing her thoughts sarcastically as illustrated below. At one lesson, she becomes even more caustic and cynical, interrupting William and saying,

I got it! William, I told you. I thought I was a girl (making parallel and series circuits, May 16, 2000)!

Textbox 6-13. I Thought I Was a Girl!
In this scenario, Margarite sarcastically remarks to William that she is a girl, referring to an earlier comment that he made that girls are not capable of achieving success in science. However, Margarite affirms that he is wrong because as a girl she does master creating a circuit and proves it to him and the other boys by accomplishing the task. Once again she has to prove her worth within the group and alter boys’ misconceptions about girls and their ability to achieve.

Notwithstanding, it was observed that the girls have a tendency to huddle together preferring to reach consensus together rather than in a mixed group. The nature of their conversation appeared to be more fluid, easygoing, subdued, and quiet. Furthermore, when they collaborated to learn about the forces of motion, they appeared to appreciate each other’s ideas more during their exchange whereas when both girls and boys attempted to reach a solution their means of communication tended to be filled with commands, derogatory comments, and sarcasm. Such words as “Gimme it!” “It’s my turn!” and “Let me do it!” were invariably spoken when they met in a co-sexual setting (Greenspan, 2000).

Margarite explains how she feels about working with boys.

Like I was upset when we were fighting about the rockets. I was upset that the boys felt that way that girls shouldn’t do it (interview, May 20, 2000).

Textbox 6-14. Margarite’s View on Working with Boys.

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Margarite does not like confrontation and tries to prevent it by all possible means. A familiar scene saw the boys 'ganging up' on the girls as each girl tried to mediate an ugly situation and appease them. But, surprisingly, all the girls are conscious of how the boys feel about them as they learn science and what role both should play throughout the learning process. They appear to accept the boys' attitudes to a certain point. Even though Margarite and the other girls strive for peacefulness, they are the first to argue for their rightful place and an equal opportunity to participate in the group. However, once the initial anger dissipates, they concede to the boys' expectations and submit to their demands.

**The Boys**

Three boys, an African American, an Asian, and a Hispanic participated with the girls. As with the girls, the boys maintain certain attitudes about who they are and how others perceive them in their collaborative learning group. On the whole, the boys appear on the surface to be self-confident and assured about their ability to learn science. All of them confirm these feelings in the following remarks:

| William: | Let the master do it! I'm metric boy with a ruler (testing airplanes, February 22, 2000)! |
| Tom:   | I think this is my kind of thing. I like to assemble. I like to fix things and build these kinds of things like rockets and maybe Cathy and Amy don't like to do hands-on things like this (interview, May 23, 2000). |
| Don:   | Yes, I consider myself smart even though I don't like bragging very much. |
I think I'm smart. Yes (interview, May 22, 2000)! 


It is noteworthy that Tom, like the other boys, exhibits high self-esteem but probably believes that two of the girls do not like hands-on activities. He implies that since the girls do not engage actively in the assignment they are probably not interested in it. Although that may be the case, it is an assumption on his part on how girls feel and learn about science.

Just as the girls displayed moments of anger, so did the boys. Some of the time the conflict was overt and other times it was covert. It is exemplified in the conversations from the following video segments:

**Margarite:** No, you didn't. It's my airplane. You threw it at me.

**Cathy:** Give him an airplane.

**William** (to Tom) I don't want to be a part of this group (airplane designs, February 24, 2000).

**Margarite:** I'll go get string. You boys are having problems!

**William:** No, we are not! We don't want you in our group (balloon-static electricity, March 6, 2000).

**Cathy** (to Don): Give me the glue! I need 4 paper towels (Don gets them).

**William:** Too much (making rocket balloons, February 17, 2000)!

Textbox 6-16. Boys Display Anger.

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The boys appear, in these instances, to become angry as a result of interacting with the girls about what the boys believe belongs to them. As a norm, the boys behave aggressively by pulling objects from the girls but generally act more covertly, sometimes whispering remarks to other boys or mumbling under their breath about something one of the girls has done. Rather than taking a stand in an open and candid manner, the boys simply resort to sarcasm. Using sarcastic idioms such as "I told you so!" "Whatever!" and "Just tell me what to do!" are commonplace for the boys.

When he was asked why there are arguments, Don was perceptive. He recognizes that each person in the group has a different perspective and each one believes that she/he is correct. Best stated in his words, Don remarks:

| Some people say, “No, we should do it this way!” No, why don’t we do it this way!” “All right, you all know I am right!” You know everyone’s arguing their perspectives because they think they are right. Each one of us has different perspectives and one person has to be right either way (interview, May 22, 2000). |

Textbox 6-17. Don’s Perspective on Collaborative Group Learning.

Don, like Margarite, is mature beyond his years. He verbally expresses his opinions and in this instance appears to understand the dynamics of the learning group. He recognizes that each person has a belief or a point of view that needs to be expressed as the correct one. He believes that some of the girls and boys
in his learning group require recognition from their peers for being accurate and in their effort to convince each other, altercations may occur among them as they assert what they believe to be true.

Boys also display angry tendencies when they feel superior toward the girls. They use name calling that downplays girls’ ability and utter remarks about girls ‘messing up our planes’ (making airplanes, February 22, 2000) or refer to their intelligence in a derogatory fashion by calling one ‘a smarty science girl’ (William’s interview, May 16, 2000). Such language and behavior can only affect girls’ self-perception and self-worth.

But even though there is strife among the girls and boys as they engage in science discourse, the boys acknowledge the importance of girls participating in their learning group. One of the boys recognizes and admits that they need girls to achieve. William said,

I don’t know what to do. Where is Margarite when you need her (making a circuit board, June 7, 2000)?

He further said:

| We feel bad because, we like, we feel we need a girl, but at the end we needed some help from Margarite because she did that when she was in third grade (interview, May 22, 2000). |

While William has confidence in his ability to perform an experiment, in the long run, he recognizes that Margarite is an asset to his group because of her previous experiences in third grade. Usually the first to begin an experiment and preferring to be in control of any given situation, he relates that science is confusing for him at times, and he is not very good at it; therefore, he needs the girls to help him. It is unclear whether his respect for Margarite is derived from her previous experiences or her expertise and intelligence.

When William was asked who he would like to have in his collaborative learning group if he had a choice, he stated that he liked everyone in his group because they were all friends and they always received an ‘A’ for their projects. Specifically he mentions two of the girls as assets:

**Mrs. Greenspan: Why would you choose those two girls?**

**William:** Those two girls because they always help us and we learn new things from them (interview, May 22, 2000).

Textbox 6-19. A Boy’s Admiration of Girls.

Later, in the same interview, William affirms that if the group was comprised of only boys, then there would be too much talking and the experiment would not be completed because the girls are patient with them and help them read instructions. He divulged that science is confusing for him especially the units on magnetism and electromagnets and that the girls are good in science. William is
aware that he needs help in this subject and relies on the girls to get him through the necessary steps in the learning process.

Don, like William, is proud to be a member of his collaborative learning group:

I like science very well because apart from the arguments that we have it really is a good group to be in. Because they're nice to me when I'm not trying to help them. When I'm trying to help the group sometimes they don't understand (interview, May 22, 2000).

Textbox 6-20. Don’s Views on Girls.

In the above narrative Don believes that everyone in his collaborative learning group works diligently and he also claims they are very smart, especially admiring Margarite's ability to get a task done.

In other words, boys recognize that girls contribute to the success of the learning group even though they are unaware of how they behave toward them. For the boys, it is perfectly natural for them to poke fun at the girls and downplay their capabilities. However, when the girls become angry and resort to sarcasm as the boys do, they do not directly stab at the boys' ability to achieve. Rather the girls, as admitted by the boys, are patient and willing to help them overcome any misconceptions in science.

**Opinion Survey**

Further findings were compiled from an opinion survey, which was submitted to each of the students in the beginning of the school year and at the end of it.
Although it was my intention to create a similar parent opinion survey to understand parents’ perspective on how they feel about the teaching and learning of science, which may affect their children’s views, it did not come to fruition due to time constraints and the inaccessibility of the parents.

The following table is organized to elicit an understanding of how each student feels about a particular question related to science learning. There are nine columns for nine questions that each stakeholder answered in the questionnaire. I have created a table for fifth grade girls and one for fifth grade boys, arranging the female and male stakeholders at random. Questions were open-ended as much as possible in order to give each student an opportunity to express their opinion candidly and honestly.

Table 6-1 expresses the opinion of the fifth grade girls and Table 6-2 exhibits the convictions of the fifth grade boys. At the time of the first survey, all of the fifth grade students anonymously responded to the questions while on the contrary at the end of the school year, only the targeted six students responded. The below tables are a compilation of the results of the latter survey collected over a two-month period from May to June 2000. The questionnaires were submitted to the majority of the targeted students just before several science classes and those who were absent completed the survey a week or two later. In some cases, the six students were unable to complete the questionnaire in the allotted time and completed it over several sessions.
Table 6-1

**What's Your Opinion (Fifth Grade Girls)?**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Do you like working in learning groups?</th>
<th>Do you like learning with girls or boys in learning groups?</th>
<th>How do you like to learn science? By yourself with a partner or in a group?</th>
<th>What ideas did you learn about plant and animal cells? Forces of motion? electricity?</th>
<th>How do you learn Science best?</th>
<th>Is there anything I can do to help you learn science better?</th>
<th>Do you like having a special job in your learning group?</th>
<th>What special job do you like best in your learning group?</th>
<th>Do you ever have any conflicts in your group? If so, what are they? How do you resolve your differences?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margarite</td>
<td>Yes</td>
<td>Girls &amp; Boys Group</td>
<td>They're all very complicated to learn about, but once you've got it, it's easy.</td>
<td>Group</td>
<td>No</td>
<td>Yes</td>
<td>Does not matter</td>
<td>Yes one big conflict that I think was existent on the side of the boys was in the rocket building. While building the rocket the boys told the girls to read the instructions and they built. We said that wasn't fair, and one of the boys said, &quot;Let the boys do it!&quot; So the girls took the materials so they had no choice but to let us help.</td>
<td></td>
</tr>
<tr>
<td>Amy</td>
<td>Yes</td>
<td>Girls Group</td>
<td>Some ideas I have is that most cells are small. They can only be seen through a microscope. I think that's cool.</td>
<td>In a group</td>
<td>No</td>
<td>Does not matter</td>
<td>Assistant manager. I like that job because it's the most active job in my science group.</td>
<td>Yes, we do. Some conflicts we have are who is going to have what job. Tom and Cathy always have about being project director. Some ways my group solves that problem is one day Tom and the other day Cathy. Another conflict my group has is who do what. One way we solve that problem is we all take turns doing one job.</td>
<td></td>
</tr>
<tr>
<td>Cathy</td>
<td>Yes</td>
<td>Girls Group, Partner Group</td>
<td>I learned in all that no matter what angle you look at things, they are never the same. Girls, Group of friends</td>
<td>Explain more, give more time.</td>
<td>Yes</td>
<td>I like reporter cause it makes me feel important.</td>
<td>We solved it with the project director about who would do what.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Table 6-2

What's Your Opinion (Fifth Grade Boys)?

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Do you like working in learning groups?</th>
<th>Do you like learning with girls or boys in learning groups?</th>
<th>How do you like science?</th>
<th>By yourself or in a group?</th>
<th>What ideas did you learn about plant and animal cells? Forces of motion? Electricity? Magnetism?</th>
<th>How do you learn science best?</th>
<th>Is there anything I can do to help you learn science better?</th>
<th>Do you like having a special job in your learning group?</th>
<th>What job do you like best in your learning group?</th>
<th>Why do you like that job the best?</th>
<th>Do you ever have any conflicts in your group? If so, what are they? How do you resolve your differences?</th>
</tr>
</thead>
<tbody>
<tr>
<td>William</td>
<td>Yes</td>
<td>Girls &amp; Boys</td>
<td>Group</td>
<td>I learned what was the most powerful thing in the cell.</td>
<td>In a group</td>
<td>Put one person out and another person in</td>
<td>Does not matter</td>
<td>Manager (erased)</td>
<td>Who gets to hold the stuff?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don</td>
<td>Yes</td>
<td>Boys</td>
<td>Group</td>
<td>Cells make tissue-pull, pull, protons, neutrons, electrons, electromagnet</td>
<td>In a group</td>
<td>No</td>
<td>Yes</td>
<td>Materials manager, because I get to handle all materials first.</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tom</td>
<td>Yes</td>
<td>Girls &amp; Boys</td>
<td>Group</td>
<td>Lot of interesting facts.</td>
<td>In groups</td>
<td>No</td>
<td>Does not matter</td>
<td>Materials manager, I get to handle most supplies.</td>
<td>We fight over jobs and we alternate jobs every time.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relevant to the findings of this study, fifth grade girls like working in groups and learn science best in a collaborative learning group, although one states she prefers working with just girls, her friends. The one that chooses to work with only girl friends has a tendency to sit quietly and wait for the others in the group to become organized before she participates. It was observed that during the initial stages of group learning, Cathy rarely takes the first step toward
manipulating objects especially when the boys do. It is difficult to judge whether this behavior is based on her personality or her attitude that arguing with the boys would be non-beneficial and useless.

Critical evidence from this survey reveals that girls are basically aware that learning science with boys affects their well being because two of the girls choose and prefer to work only with girls whereas one girl prefers to work with both girls and boys. Two of the three girls in this research project, if given a choice, elect to work with girls in a same sex setting. In other words, girls feel safer and more comfortable when they engage in science with their own kind (Kruse, 1996).

In addition, when the girls were asked what ideas they learned from the fifth grade science curriculum, their responses were quite complex. One perceptively cites that all science ideas are complicated but once they are learned they are easy to grasp whereas another is intrigued with the ideas that cells are microscopic and cannot be viewed by the naked eye. Still another girl generalizes about the world around her from what she learned in science.

Two of the girls prefer a special job and one responded that it does not matter (see Chapter One). Surprisingly, assistant manager and reporter are the jobs that girls prefer other than the one girl who replied that it does not matter. The role of the assistant manager is to confer with the manager, a job of subordinate position. The reporter is accountable for writing and reporting what the group accomplishes during a lesson, explaining results and conclusions of an experiment. In a way, the reporter takes charge of the lesson because the
structure of the job entails recording all the information gathered during an activity (see Chapter Five). Therefore, in one regard, I believe that girls seek a secondary position as assistant manager, rather than manager, because they may realize how difficult it would be to handle boys who might become aggressive toward them. Also, they may not pursue that position because they are not confident that their peers would choose them to be manager since it is a job reached by consensus. Conversely, I believe girls have a strong desire to be a reporter, a primary job within the learning group, because they want to be the focus of the group, writing the group's words that represent and summarize the lesson.

When the girls discuss if conflict exists in their group, they are all conscious of it, confirming that each one solves conflict differently. In one scenario, two of the girls describe what they observed in a conflict situation. One girl aggressively removed the necessary materials for an experiment in order for the girls to have an equal opportunity to participate while another girl explains that the project director, a boy, was responsible for maintaining peace among members, which is a job girls do not prefer. Finally, one girl explains that conflict is resolved by equitably sharing jobs from one lesson to the next.

Although the responses from this survey are derived from three girls and three boys, the findings are crucial in understanding how they all feel about group learning. Boys, not as verbal in their accounts as the girls, tend to give short, one-worded answers. According to the data, fifth grade boys prefer learning and working in collaborative learning groups, a feature that implies that these boys
are comfortable learning in a group rather than individually or in partner-pairs. However, more significant is that two of the boys favor working with girls and boys, and only one boy prefers to work with just boys. This implies that two of the three boys are secure and confident in a co-sexual setting, in comparison to two of the three girls who prefer to work only with other girls.

When they were asked if they preferred a special job, two of the boys remained noncommittal while one boy said he preferred it (see Chapter One and Chapter Five). In essence, they admit that they favor the job of manager and materials manager, supervisory jobs. I believe one of the reasons for choosing these jobs is because it places the holder of the job in a responsible, authoritative position. If a student is a manager then he is in charge of everyone throughout the lesson, ensuring that each individual is accountable for his assignment, performing accordingly and staying on task. In the same regard, the materials manager is responsible for getting the supplies from the teacher and takes control of the manipulatives from the onset of the lesson, without allowing anyone else in the group to touch them. It is interesting that the majority of the boys prefer these positions within the group, thus allowing them to be in a role of authority.

Summary

In terms of learning science, both girls and boys appear to be generally self-confident, proud of their accomplishments and are motivated to learn science. Both girls and boys display moments of anger as they interact with each other.
but the boys’ anger tends to belittle girls’ abilities as they engage in solving a science problem even though the boys recognize that girls contribute to the success of their learning. As this conflict both overt and covert occurs, it affects girls’ self-assuredness and ability to complete a task. Consequently, these girls appear to alter their behavior and become more inhibited. In other words, they pretend they are someone else, holding back what they really know. These new attitudes, on the part of both the girls and the boys, cause anxiety and an undue amount of stress. However, there are times when girls do struggle for an equal opportunity to express their viewpoint, but eventually they accept their role in an effort for peaceful co-existence. Ultimately, this behavior impacts how they learn science.
"Cause like the kind of things we like is more like scary stuff, action stuff, and funny stuff than like girls. And we like burp and we drink soda a lot and tv, we watch movies like "Scream" and when blood comes out we like action movies and we like to sweat, too (A boy's remarks on differences between girls and boys, William's interview, May 22, 2000).

**Introduction**

The purpose of this research was to determine if social and cultural factors impact how girls learn science as they engage in science discourse with other girls and boys. After analysis of the data and in reference to the original questions stated in Chapter One, possible implications will be presented in this chapter followed by a discussion relevant to present day literature on gender equity.

The following matrix, related to the questions of this investigation, serves as a summary guide to a further understanding of how the three girls and three boys learn science. It suggests what role each plays as a stakeholder, how and if leadership qualities are apparent, and how each engages with the other in
science discourse. The last section of the matrix illustrates interaction among stakeholders throughout the process of learning science. The letters represent the fifth grade strands based on the Sunshine State Strands and Standards for Science (see Appendix J).

Table 7-1

A Summary of How Stakeholders Learn Science

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Margarite</th>
<th>Amy</th>
<th>Cathy</th>
<th>William</th>
<th>Tom</th>
<th>Don</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>Gathers girls to learn together, peacemaker A,B,C,F</td>
<td>More comfortable with girls and frustrated with boys A,B,C,F</td>
<td>Flirts with Don, interacts with girls more often, prefers to retreat into silence B,C,F</td>
<td>Gives orders, bossy, demands attention from all stakeholders A,B,C,F</td>
<td>Quietly shares knowledge with all stakeholders B,C,F</td>
<td>Listens to all stakeholders, especially girls, occasionally off-task B,C,F</td>
</tr>
</tbody>
</table>

Note. Strands are represented by letters: A = magnetism, B = electricity, C = forces of motion, F = animal and plant cells

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Implications

The results of this study indicate that there are clearly some social factors that impact how girls learn science. Throughout Chapters Five and Six, I reviewed students' narratives and comments as a means toward understanding how both fifth grade girls and boys feel about the teaching and learning of science. With reference to the two questions I posed in the beginning of this inquiry and have repeated below, those conversations add credence to the inferences I will suggest from one question to the next in this discussion, and the reader will note that the assumptions may overlap because, in reality, one may be the result of the other.

How Do Girls, as Stakeholders in Collaborative Learning Groups, Engage in Learning Science?

Current literature has found that on a cognitive level, girls and boys solve problems differently. In Chapter Two, it was mentioned that the Woodrow Wilson Gender Equity in Mathematics and Science Congress (1993) confirmed that girls are inclined to use inductive, experiential, creative and intuitive thinking and boys tend to use deductive, rigorous, structured, and axiomatic thinking. Harding (1996) also discussed how girls learn and remarked that girls are cautious when they begin, wanting to know how, why, and whom. This inquiry appears to corroborate some of those findings.

As I observed six students engaging in science learning, it seemed that the girls started to solve a problem more prudently than the boys. They appeared to
think carefully about what they had learned in another grade and then attempted to reach a solution in a creative manner, as the rocket building (see Textbox 5-12) and rocket balloon experiments exemplify (see Textbox 6-5).

In Margarite's case, she appeared to be more intuitive than the boys when she solved a scientific problem. For instance, during the roller coaster experiment, Margarita knew what to do to achieve the required speed of the marble for the group's roller coaster from observing roller coasters in real life as shown in Textbox 5-13. In the rocket building project, she resorted to her own experiences in third grade to assemble a perfect rocket for launching (see Textbox 5-12).

However, the literature indicates that boys tend to solve scientific problems contrary to the way girls do, claiming they are deductive, rigorous and structured. But, generally speaking, from what I observed, boys were not structured and rigorous as they approached a science problem. The boys in this inquiry immediately played and handled the manipulative materials, proceeding in a haphazard fashion. They hurried and grabbed materials in order to explore, not taking the time to think through the learning process as shown in Textbox 5-10. After seeking one alternative solution after another without much success, they approached the girls for their input. Some of the time they read directions together and negotiated toward consensus (see Textboxes 6-18 and 6-19), although there was dissension. It is difficult to say whether this was due to the boys' immaturity or a lack of understanding about a science problem, as one boy
confirmed that he needed girls to help him understand scientific concepts (see Textbox 6-19).

The data from this research also suggests that girls are not on equal terms with boys as they engage in learning science in a small collaborative learning group as evidenced in Textboxes 5-22, 6-7, and 6-8. It implies that some girls may be cognizant of the process that is occurring, even though they know it may affect their performance in a given lesson. This was evidenced in the way that Margarite's behavior changed from third grade to fifth grade. During the third grade, Margarite was a self-reliant and independent learner who preferred to learn science with her friends and was usually the first to initiate a lesson, as shown in Textbox 5-15. She claimed she did not care if she worked with girls or boys even though she generally chose a girl to be her partner (see Textbox 5-17). She was self-absorbed at times, but she willingly helped the members of her group, conferring with them to reach a decision (see Textboxes 5-3 and 5-9).

Although most of these attributes remained with her throughout the fifth grade, certain behaviors and attitudes changed. Where once she would have been the first to start an experiment, in fifth grade she had a tendency to wait until the boys began the lesson and when they required her expertise, she acted as shown in Textbox 5-12. In the fifth grade, she also appeared to be more inhibited in the presence of boys and admitted that she did not like to show how smart she was (see Textbox 5-24). As she engaged in science discourse, Margarite realized what was occurring which caused her heightened anxiety, obvious by her frustration. She knew she was an equal to the boys in
intelligence yet in spite of her attempts to alter the situation, she was not always successful (see Textbox 5-23).

However, despite these drawbacks, the majority of the girls in this study entered into and engaged in science learning with confidence in their ability to achieve and assurance in thinking through the steps of the learning process to solve a problem. As they engaged with others, particularly the boys, these behavior traits and attitudes began to diminish and they struggled for their rightful place within the group. They knew they were capable and knowledgeable in science but the fear of being too clever in the presence of boys inhibited what they demonstrated they knew and came to understand. This may also have been a reflection of the attitude and expectations of the boys merging with their own expectations.

Orenstein (1994) confirmed that girls have reduced expectations and less confidence in their abilities than boys have as they emerge into the teen years. From my investigation, it is apparent that social factors impact how girls are learning, diminishing how they feel about themselves as science learners. It was evident that when the boys attempted to communicate their viewpoint, two in the group consistently had a tendency to confront what the girls knew. I believe that at this point, the girls feared rejection and, aside from an initial show of force, accepted a subservient place in the group. The implication is that this pattern of behavior ultimately affects their learning of science because once they are not given respect for what they know and want to know, they may lose self-esteem.
and motivation to learn. As a result, their feelings toward science are compromised, possibly affecting their future learning of the subject.

Thus, the girls in this study did not enjoy the equal opportunity to learn science that they believed belonged to them as they engaged with other girls and boys. Not only did they hide their intelligence but they also resigned themselves to take on secondary roles within the collaborative learning group. It has been shown that they preferred subordinate jobs even though they knew they were responsible and capable. Rather than striving to be managers of a team, they preferred to be assistant managers and reporters as shown with Margarite in Textbox 5-3. Because they held an inferior place within the group, they were not given an equal chance to manipulate objects, share knowledge and jointly participate, which is one of the primary goals of teaching through hands-on activities. "Dewey argued that classroom life should embody democracy, not only in how students learn to make choices and carry out academic projects together, but also in how they learn to relate to one another" (Johnson & Johnson, 1991, p. 19).

How Do Girls Interact with Others in Collaborative Learning Groups?

AAUW (1998) and Sadker & Sadker (1994) imply that girls are stereotyped into traditional female roles, which may interfere with how they learn. As mentioned in Chapter Two, AAUW report some patriarchal cultures encourage conventional roles and send subtle messages to girls, inhibiting and preventing them from making life choices. Sadker & Sadker also confirm that girls are receiving less attention in classes than boys do, and teachers respond more to the aggressive,
demanding needs of boys than to the passive, submissive behavior of girls.

In reference to the second question of this investigation and in an effort to verify the reports of AAUW (1998) and Sadker & Sadker (1994), conflict appeared to be commonplace among the girls and boys as they interacted with each other in their collaborative learning group. When the conflict became too tumultuous, girls, as stakeholders in their collaborative learning group, took on the role of nurturer and mediator, acting as peacemakers. In that role of appeaser, two of the three girls generally reacted by behaving passively, mentally stepping away from the active energy emanating from the rest of the members of the group. The other girl, who referred to herself as the most popular girl, also retreated from learning, becoming frustrated and finally allowing the boys to take a position of authority as shown in Textboxes 6-6 and 6-14. However, in spite of the situation and in an effort to overcome these obstacles, the three girls appeared to be determined to learn science (see Textboxes 6-4 and 6-5).

Mentioned in Chapter Two, Orenstein (1994) asserts that girls select and prefer coursework that emphasizes social relationships and verbal skills. Murphy (1996) corroborated that boys are encouraged to play with toys centered on the nature of science while girls do not choose those types of toys. Consequently, she claimed that girls display boredom and disinterest when such activities are presented in the science classroom. This may contribute to the behavior of the girls in this investigation because occasionally they demonstrated the traits of a passive learner (see Textbox 6-10). However, I believe that as the girls learned
science, they struggled to be active listeners, competent doers, and committed stakeholders. But in order to persuade the boys about what they knew and in defense of their beliefs, they resorted to banter and sarcasm, which helped them vent the hostility they were feeling. Eventually they retreated, becoming frustrated with the situation.

Of course, sometimes they succeeded in convincing the boys about what they believed and because they usually were accurate in their predictions, the boys inevitably conceded to them. What is significant and what I wish to suggest is that rarely did the girls take the initiative to manipulate objects or read instructions at the onset of a lesson and when they did, they were usually attacked verbally by the boys, causing them some stress and anxiety. Such behavior may be a result of cognitive differences between how girls and boys learn science (see Textbox 6-5) as suggested in the findings cited in Chapter Two of the Woodrow Wilson National Fellowship Foundation (1993).

The inference is that girls’ self-perception may be diminished. Not being able to share their knowledge in some hands-on activities, they did what was expected of them. In other words, they sat back and listened rather than actively participated, displaying moments of anxiety during these learning situations. When asked with whom they preferred to interact as they learned science, two of the three girls chose a single-sexed setting rather than a co-sexual one, confirming a study conducted by Kruse (1996) which claimed that a single-sexed setting develops girls’ self-esteem.

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In that regard and also mentioned in Chapter Two, Kruse (1996) confirmed the findings of Frieze (1978) who learned that girls and boys have different expectations and are treated differently as they grow and develop. Kruse studied single-sex settings where two teachers, a man and a woman, mixed their classes and segregated girls and boys for long and short periods in specific subjects. She found that initially girls were somewhat insecure and restrained as they worked together but over time they grew more and more confident, free, open, and talkative. They expressed their opinions more candidly and were better at holding on to their opinions. She concluded that girls in an all girls' educational setting worked in a more concentrated effort, were more well-prepared, stayed on task, shared more knowledge, showed respect for each other, and helped one another more than when they learned in a co-sexual setting. "We find that the idea of developing a feminist pedagogy for girls in a single-sex setting as a strategy to empower them personally and professionally is a most effective method and one that has been consolidated" (p. 174).

This has implications for the teaching and learning of science because in a group consisting solely of girls, girls feel better able to share their knowledge equitably. Baker (1996) also confirms that female friendly instruction in science includes increasing the amount of time and varying observations during activities as well as incorporating and validating personal experiences to make students more confident in their abilities. As a result, students, particularly girls, will be more motivated to work in small groups. Such learning conditions are conducive to promoting self-satisfaction which follows accomplishment rather than
encouraging youngsters to believe that self-esteem precedes achievement (Ruggiero, 2000). Consequently, girls can behave accordingly and achieve to the best of their ability. This is not to say that an all girls’ environment would be the wherewithal solution, but the majority of girls in this study believed it would help them to learn science better.

**Discussion**

In Chapter Two, a report from AAUW (1998) further verified that gender bias and discrimination are prevalent and that there is a continuing cultural, social, and economic gap between females and males. Gender bias is commonly pervasive in science education causing many girls not to matriculate in secondary science courses, which in turn may prevent them from pursuing careers in science. Both MacDonald (1995) and Mason (1995) agree that the best method of learning for girls should be grounded in a social environment that is conducive to building self-esteem, where girls are comfortable to confront ideas and have the opportunity to explore challenges.

Pertinent to these studies, my research suggests that fifth grade girls are affected by social and cultural factors as they engage in science discourse with their peers. In an earlier effort, AAUW (1995) indicated girls’ self-perception is lower than for boys and this inquiry validates those findings. It has shown that the three girls were basically aware of their intelligence, and truly believed that they could do anything the boys could do, but they disguised what they knew and became more inhibited as they progressed through the learning process (see
Frustrated and anxious because of the circumstances they encountered, the girls ultimately altered their personalities and conformed to the boys’ expectations. On the one hand, they perceived themselves as confident, bright human beings and on the other, they behaved differently in the presence of boys who expected them to conduct themselves contrary to who they were.

Orenstein (1994) further confirmed these discoveries in his investigation when he stated that as students emerge into the teen years, girls develop poor self-image, diminished self-confidence and reduced expectations. Thus, it appears that social and cultural factors are influencing these girls’ self-esteem as they edge into adolescence, impacting how they are learning science in fifth grade.

Additionally, it is evident that stereotyping exists in this small collaborative learning group just as in society-at-large (Frieze et al., 1978). The girls in this study occasionally encountered negative feedback from the boys in the form of sarcastic and angry comments when they attempted to participate actively in a science activity. On the other hand, they received positive feedback when they acted according to how the boys expected them to behave, causing each girl to adjust her actions. For instance, when Cathy made a concerted effort to read the directions for an experiment because she had prior experience, the boys refused to allow her to do it, and she submitted into silence (see Textbox 6-3). For Amy, a similar scenario occurred when she attempted to read instructions for another experiment and one of the boys told her that she was reading too fast (Amy’s interview, May 16, 2000). Likewise, Margarite attempted, time and time again, especially in the rocket assembly project to lead the group toward a successful
outcome, knowing that she was correct in her reasoning (seeTextbox 5-24). Using her persuasive techniques, Margarite at times convinced the boys that she was knowledgeable although there were other times when she appeared restrained and submissive (seeTextbox 5-20). In other words, these girls fall into a stereotypical female role of yielding to the expectations of boys.

Most of the time, two of the girls in the group deferred to the boys (seeTextboxes 6-3 and 6-6). In their attempt to become empowered, the girls sometimes faced antagonism from the boys but they responded in kind and more often than not, they succeeded in proving that they had something to offer in solving a problem (seeTextboxes 6-7, 6-8, and 6-13). However, in the long run, if they continue to encounter similar obstacles with boys, their self-image will probably be further impaired and the pattern of having to alter whom they really are will most likely affect their learning.

For Margarite, how she interacted socially with the boys influenced her learning. She admitted that the boys recognized her for her expertise and ingenuity because she was interested in sports and acted like a tomboy more than the other girls as shown inTextbox 5-26. In other words, in her eyes, to be accepted into the world of the boys, she has to be like another boy. In that regard, we can conclude that Margarite reasoned that the boys approved of her because she enjoyed sports like them. She on her own was stereotyping female and male roles in order for them to recognize her worth. But will the boys accept her for whom she really is? Recognizing that social and cultural factors affect all human beings as they live and work together, it is significant that this study
indicates that in the early years of learning, young girls are gradually becoming cognizant of boys' expectations (see Textboxes 6-8 and 6-12). As a result, that awareness may provide boys with an understanding of how girls feel about the teaching and learning of science and shape their behavior accordingly.

Appropriate to this inquiry, Fennema (1993) noted that females and males are equally intelligent but social and cultural factors lead them to behave differently. As I observed the six students, I noticed an underlying current of rivalry between the girls and boys (see Textboxes 6-9 and 6-10), affecting girls' self-esteem. One boy remarked "Why don't we measure it now? It would be smart" (sarcastically to Amy, Rocket balloons, February 17, 2000). These kinds of exchanges may ultimately hinder a girl from being successful and may prevent her from establishing a competitive nature in the future simply because it attacks her personal ability.

It is no wonder that girls think and believe that they achieve poorly because they lack ability, as Tobias (1993) verified in a study. She claimed that when girls achieve poorly, they attribute it to lack of ability, based on cultural expectations and when boys execute poorly, boys presume it is because they have not dispensed their best effort. In the same regard, when they perform well, girls believe it is based on luck while boys on the other hand, think they succeed because of their ability. Haag (1999) and Mann (1994) also substantiated these findings when they suggested that young adolescent boys place intense sexual pressures on adolescent girls, causing them to fight back. Although these fifth grade girls are self-confident at the outset of a lesson, as boys continue sending
subtle, derogatory and mixed messages, girls will continue to lose their self-confidence and innate capacity to compete.

What makes this inquiry unique is that younger girls act and react to boys' attitudes just as older girls do. Most of the studies conducted on gender discrimination center on secondary school girls (AAUW, 1995, 1998). One of the purposes of this investigation was to determine if young girls were equally affected, especially as they learn science. It is apparent that it is indeed true. Margarite, for instance, even in third grade was cognizant of the differences between girls and boys learning science. She claimed, “the boys were a lot calmer then” (Margarite's interview, May 2, 2000) (see Textbox 5-18). At that time, she preferred to learn with her friends, not caring if they were girls or boys.

Although she continued to justify that belief, she faced a constant badgering from the boys in her fifth grade collaborative learning group, always striving to take what she believed was her legitimate place in a learning environment which just happened to be a prototype or mini-model of society. Gipps (1996), as noted in Chapter Two, remarked that girls might be achieving in science but not really engaging in the subject. He believed that girls are not taking ownership of learning science or being motivated enough to overcome the social and cultural pressures needed to break the norms of society. One is to wonder that if girls continually confront such stereotypical behavior, then the trend toward inequality in the classroom will continue. Young elementary school girls, who live and work under these circumstances, will probably grow from adolescence to adulthood having to co-exist in a society that perpetuates gender discrimination.
What we have to recognize is that providing access and opportunity to do real science is not necessarily the solution to gender inequality. In order to create a female friendly science classroom; educators probably should address the issue of science as a male domain (Baker, 1996). Science today as a male dominated subject, mentioned in Chapter Two, warrants changes in the way that boys think about girls in the teaching and learning of science. It has been noted that science textbooks advocate and encourage science as a male-oriented subject omitting girls and women as influential figures in society (Giroux, 1991; Harding, 1996), portraying girls in traditional female roles.

Even assessment tests disadvantage girls because their content capitalizes on skills that boys are more likely to have than girls (Sanders et al., 1997). The results are that girls perform poorly on such tests as the Preliminary Scholastic Assessment Test, also mentioned in Chapter Two, which ultimately shortchanges girls from attending highly selective schools (Sadker & Sadker, 1994). Girls, like Margarite, Amy, and Cathy claim they love the subject of science and one stated she wants to be a scientist when she grows up but does the context of the school environment promote girls' values? Baker (1996) believes creating curriculum that explores social and technological implications of science that provide a context and rationale to commit science to real life situations and consider contributions of women may be the solution to helping girls narrow the gender injustices that exist.

How else can such a dilemma be solved? First, the educational system has to change by reforming the structure of teaching and making teachers aware of
the inequities that girls face on a daily basis. “Change, of course, may be either a matter of degree or of kind, so we can both gain qualities we don’t now have and also enlarge the qualities we do have” (Ruggiero, 2000, p. 15). If teachers would implement more collaborative learning groups into their teaching by promoting social skills, discussion, and inferring, they may help girls to become more empowered and responsible for their own learning. However, incorporating collaborative learning groups is not necessarily the solution. The group dynamics may reinforce stereotypes where boys take leadership roles and girls defer to their decisions (see Textboxes 5-20, 5-22, 5-23, 5-24, and 5-25). “Girls have less opportunity to speak in groups. When they do speak, they have difficulty holding the boys’ attention or their ideas are rejected” (Baker, 1988, p. 1).

But collaborative learning groups that emphasize inquiry-based projects can be beneficial for both girls and boys. One of the boys in this study agreed that collaborative learning is advantageous for all stakeholders.

Well, as the school year went along we’ve gotten to know each other a lot better. And build rapport. So we work a lot better together now and instead of not working together we all came together and worked together with all our skills. We finished the rocket and it went really good (Tom’s interview, May 23, 2000). Reeve (1996) confirms that developing academic skills through active, problem-based and collaborative learning leads to increasing students’ academic skills, with a corresponding increase in self-esteem. Also in Chapter Two, it was
recounted that Haag (1999) and Mann (1994) believed that collaborative learning ensures opportunities for both sexes to discuss their knowledge and opinions.

Margarite, chosen to represent the attitudes and behavior of fifth grade girls, reflected on learning science with boys in a collaborative learning group. Her behavior affirms that gender discrimination was indeed evident as she engaged in science discourse with her peers. First, she perceived herself differently from how others perceived her as shown in Textbox 5-20 and modified her behavior accordingly. Second, she felt more inhibited in sharing her knowledge because she was aware of the potential consequences of not being accepted by her peers (see Textboxes 5-13, 6-7, 6-10, 6-12, and 6-14). However, she continued as a perfect example of an individual who is secure in her academic achievement as she learns science. Even though the boys berated her, she was determined to learn science, no matter what she encountered as evidenced in her essays reproduced in Textboxes 5-1, 5-4, 5-7, and 6-5. Also, it is gratifying to note that Amy changed remarkably from a passive learner to a more active learner during the school year. She learned to overcome some of her anger and frustration and became confident about her science ability, although there were moments of extreme tension between her and the boys. Ultimately, she was proud of her accomplishments (see Textbox 6-2).

Keeping in mind that the intent of this research study was to determine if girls' attitudes toward science were altered as they interacted with other girls and boys, it is essential to further discuss the ramifications of this issue. Interestingly, girls appeared not to have many altercations with each other, preferring to learn
science together (see Table 6-1). Based on mutual respect, kindness and shared courtesies, behaviors rewarded in the classroom, they were generally cordial, helpful, and cooperative with each other. However, as they interacted with the boys, I believe that the attitudes of the three boys toward the girls in their collaborative learning group affected their self-image. What the boys conveyed to the girls during the process of learning science, exemplified in previous narratives, and how they communicated as they negotiated toward solving a scientific problem affected the attitudes of the girls, resulting in anger and frustration (see Textboxes 6-5 and 6-6). This possibly could have long term effects on girls’ attitudes toward learning science.

In this investigation, how did the girls’ attitudes significantly change relevant to learning scientific concepts because of the boys’ behavior toward them? As a matter of fact, the girls wanted to learn science no matter what obstacles they faced, and they consistently struggled to perform to the best of their ability, even though they were placed into positions that caused them to become frustrated and hostile (see Textboxes 6-6 and 6-8). It is my belief, at this point in time that generally speaking, these elementary aged girls were still determined to achieve in science because of their enthusiasm and natural curiosity, contrary to the barriers they encountered as they interacted with the boys. Just beginning to be cognizant of gender differences and, at the same time mature enough to reflect on them, these girls struggled to achieve and learn science. In spite of the odds, they also attempted to derive an inner feeling of success as shown in Textbox 6-1. However, over time as these girls emerge into
adolescence, wanting to be more socially accepted by their peers, the fear of being rejected will probably outweigh the desire to learn science. "The choices made and paths taken at adolescence have the potential to be pivotal, setting a course for the educational and vocational direction—and the psychological and relational character—of adulthood" (McLean Taylor, Gilligan & Sullivan, 1995, p. 69).

In my opinion, this continued pattern of behavior on both the parts of the girls and boys would presumably affect and influence how girls feel and learn about science. On the other hand, what we have seen in this investigation may be attributed to the normal development of girls as they proceed through the stages of becoming adolescents. But that will require a future research study.

Summary

By implementing the principles of constructivism in this inquiry, which encourages active learners to link their new knowledge to prior knowledge and apply expanded understandings to authentic situations, three girls and three boys engaged in science discourse in a collaborative learning group (Olsen, Panetski & Polka, 2000). The intent was to enhance their science knowledge and improve their understanding of science concepts. The students utilized manipulative materials and were encourage to ask thoughtful, open-minded questions (Grennon-Brooks & Brooks, 1993).

Through this constructivist framework, two questions have been addressed appropriate to how girls engage in learning science and interact with other girls.
and boys in a social setting. By observing and examining Margarite over three years and these girls and boys over one school year, I have attempted to come to understand how they value themselves within a learning group and how that is influencing their early development years.

Based upon what I have uncovered utilizing qualitative research and confirmed according to current literature, there seems to be an appreciable impact on the way girls appear to learn science. Rooted in the data, the results mirror the conclusions of previous studies, which indicate girls are generally conscious about their interrelationships with boys, affecting their self-perception and how others perceive them. As a consequence, girls modify their behavior and alter the way they learn science.

Hopefully this research study has answered some of the views relevant to how girls judge themselves as they learn science and will provoke further questions about their behavior during the learning process with other girls and boys in a collaborative learning group.
APPENDIX A

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for Research
Tallahassee, Florida 32306-3112
(904) 644-3600 • FAX (904) 644-6800

APPROVAL MEMORANDUM
from the Human Subjects Committee

Date: July 13, 1996
From: Jack Brigham, Chair
To: Vesta P. Greaves
12402 Southeast 60 Court
Miami, FL 33166

Dept.: Education - Curriculum & Instruction

Sub: Use of Human Subjects in Research
Project entitled Learning Science through Action Laboratories

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on April 8, 1996. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approval which may be required.

If this project has not been completed by July 13, 1996 you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is H1336.

cc: F. Glazer
99/commemo.doc
APPLICATION NO. 99.128
APPENDIX B

REAPPROVAL MEMORANDUM
from the Human Subjects Committee

Date: August 2, 1999

From: David Gorse, Chairperson

To: Yvette Greeneson

13461 Southwest 63 Court
Miami, FL 33183

Dept: Education-Curriculum & Instruction

Re: Reapproval of Use of Human subjects in Research

Project entitled: Learning Science Through Action Experiments

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by July 13, 2000, please request renewed approval.

You are reminded that a change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must report to the Chair promptly, and in writing, any unanticipated problems involving risks to subjects or others.

By copy of this memorandum, the Chairman of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols of such investigations as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

cc: P. Gómez

FINISHED by

APPLICATION NO. 09.283.0.

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APPENDIX C

Florida State University
Office of the Vice President for Research
Tallahassee, Florida 32306-2765
(904) 644-4899 • FAX (904) 644-4902

REAPPROVAL MEMORANDUM
from the Human Subjects Committee

Date: June 12, 2000
From: David Candiago, Chairperson

To: Yvette GreenSPAN
12401 Southeast 58 Court
Miami, FL 33165

Dept: Education-Curriculum & Instruction
Sub: Reapproval of Use of Human subjects in Research
Project entitled: Learning Science Through Action Experiments

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by July 13, 2001, please request renewed approval.

You are reminded that a change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must report to the Chair promptly, and in writing, any unanticipated problems involving risks to subjects or others.

By copy of this memorandum, the Chairman of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols of such investigations as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

cc: P. Gilmer
humanecommittee
APPLICATION NO. 307898

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Dear Parents,

As you know, the children in our classroom learn science in many different ways. One technique I incorporate is cooperative learning groups, which allows the children to share their knowledge. I am collecting this information to help me learn how to help my students learn. This is part of the research that I am doing for a doctorate degree in science education at Florida State University. I may utilize some of the information for my dissertation and for when I make research presentations at professional education meetings.

I would like to videotape the children at work, learning science. I will use short videotape segments of them organizing and planning their science experiments in the classroom, communicating their responsibilities within the group and reaching shared decisions and conclusions. This will be a wonderful learning experience for the children because I plan to show them the videotape so they can see how they learn. I will dispose of the videotape by June 30, 2004.

I would appreciate it if you would give me permission and sign on the line below. Thank you for all your support and continued cooperation. If you have any questions, please feel free to stop by the classroom or call me at 305/665-5483. No penalty if subjects chose to decline and that subjects may withdraw participation at anytime.

Sincerely,

Mrs. Yvette Greenspan
305/665-5483

I give permission for my child to participate in Mrs. Greenspan’s project.

Child's Name

Parent's Name

Date

Parent's Signature

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Dear Children,

I hope that you are learning all about science in our classroom.

I would like to videotape you while you are learning science with your friends. You will be able to see the videotape and see yourself conducting experiments, manipulating objects and sharing what you know. I will throw away the videotape when you are in tenth grade.

If this is alright with you, please sign below. Thank you!

Sincerely,

Mrs. Yvette Greenspan
Your teacher
305/665-5483

__________________________________________
Your name

__________________________________________
Your signature

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APPENDIX F

Questions Required by Human Subjects Committee

Question 1: Give a complete description of your research procedures as they relate to the use of human subjects.

I plan to work with my elementary school students both during the spring and fall '98 semesters. Currently I have 25 third grade students, ages eight and nine years of age, who are participating in various action science experiments in a collaborative learning setting. The school is located in an urban community, with a population of 55.5 percent Hispanic, 28.6 percent Anglo-American, 14.3 percent African-Americans and 1.5 "Other" in a lower to middle class neighborhood. There are 545 students attending the school. Within my own classroom environment of 25 students, there are five gifted students (with four attending the in-house Gifted Program while the other attends a nearby Resource Gifted Center twice weekly), one ESOL (English for Speakers of Other Languages) student, and one ESE (Exceptional Student Education) student. There are 12 females and 13 males, with six White, 14 Hispanic, three African-American and two Asian students. Parental involvement is highly encouraged, and it is not unusual to find a parent visiting the classroom. Additionally, during the course of the year college students who are assigned by their universities observe the teacher's methodology and classroom management.

The desks are arranged into groups of four to five students in order for them to be accessible to each other to share their understandings and learning. The learning activity determines the size of the group and its configuration.

Question 2: Have the risks involved been minimized and are they reasonable in relation to anticipated benefits of research to the subjects and the importance of the knowledge that may reasonable be expected to result? What provisions have been made to insure that appropriate facilities and professional attention necessary for health and safety of subjects?

The students have been told of the purpose of the project, and they also know that they will be able to view the videotape sometime before the school year ends. The videotaping will take place within the classroom during school hours.
Question 3: Describe procedures to be used to obtain informed consent.

As the third grade teacher, I have written a letter (see attached) to the parents for permission for informed consent for their child to be videotaped in my classroom. My principal and assistant principal approved the letter and allowed me to distribute it to the parents via their children. It was sent out to the parents to be signed and returned as soon as possible.

Question 4: Describe how potential subjects for the research project will be recruited?

There will be no other subjects of research for the project. Only the children enrolled in my class for each semester will be the subjects of this research. If a new student enters between now and the end of that semester, a permission letter will be sent to the parent.

Question 5: Will confidentiality of all subjects be maintained?

I will maintain the confidentiality of the names of the research subjects at all times. During any oral research presentations, I will not use the names of any of the children nor will I refer to their personal histories. During the research period during spring '98, I plan to present the video as part of my NARST '98 conference presentation and possibly at some other conferences on teaching and learning. The videotapes will be stored in my locked office for a period of two years.

Question 6: Is the research area controversial and is there a possibility your project will generate public concern?

The research is not controversial, and I do not expect this project will generate any public concern. On the contrary, it will be an excellent learning experience for the children to view themselves working together to solve problems and reach solutions consensually.

Question 7: Describe the procedure to be used for subject debriefing at the end of the project. If you do not intend to provide debriefing, explain.

Students will preview the video at the end of the project and will discuss what they observe concerning how they learned.
# APPENDIX G

## What Do You Think? (Third Grade Pilot Study)

Select the number that tells your opinion.

<table>
<thead>
<tr>
<th></th>
<th>A Lot</th>
<th>Very Much</th>
<th>Much</th>
<th>Little</th>
<th>Very Little</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like learning science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I like to do experiments with my team.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I like to learn about Primates.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Learning about patterns was challenging.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Studying cells was easy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Science is my favorite subject.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>My family likes me to tell them what I have learned in science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
APPENDIX H

Name_________________________  Date__________________

What's Your Opinion? (Fifth Grade Pilot Study)

CIRCLE YOUR OPINION  or  WRITE YOUR OPINION.

1. Do you like working in learning groups?
   Yes          No          Maybe

2. Do you like working with girls or boys in learning groups?
   Girls        Boys        Neither

3. How do you like to learn science?

4. What science have you learned in fifth grade so far?

5. How do you learn science best?

6. Is there anything I can do to help you learn science better?

7. Do you like having a special job in your learning group? What is it?
   Yes          No          Does not matter

8. What special job do you like the best in your learning group?

9. Do you ever have any conflicts in your group? What are they?

10. Do you like learning about primates and patterns? Why?
    Yes          No          Does Not Matter

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APPENDIX I

Name ___________________________ Date ______________

What's Your Opinion? (Fifth Grade)

CIRCLE YOUR OPINION or WRITE YOUR OPINION.

1. Do you like working in learning groups?
   Yes       No       Maybe

2. Do you like working with girls or boys in learning groups?
   Girls     Boys     Neither

3. How do you like to learn science? By yourself, with a partner or in a group?

4. What ideas did you learn about plant and animal cells? In the forces of motion? In electricity? In magnetism?

5. How do you learn science best?

6. Is there anything I can do to help you learn science better?

7. Do you like having a special job in your learning group?
   Yes       No       Does not matter

8. What special job do you like best in your learning group? Why do you like that job the best?

9. Do you ever have any conflicts in your group? If so, what are they? How do you resolve your differences?

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APPENDIX J

Summary of Strands and Standards for Science

A. The Nature of Matter
   1. The student understands that all matter has observable, measurable properties.
   2. The student understands the basic principles of atomic theory.

B. Energy
   1. The student recognizes that energy may be changed in form with varying efficiency.
   2. The student understands the interaction of matter and energy.

C. Force and Motion
   1. The student understands that types of motion may be described, measured, and predicted.
   2. The student understands that the types of force that act on an object and the effect of that force can be described, measured and predicted.

D. Process that Shape the Earth
   1. The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth.
   2. The student understands the need for protection of the natural systems on Earth.

E. Earth and Space
   1. The student understands the interaction and organization in the Solar System and the Universe and how this affects life on Earth.
   2. The student recognizes the vastness of the Universe and the Earth's place in it.

F. Processes of Life
   1. The student describes patterns of structure and function in living things.
   2. The student understands the process and importance of genetic diversity.

G. How Living Things Interact with Their Environment
   1. The student understands the competitive, interdependent, cyclic nature of living things in the environment.
2. The student understands the consequences of using limited natural resources.

H. The Nature of Science
1. The student uses the scientific processes and habits of mind to solve problems.
2. The student understands that most natural events occur in comprehensible, consistent patterns.
3. The student understands that science, technology, and society are interwoven and interdependent.
REFERENCES


Kaye, S. (1998, September). Effective communication skills for engineers. IIE Solutions, 30, 44.


Science "coeducation": Viewpoints from gender, race and ethnic perspectives (pp. 37-49). NARST Monograph (Whole No. 7).


Richardson, G., & Livingston, B. (1999). *Confronting the gender gap in science and mathematics: The sisters in science program.* Presented at the annual meeting of the National Association for Research in Science Teaching, Boston, MA.


Fraser (Eds.), *Windows into science classrooms: Problems associated with higher-level cognitive learning* (pp. 1-13). London: The Falmer Press.


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BIOGRAPHICAL SKETCH

EDUCATION
Ph.D. Candidate, Science Education, Florida State University  Present
Master of Science, Bilingual Education, University of Miami 1983
Bachelor of Arts, Elementary Education, Roosevelt University 1966

AWARDS, FELLOWSHIPS, GRANTS
Aerospace Education Foundation Educator Grant 1997
Technology Grant ($90,000) 1995
National Science Foundation (USI) 1994-Present
Eisenhower Title II Grant, Science Multimedia Specialist 1994
Dade Public Trust Foundation 1993

POSITIONS HELD
Educational Specialist, Miami-Dade County Public Schools, Division of USI Mathematics and Science, Present
Provide support for teachers in mathematics and science to enhance instructional methodologies as teachers assess the status of their professional development.
Miami-Dade County Public School Florida Certified Teacher, 1983-Present
David Fairchild Elementary School: Bilingual teacher for 8 years, third grade teacher for 7 years, fifth grade teacher for two years.
Science Chairperson, 1988-2000
Initiated and organized annual Science Fair involving parents and community in developing a successful Fair with participation of over 94% of the student population. Developed a series of experiments to demonstrate on the in-house television news station, incorporating ongoing weather newscaster daily telexcasts. Established and implemented four Science Parent Evenings each school year.
Urban Systemic Initiative Teacher Consultant, 1994-1999
Miami-Dade Country Public Schools, Division of Mathematics and Science
Ambassador to schools with responsibility for improving the teaching of mathematics and science elementary schools; i.e., presenting inservice to teachers, modeling lessons, providing background research and general support in these disciplines, reaching out to community in cooperation with Public Libraries and shopping malls.
Science Multimedia Specialist, 1994
Recipient of Eisenhower Title II Grant through Miami-Dade Community College. Authored science module for the Macintosh computer that is included on a videodisc and CD-ROM for distribution to Miami-Dade County Schools.
Science Curriculum Author, 1993
Developed science curriculum for Summer Intersession.
Project Phoenix, 1993
Presented a model weather station to Miami-Dade County Public School teachers and administrators.  
**Computer Based Science Laboratory, 1990**
Developed curriculum for a hands-on, minds-on approach to teach science, utilizing the computer as a tool for learning.

**Bilingual Science Laboratory, 1987**
Developed the curriculum for bilingual science laboratory schoolwide for two years.

**Author, School Based Management Shared Decision Making, 1985**
Recipient of grant to incorporate a weather station into the school and relay data information through an in-house television station, WKID.

**Science Workshop Coordinator, 1988-1991**
Organized inservice training for teachers with District Science Coordinators and consultants.

Wrote proposal for David Fairchild, organized yearly schedule, agenda, and annual evaluations.

**Miami-Dade County, Florida Teacher, 1981-Present**
Peace Corps Volunteer, Tacna, Peru, 1967-1969
Taught professional development courses to teachers in Primary and Secondary Schools.

**Teacher, Chicago Public Schools, K-3, Library Specialist, 1965-1967**

**PUBLICATIONS**
"Teachers Doing Science+Teaching Science=Meaningful Science," SERVE, February 1999

**CONFERENCE PRESENTATIONS**
NSTA, Orlando, Florida, April 2000
"Learning Science with Action Experiments, As Seen Through the Eyes of a Teacher," NARST, San Diego, California, April, 1998

**PROFESSIONAL ORGANIZATIONS**
Member and former Financial Secretary of American Association of University Women
Member of MADD, Audubon Society, Alumni Association-University of Miami and Roosevelt
First Vice President and Co-Editor of Newsletter, Dade County Science Teachers' Association
Member and Secretary of Educational Excellence School Advisory Council
Honor Society: Phi Kappa Phi, Pi Lambda Theta

**LANGUAGES**
Fluent in Spanish, some French
Traveled throughout USA, Europe, Central and South America, Middle East and Far East, Southeast Asia. Lived in England, Peru, and Colombia.

**INTERESTS/ACTIVITIES**
University of Miami Clinical Teacher, Community Service, Traveling, Reading, Bicycling, Aerobics

**HONORS**
Presenter at Principal's Conference (USI) 1998
Teacher of First Place Winner, Miami-Dade County Science Fair 1994, 1995, 1997
Science Teacher of the Year/ Miami-Dade County nominee 1995
Computer Teacher of the Year Nominee 1995
COMPUTER SKILLS
Windows 95, 98, 2000; WordPerfect; dBase; Dos; Microsoft Works; Microsoft Office; PowerPoint; Publisher; Internet; ACT; Macintosh Course Builder; ClarisWorks for Macintosh. Proficient in accounting software: Quickbooks, Quicken, Pacifi